

# Vital Link

The journal of the Canadian Association of Naturopathic Doctors

## Feature Articles

- 🔥 *Vis Medicatrix Naturae* in the Modern Landscape: Time for a Change in Naturopathic Education and Practice?
- 🔥 Modernization, Microbial Ecology and the Loss of Diversity
- 🔥 Nature Rx: Health Benefits of Spending Time in Nature
- 🔥 Urban energy: The Effects of Sound and Light Exposure On Sleep and Overall Health
- 🔥 Health Consequences of Living Near Wind Turbines and Solar Panels
- 🔥 What are the Health Effects of Living Near Mobile Phone Base Stations?
- 🔥 High-Rise Living: Impacts of Living on Higher Floors

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Volume 22, Issue 3  
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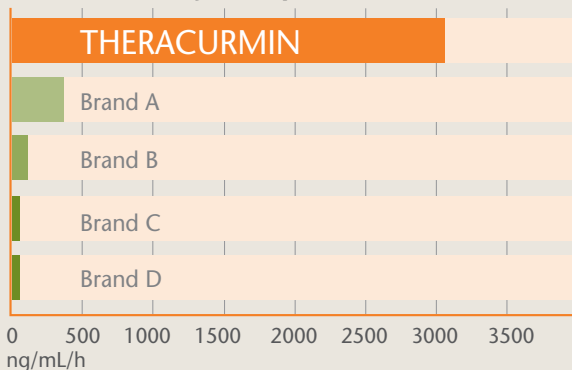
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Volume 22, Issue 3, Fall/Winter 2015

Healthy Environments: Where we live and play

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The *Vital Link* is the professional journal of the Canadian Association of Naturopathic Doctors (CAND). It is published primarily for CAND members and features detailed reviews of specific causal factors: philosophical and research-based papers, clinical practice articles and case reviews, as well as international updates on the profession. The *Vital Link* has an outreach to other health care professions and promotes qualified naturopathic doctors to corporations, insurance companies and the Canadian government.

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**Spring 2016** Naturopathic Primary Care

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# Naturopathic Notes

Dr. Iva Lloyd, BScH, BCPP, ND

In this edition of the *Vital Link* we explore the link between where one lives and the status of one's health. Often the notion that *where you live affects your health* is linked to floods and known exposure to environment toxins. The articles featured here expand that awareness and provide a comprehensive review of the links between geography, the built environment, and health status.

Dr. Alan Logan provides the editorial for this topic. In his article, entitled, *Vis Medicatrix Naturae in the Modern Landscape: Time for a Change in Naturopathic Education and Practice?* he looks at how nature affects behaviour and the healing potential of nature. Dr. Logan has spent much of his naturopathic career exploring the link between nature and health and he is a prolific researcher, author and speaker. His editorial piece is a strong reminder of the roots of naturopathic medicine.

Naturopathic doctors Tracey Beaulne and Kim Bretz look cleverly at the hygiene hypothesis in their article, entitled, *Modernization, Microbial Ecology and the Loss of Diversity*. Their article highlights and explores the reality that "research on the human microbiomes continues to inform us that humans live in symbiosis with a vast and diverse microbial population and raises questions such as what microbial exposures do we need at each stage of life and how do these exposures affect our health for the better or worse?" Tracey and Kim raise a number of questions around the health impact of living in an environment made of bricks and mortar versus living in nature. They remind us that we are part of nature and that we need nature to survive.

The idea of spending time in nature as part of a treatment plan is explored by naturopathic doctors Cyndi Gilbert and Katie Smith in their article, *Nature Rx: Health benefits of spending time in nature*. Cyndi and Katie remind us that using nature as part of the healing process was the root of naturopathic medicine. The authors go on to provide the research behind this thinking, including the positive impact nature has on stress, immunity, mood and overall health; they also explore the topic of pregnancy and nature and the impact of spending time in nature as it relates to mortality and life expectancy. Nature is a valuable treatment tool, the article reminds us.

The following articles delve into more specifics about where a person lives. Naturopathic doctors Melissa Lee and Katie Rothwell explore the impact of sound and light on sleep and health; in their article, *Urban energy: The effects of sound and light exposure on sleep and overall health*, the authors explore the idea of sound and light as pollution and the impact of light on the body's circadian rhythm. Melissa and Katie provide research supporting the link between circadian disruption and increased cancer risks, changes in metabolism and increased rates of obesity. Noise pollution, on the other hand has been associated with disrupted sleep, increased risk of cardiovascular events and other health issues.

Dr. Shannon Morgenstern in her article, *Health consequences of living near wind turbines and solar panels*, considers the growing body of research indicating a link between living near wind turbines and solar panels and experiencing sleep disturbances, tiredness, headaches and increased stress levels. The author also explores the numerous challenges of acquiring strong, convincing research in this field.

Another area of concern is the potential effects on health of living in a high-rise building. Naturopathic doctor Mark Fontes's article, *High-Rise Living: Impacts of Living on Higher Floors* looks at the growing body of research exploring the link between how high you live and what diseases you are most likely to incur. Some research indicates that living above the fourth floor actually decreases your overall risk of mortality, especially as it related to respiratory and cardiovascular risk. Those living on lower floors may have increased exposure to environmental toxins; however, those living on higher floors may have increased exposure to electromagnetic radiation. Mark provides a valuable review of the current research in this new area of science.

Dr. Michael Mason-Wood, ND asks us to question the impact of living near cell-phone towers. Michael draws on the naturopathic principle of disease prevention and asks the reader to question the safety and health impact of the cell-phone towers, appliances and devices that emit electromagnetic energy; especially as these devices have been allowed to become such as prominent and ubiquitous aspect of our environment without sufficient long-term studies to prove their safety. Dr. Mason-Wood's article balances the world of research and inquisition. It reminds naturopathic doctors of our duties to be forward-thinking and recognize not only proven risk, but also potential risk.

We hope this issue provides you with the tools to integrate with your practice considerations about your patients' built and natural environments.

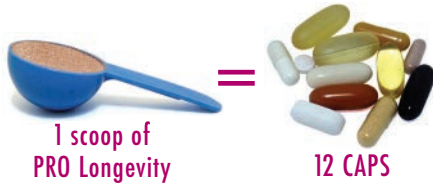
## Some interesting, recent publications about health and our natural and built environments:

*Green City: Why Nature Matters to Health – Staff report*  
Medical Officer of Health, City of Toronto (September 2015)  
<http://www.toronto.ca/legdocs/mmis/2015/hl/bgrd/backgroundfile-83420.pdf>

*Green City: Why Nature Matters to Health – An Evidence Review*  
Toronto Public Health (September 2015)  
<http://www.toronto.ca/legdocs/mmis/2015/hl/bgrd/backgroundfile-83421.pdf>

*The impact of green space on heat and air pollution in urban communities – A meta-narrative systematic review*  
David Suzuki Foundation (March 2015)  
<http://www.davidsuzuki.org/publications/reports/2015/the-impact-of-green-space-on-heat-and-air-pollution-in-urban-communities/>

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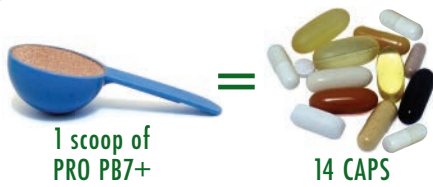


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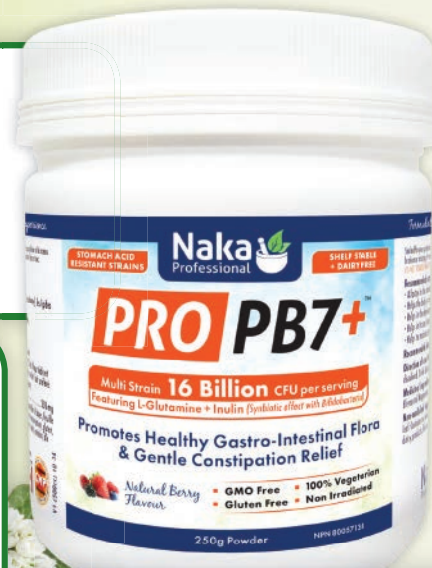
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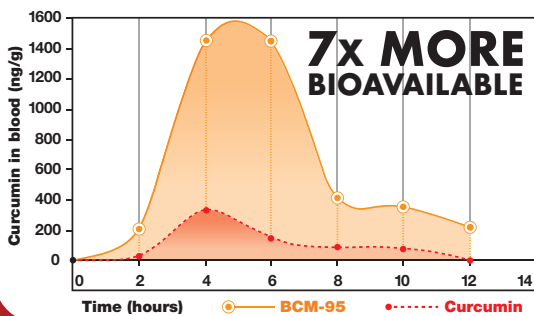
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# Vis Medicatrix Naturae in the Modern Landscape: Time for a Change in Naturopathic Education and Practice?

Dr. Alan C. Logan, ND



Just a shade over one century ago, famed biologist Sir John Arthur Thompson delivered the keynote address at the annual meeting of the British Medical Association. The title of Thompson's much-anticipated talk was *vis medicatrix naturae*.<sup>1</sup>

As he opened his talk, he acknowledged that there are many ways to interpret this ancient Hippocratic phrase, including the most common explanations wherein it refers to the innate healing abilities within organisms, and the healing virtues that can be derived from natural substances. Thompson, however, had a very specific interpretation:

*“What, then, do I mean tonight by the healing power of nature? I mean to refer to the way in which Nature ministers to our minds, all more or less diseased by the rush and racket of civilization, and helps to steady and enrich our lives.”*

Over the course of his lecture in July 1914, Thompson methodically presented his argument that modernization and the conditions associated with urbanization were eroding an evolutionary-rooted layer of resiliency that otherwise protects against psychological distress and chronic disease. In his view, the “*very potent vis medicatrix naturae*” afforded by acquaintance with all aspects of nature - from stars in the sky, to the sounds of the ocean - was being weakened by lack of opportunity. Diminished access to *experience* nature. Therefore, the health problems associated with crowded, noisy, built environments and other factors of urbanization were being compounded by the loss of mindful contact with biotic and abiotic aspects of natural environments.

## Allostatic Load, Postal Codes and Health

Today, Thompson's keynote address is arguably more relevant than ever. It is now abundantly clear that residential environments within North American Postal/Zip Codes can be a major determinant of health outcomes. Many non-communicable diseases (NCDs), including mental disorders, are not distributed randomly in the population. There is a well-defined socioeconomic gradient wherein the highest burden of NCD is carried by the most disadvantaged groups.<sup>2</sup> Obviously there are many factors that might help explain the non-random distribution of disease and health inequalities,

otherwise known as the health gap. Collective exposure to social, physical (e.g. pollution), and psychological stressors can manifest in physiological wear and tear known as allostatic load (AL).<sup>2</sup>

As NDs know well, AL theory allows for an understanding of the ways in which chronic stress can lead to disease. Environmental pressures set in motion a series of compensatory physiological responses - neuroendocrine, cardiovascular, immune and others - that over time can compromise the structure and function of bodily systems. Healthy lifestyle habits are associated with lower AL, while on the other hand, AL itself can compromise mood. Perhaps not surprisingly, markers of AL such as low-grade inflammation and oxidative stress are documented to be higher in neighborhoods with high levels of socioeconomic deprivation.<sup>2</sup>

There is little doubt that in certain neighborhoods, the odds are stacked against the adoption of healthy lifestyle habits. Many of these areas are primary zones of grey space - i.e. top-heavy with industrial and commercial activity, major transportation routes, bars, liquor stores, convenience stores, fast-food and tobacco outlets. These features, along with visual marketing - e.g. billboards, sidewalk signage, targeted screen media delivery - further encourages the maintenance of unhealthy lifestyle choices such as fast-food consumption and tobacco use.<sup>2</sup>

Environment shapes behaviour. Consider that in urban environments, as much as 31% of the variance in excessive fast-food consumption may be due to residential density of fast-food outlets in urban settings.<sup>3</sup> Residential proximity to billboard advertising of snacks and sweet drinks is associated with decreased daily fruit or vegetable consumption.<sup>4</sup> We shouldn't be surprised, therefore, that brand name logo recognition of major fast food outlets is significantly higher in children from disadvantaged neighbourhoods.<sup>5</sup>

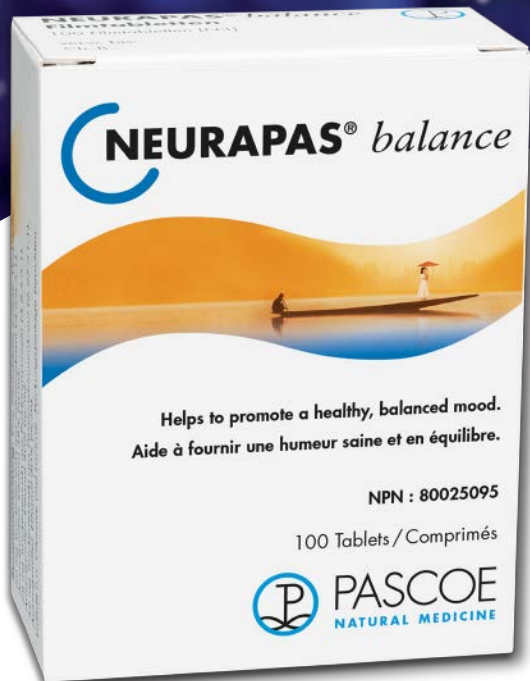
Although it is difficult to paint every North American metro region with the same brush, socioeconomic disadvantage often translates into higher exposure to environmental toxins and noise. The living environment is often much more crowded and the disadvantaged are more likely to contend with physical stressors such as extremes of heat and cold<sup>2</sup>. Blood levels of carotenoids and other markers of healthy dietary patterns are often lower.<sup>6,7</sup>

## Natural Environments

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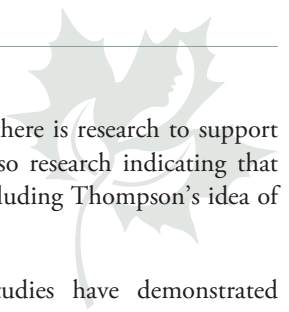
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within various scales of ‘neighborhood’ is not only related to perceptions of health, it is connected to many non-communicable disease (NCD) risks. These include cardiovascular disease, cancer, Type II diabetes and mental disorders. These associations have been reviewed in detail elsewhere.<sup>8,9</sup> However, the ability of natural environments to narrow the health gap is worth highlighting. In this sense, natural environments are considered ‘equigenic’ environments.

A landmark study by Richard Mitchell and colleagues examined land-use data in all major cities in the United Kingdom; they found that low income and low residential-area green space was associated with cardiovascular mortality rates twice that of high socioeconomic areas. However, when examining the combination of low income and high levels of residential-area urban green space, the gaps in mortality rates became narrowed.<sup>10</sup> Recently, Mitchell and colleagues reported that the usual socioeconomic inequality gap in mental well-being in 34 European cities was 40% smaller (narrower) when respondents reported good access to green/recreational areas. The author did not mince words:

**“If societies cannot, or will not, narrow socioeconomic inequality, research should explore the so-called equigenic environments - those that can disrupt the usual conversion of socioeconomic inequality to health inequality. This large, international, observational study suggests that access to recreational/green areas may offer such a disruption.”<sup>11</sup>**

Prenatal and early-life stress can induce epigenetic changes that may influence lifetime risk of NCDs.<sup>12,13</sup> In that context, remarkable connections between higher levels of residential greenness and healthy term pregnancies have been noted. For example, a recent examination of birth outcomes in Vancouver (even after controlling for air pollution, noise, walkability, and distance to the nearest park) showed that greenness within 100 meters of the home is associated with healthy term birth weight and reduced likelihood of preterm births.<sup>14</sup> The implications of these findings are obvious.

It is also worth noting that green and grey spaces may overlap in the ways in which they might influence lifestyle behaviors for better or worse. Living closer to urban green space and greater park access is associated with healthier dietary habits (e.g. more fruits, vegetables, nuts/beans, and less fast-food, processed grains, sodium-rich food and sugar-rich beverages) and lower insulin resistance. On the other hand, in socioeconomically disadvantaged neighborhoods, lower levels of open space for physical activity have been linked with greater density of fast-food outlets.<sup>15-18</sup> Again, grey space isn’t increasing the odds of adopting healthy lifestyle habits.

## Psychological Mechanisms

Large scale epidemiological studies have certainly helped support the argument that green and/or blue space around one’s residence is an important public health consideration. Obviously, it is important to understand how and why certain environments might be conducive to the promotion of health. It is easy to explain the value of natural environments via increased opportunity for physical

activity and social interaction. Indeed, there is research to support this contention.<sup>8,9</sup> However, there is also research indicating that some other factors might be at play, including Thompson’s idea of reduction of psychological stress.

A variety of laboratory and field studies have demonstrated that viewing scenes of natural environments, or walking within natural environments (vs. viewing images of, or spending time in urban built environments), can improve mental outlook and cognitive functioning.<sup>8,9</sup> Often, these findings are explained by the complementary psycho-evolutionary stress recovery theory (SRT) and the attention restoration theory (ART). SRT argues (as Thompson did) that several million years of evolutionary experiences within natural environments have primed us to be better adapted to such settings. Spending time in nature fosters positive emotions, which of course would diminish the burden on stress physiology.

ART proposes that natural environments are cognitively restorative because they are inherently *fascinating*. Natural settings support automatic engagement of attention (involuntary attention) in ways completely divergent from the purposeful attention required in modern urban streets or work environments. Activities in the latter environments place a heavy tax on the executive system.

## Physiological Mechanisms

The differences between urban built and natural environments are far more than visual; researchers are turning their attention to what might be in the air within natural environments, including chemicals released by trees. Natural environments place one in contact with a host of plant-derived airborne chemicals; known as phytoncides, these chemicals have been an area of interest in Japanese natural environments research for many years. For the last 25 years, the study of *shinrin-yoku* — translated from Japanese as forest-air bathing — involves an understanding of the physiological effects of the “*components emitted from the forest*”.<sup>19</sup>

In addition to phytoncides, the air within natural environments presents with relatively higher concentrations of negative air ions and non-pathogenic microbes. In particular, experience with non-harmful microbes may be a critical pathway to help explain some of the long-term benefits of natural environments, especially in early life. Full discussion of how non-harmful microbes in the external environment may promote health is beyond the scope of this Editorial; the reader is referred to an expert, open access review by noted microbiologist Dr. Graham Rook.<sup>20</sup>

## Nature Relatedness

Canadian psychologist Elizabeth Nisbet is a leader in the field of nature and health. She and her colleagues have developed an easy-to-use scale to determine the extent to which an individual might be connected to nature.<sup>21,22</sup> Known as the Nature Relatedness (NR) scale, higher NR (and other similar measurements of nature connectivity, nature connectedness) scores have been connected to mental well-being, vitality and life satisfaction.<sup>23</sup> The NR



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scale captures the degree to which someone has an awareness and understanding of the natural world — fascination with, interest in, and desire for nature contact. The NR-6 is a simple 6 question scale that has been validated in recent research.

There are numerous ways in which the NR and NR-6 scales could be used by naturopathic clinicians and researchers. Some evidence suggests that NR can be cultivated, and since it is so highly associated with health, that could be an important consideration. Does baseline NR (or changes in NR) correlate with or influence clinical outcomes? It would also be interesting to know if individuals drawn to the naturopathic profession score higher in NR, or if NR scores change over time through the 4-year naturopathic program.

## Naturopathic Education and the Oath

Thus far in this editorial I have remained mostly detached from the research-based discussions on built and natural environments. Please allow me to shift gears a bit, first by acknowledging the Canadian Association of Naturopathic Doctors for deciding to take on the topic of healthy environments in these pages, and second for allowing me the privilege of making a contribution. The CAND has opened the door to subject matter that transcends health geography *per se*. These are discussions that are, or should be, at the core of naturopathic medicine; they are discussions of biodiversity, climate change and the health of the planet itself.

There is a highly complex, yet evidence-based body of research that has been served up by disciplines ranging from anthropology and ecology, to landscape design and therapeutic horticulture. Although this research sits well within the domain of naturopathic medicine, it remains largely untouched within the four-year academic programs. In the era of environmental degradation, biodiversity loss, urbanization and anthropogenic climate change,<sup>24</sup> we should all find that to be unacceptable.

I would argue that we — the profession — should be cultivating leaders in this field, clinical awareness, and a confidence within graduating ND students such that they have a full grasp of how important natural environments are (to self, patient health, community, and pressing global issues). Sadly, it is often assumed that NDs already know this information, and that it is too simple. It's time to wake up out of that slumber of academic naivety and disconnect. Environmental determinants of health are far from simplistic — yet they are crucial discussions when considering that sustaining human health is ultimately dependent upon biodiversity and environmental sustainability.

Science drives policy and practice, and without such critical research, perhaps that planned urban park will be a parking lot instead. Patients, too, want guidance. Exercise in nature you say. How much, for how long, where, does time of day matter? Are certain natural environments more conducive to health promotion? Are there some design aspects within parks that could actually compromise the expected stress reduction? Does nature relatedness matter to the prescriptions? Research suggests that it all matters.<sup>25,26</sup> This, of course, does not preclude generalized advice and engagement with

incredibly important public health projects such as the David Suzuki Foundation's annual 30x30 Campaign to get Canadians outdoors.

Still, from a professional perspective we need a paradigm shift. Conventional medical programs are not sitting back assuming that students already understand the urgency and clinical relevancy of these connected topics. They are already ratcheting up their efforts to educate the “physician of the future” — i.e. a medical doctor fully informed on the issues of biodiversity loss, urbanization, climate change and other issues of environmental degradation, and how these impact health.<sup>24,27</sup> In April, 2015, the United States White House Press Secretary announced that the Administration is gathering the top academic leaders in medicine to “ensure that the next generation of health professionals is trained to address the health impacts of climate change”. In a recent commentary in the *Canadian Family Physician*, it was stated:

***“Some physicians shy away from engaging with wider social issues, focusing instead on the individual patient. However, when it comes to action on climate change, such a position becomes untenable given that many of the measures that could mitigate harmful environmental effects would also be of direct benefit to individual health.”***<sup>28</sup>

The naturopathic profession needs to gather its collective, *educated* voice. The time is now for an environmental naturopathy course, one that can easily be blended into the early academic calendar within the theories and philosophy of naturopathic medicine, and again in clinical relevancy during the latter parts of the program. A required course *must* be built into each of the programs accredited by the Council of Naturopathic Medical Education. Lack of awareness concerning the seriousness of this topic will place the profession far behind in the very category in which it could excel!

We also need to ensure profession-wide accountability on this topic through questions that appear on NPLEX clinical examinations within the current domains of health psychology and research. Given the existing wealth of research on the environmental determinants of health, it seems strange that there is so little in the way of academic instruction and examination accountability. Graduating NDs need to understand both the environmental toxins that they read and hears so much about, and the other environmental variables, those that work *for* the promotion of health.

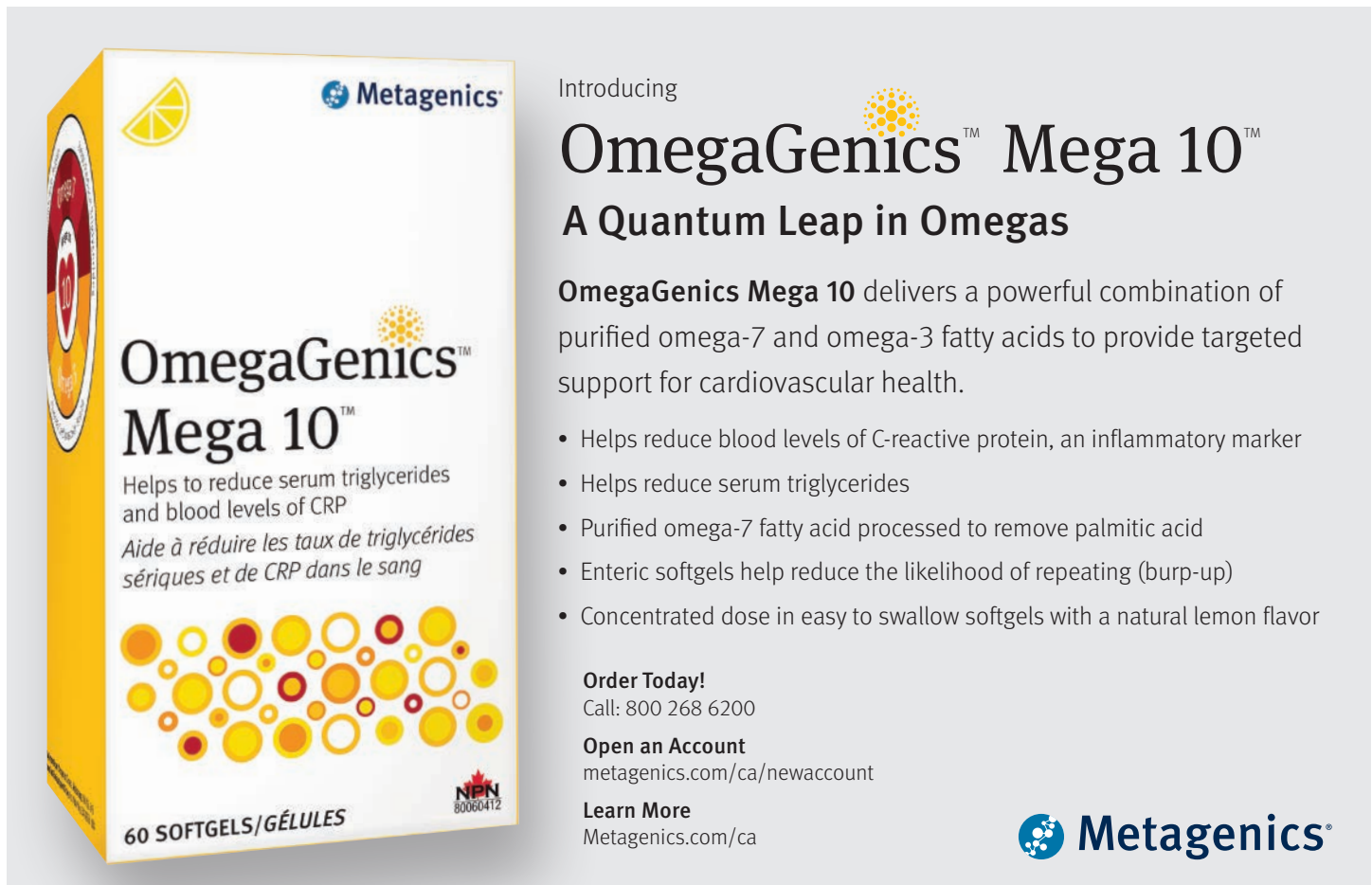
In closing, it might be worthwhile to recall the Naturopathic Oath, with its dedication to “*Act in Cooperation with the Healing Power of Nature*”. I'd like to think that oath involves a commitment to *Vis Medicatrix Naturae* as Thompson viewed it; however, the only way to ensure that graduating NDs understand the full scope of the oath is to provide proper academic preparedness. The naturopathic profession cannot stand idly by, resting on its self-perceived academic and professional laurels — personal, public and planetary health is on the line. In this issue of *Vital Link*, the CAND has opened the door to a new direction (or an old one, depending on the view) in the education and professional practice of naturopathic medicine. 🍁

## About the Author

**Alan C. Logan, ND** is a graduate of CCNM. For the last decade he has presented research on natural environments within courses offered at Harvard's School of Continuing Medical Education. He contributed to Harvard School of Public Health's recent Natural Environments Initiative position statement, and is a co-author within the upcoming Oxford Textbook of Nature and Public Health (Oxford University Press).

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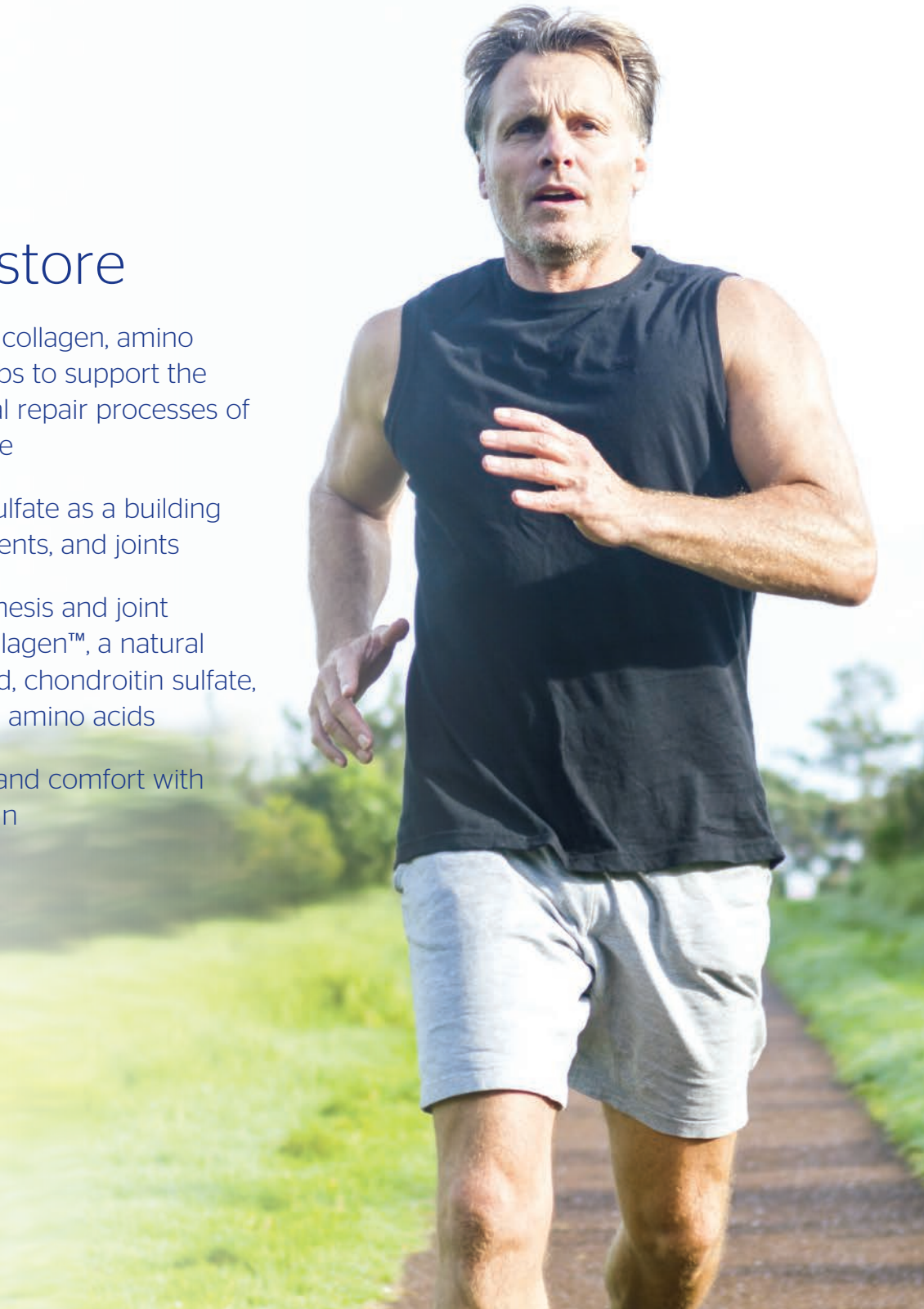




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# Modernization, Microbial Ecology and the Loss of Diversity

Dr. Tracey M. Beaulne, ND and Dr. Kim Bretz, ND

Is variety the spice of life? It can help give us our *joie de vivre* and remarkably this may now include a discussion of microbes. Evidence supports the notion that human health and well-being is dependent upon biodiversity at every stage of life, starting as early as the perinatal period.<sup>1</sup> Moreover, as we argue here in this review, exposure to a variety of different microbes — not simply those in our foods, but also from our environment at large — may be an essential part of biodiversity discussions. Science hasn't yet informed us exactly what that microbial biodiversity should look like, although as we describe below, there are some tantalizing clues.

Scientists are finally starting to ask questions that perhaps should have considered when environmentalist Rachel Carson wrote her very thought provoking book *Silent Spring* over five decades ago.<sup>2</sup> Her book was the catalyst to the consideration of our human impact on the environment. She asked a fundamental question: how might our treatment of the environment affect our health, and our species? Fast-forward to 2015 and unseen aspects of biodiversity are finally getting the attention they have long deserved. Now, there is an expanded question: “is the westernized world losing crucial components of the gut microbiome irreversibly?”<sup>3</sup> Or the microbiome of the skin, eyes, lungs, mouth and so forth?

Research on the human microbiome continues to inform us that humans live in symbiosis with a vast and diverse microbial population and raises questions, such as: what microbial exposures do we need at each stage of life and how do these exposures affect our health for the better or worse? We can ask myriad related questions. These are the questions of our time.

Will a child who is born by Caesarian section, given antibiotics within hours of their first breath and bottle fed ever catch up on the diversity of microbes that they need? What about the twenty-year-old who develops chronic viral infections but nonetheless is still

prescribed countless antibiotics and continues to live in a concrete urban environment, never going back to explore the richness of the parks, nature and microbial diversity they may have once known as a child? What about the elderly person who develops life threatening bacterial pneumonia, is given life saving antibiotics but then continues to live in the small world of their nursing home with only small exposure to the outside world for fear of their fragility? What is our measuring stick for the loss of microbes, and what exposures do they need to gain back their full richness of diversity?

To date there is very little in the research to quantify and answer these questions. International researchers raise some very interesting points with respect to an important role that nature may play in the regulation of health and disease: they state there are several important aspects of nature dose, including the quality and quantity of nature (i.e., the intensity), and the frequency and the duration of exposure. It may seem laughable to consider “doses” of nature, yet it is critically important that the human and nature interface be further studied and understood.<sup>4</sup> Whether we may like it or not, when policymakers and planners make critical decisions concerning land use for communities, they need evidence to sway them.

These points emphasize the need to take a more mechanistic approach to developing measurements of exposure to nature and therefore, potentially improve our objective understanding of how it might be manipulated to deliver better health outcomes.<sup>5</sup> From a more practical standpoint, being able to measure the microbiome with a gold standard agreed-upon measurement and then direct patients to what source of nature including quality, quantity, frequency and duration also makes sense.<sup>1</sup> What are the microbial phyla, taxa and strains — and their genetic changes — that promote health?

With the rise of non-communicable diseases (NCDs) including allergies, auto-immune disorders, asthma, obesity and depression, a connection to the environment now seems self-evident.<sup>6,7</sup> But what was not considered way back when environmental groups were forming is that we as humans are also an ecosystem that can be affected by the environment just as easily as the birds and the bees. And science is now just starting to even consider this reality.

We have to ask ourselves — do we have the right mix of a microbial diversity living in, on and around us for our health and well-being? What more do we need to learn about these microbes to help us understand their place in an NCD epidemic? As health-care professionals how are we explaining to our patients that macro-

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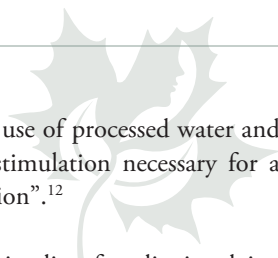


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ecosystems affect our own micro-ecosystems? Are we contributing to the germ warfare mentality that may have gotten us in this mess in the first place? There are more unknowns than knowns in the use of natural antimicrobials and probiotics over the long term. What role is our single- or multi-dose probiotics playing in fixing our loss of diversity in our eco-systems? Are we even thinking about microbes, the richness of microbes in which we live, what is on our skin and in our guts and how many of our current home and working environments may not be providing what we need to sustain ourselves as a species.<sup>8</sup>

Human beings, it would seem, need biodiversity in their microbial world just as much as they need food, shelter and water. Consider that the planet is currently under duress due to climate change, loss of biodiversity and environmental degradation. These are critical issues to be considered in the context of the discussion of the built environment. Undoubtedly, there are multiple benefits to living in an urban environment but what are the trade-offs?

### **Microbiota: Concrete Environments Vs. Natural Environments**

In 1851, 13% of Canadians lived in urban environments versus 87% living in rural environments. In 2011, over 80% of our population lived in urban environments.<sup>9</sup> When we consider this on a global scale, the rate of urbanization is so significant it is projected that 9-billion people could be disconnected from nature. Recently, many of the theories around why nature is good and why this disconnect is concerning have been focused on the psychosocial aspects of nature. But our green space is not just about the perfect view and how this makes us feel; it is much more complex.<sup>1</sup> It is about entire external ecosystems, including the microbes we breathe, touch and consume—and how this in turn affects our own ecosystem. On top of this, and beyond the scope of our discussion, consider climate change, industrial farming and the associated loss of species. How are these factors affecting the microbes of modernity? This significant change to the way we live our lives is also highlighted by the amount of time we spend indoors. Canadians are spending an increasing amount of time within man-made structures, with new research indicating that close to 90% of our activity patterns occur indoors.<sup>10</sup>

Our built environment with our bricks and mortar, HVAC systems, air filters, synthetic chemicals is divergent from the ecosystems we lived in during the past. What are we missing out on in our built environments? This switch to an urbanized society has vast consequences, one of the most significant being a massive loss of microbial biodiversity. Our loss of microbial diversity also can be due to a host of factors, including: changes in our water systems, air, methods of agriculture, ingestion of processed foods along with a loss of rural land and forests. This change in our outdoor environment has impacted our overall microbiome leading to changes in our lifestyle and health through a loss of immune tolerance, inflammatory changes, stress regulatory responses and mental health, to name a few.<sup>11</sup> In the review article, *The Helsinki Alert of Biodiversity and Health*, it is stated that “urban living in

built environments, combined with the use of processed water and food, may not provide the microbial stimulation necessary for a balanced development of immune function”.<sup>12</sup>

What we have learned from an ever growing list of studies involving isolated communities and those living those very traditional lifestyles, is that we as westerners have a much smaller diversity of microbes than these “hunter-gatherer” type communities.<sup>13-17</sup> The day-to-day existence of our relatives living these traditional lifestyles is vastly different from our own in terms of their regular exposures to microbial content. As clinicians, we have to be asking ourselves, are these microbial exposures necessary to decrease our risk of NCDs? Furthermore, with what measuring stick are we examining the microbial diversity of our patient’s microbial environment? It would be easy to argue, as our colleague Dr. Alan C. Logan has done,<sup>8</sup> that all North Americans are relatively dysbiotic to one degree or another.

### **‘Old Friends’ Hypothesis**

Much has been discussed around the idea of the hygiene hypothesis; generally, that we don’t have enough early-life microbial exposure to prime the immune system. Dr. DP Strachan introduced his idea of the hygiene hypothesis in 1989, suggesting that a lower rate of infection in young children could explain the rise of allergy related diseases.<sup>18</sup> Dr. Graham A.W. Rook, a noted expert in microbiology, extended this original hygiene hypothesis to a more ancestral viewpoint. He states that our co-evolution with microbes is as old as the history of humans. The disturbed relationship between human and microbes, as a result of modernization, may be far more complex than simply the number and type of early childhood infections. In his extension of the hygiene hypothesis, Rook argues that as humans, we have co-evolved with exposure to a wide variety of organisms, including these harmless microbial “Old Friends”, through farms, animals, feces, helminths and the basic microbiota from our environment and those around us.<sup>19,20</sup> He postulates this interaction with organisms in our environment provides us with microbial exposure from birth, beginning the population explosion in our gut leading to a training of the immune and inflammatory system.

The microbial contact helps provide a basic level of activation of the innate immune system and develops a regulatory system that stops inappropriate immune attacks on the self (autoimmunity), harmless allergens and our gut contents. In addition, his theory addresses the high level of chronic inflammation being seen in modern urban centres. For example, it has been found that in the Philippines and lowland Ecuador, where children have been exposed to a high microbial diversity right from infancy, those children even into adolescence have the lowest levels of the inflammatory marker C-reactive protein.<sup>21</sup>

Studies have shown that the Western microbiome is associated, most commonly, with changes in richness and evenness, otherwise known as our overall diversity of the microbiome. Our loss of rural/forest environment has led to a distinct loss of microbial diversity.<sup>33</sup>

What has changed is we are no longer walking through the jungle, woodlands, old growth forests as we used to; we are very different from our ancestors. For many people, these types of exposures to a wide diversity of microbes might happen on their summer holiday once a year, or maybe not at all.

As mentioned, studies comparing rural populations versus urban populations, isolated communities and those living what amounts to a hunter-gatherer lifestyle have shown vast differences in microbial variety and diversity compared to more Westernized urban dwellers. Adaptation to the post-industrialized Western lifestyle is coincident with a reduction in human-associated microbial diversity, and as a result, a decline in gut microbial stability. Diversity and stability are factors with major health implications, particularly now that the human gastrointestinal tract is increasingly recognized as the gateway to pathogenic, metabolic and immunologic diseases.<sup>6,7</sup> Co-speciation between host and microbiota over millions of years has shaped both sets of organisms into a mutualistic superorganism.<sup>22</sup> Dissolving that contact through our limited environmental exposure has had a drastic effect on health and immune function of modern Westernized human groups.

### Noncommunicable Diseases

We now know that “biologically diverse environments modify and enrich our indigenous microbiota, which are fundamental for the development and maintenance of a balanced/well-functioning immune system”.<sup>12</sup> The hygiene and its extended hypotheses brought into consideration the idea that evolutionary recent germ warfare against infection could be associated with increased levels of conditions like asthma, allergies and eczema, especially in countries with high economic status. But as our modern societies progress we are seeing our health concerns changing from an infectious disease focus to noncommunicable diseases (NCDs) — conditions that have an underlying level of inflammation.<sup>6,7</sup>

Whereas these conditions, including atopy, are partially explained in the hygiene hypothesis, we have also seen a substantial increase in autoimmune disease, cardiovascular disease, metabolic conditions and neurodegenerative disease. In the past, our focus has been on a genetic component to these conditions with the addition of environmental risk factors such as poor diet and smoking. Now, we can consider this concept of the “Old Friends” Hypothesis as an additional explanation of many of these changes, relating to altered microbiota patterns — most commonly this loss of diversity and dysbiosis.<sup>23</sup>

We tend to think of inflammation as a protective response — allowing our body to deal with infection or trauma. Symptoms of redness, pain, heat, loss of function and/or swelling allowed the body to remove the damaging initiator and begin the healing process. This however, doesn't explain inflammation in chronic disease and our body's traditional feedback mechanisms, meant to prevent inappropriate immune responses, do not necessarily downregulate

as normal.<sup>23</sup> Based on our previous understanding of inflammation, it would be expected that due to the high prevalence of infection in low-income countries, especially in early life, there should be high levels of overall inflammation into adulthood. Yet, the opposite is seen.

What research has shown is the continued exposure to immune-regulating “Old Friends”, the immune response is strong during infection, but it is relatively quiescent when it is no longer needed — resulting in a ‘resting’ CRP close to zero. In contrast, high economic status countries have shown a chronic low-grade inflammation, seen as an elevated CRP or IL-6, in the absence of any apparent inflammatory stimulus such as infection or trauma.<sup>23</sup> This inability to effectively turn off an acute inflammatory response leads to a relatively high baseline of inflammatory mediators that contribute to the development of chronic disease.

### Do Where You Are Born and Where You Live Matter?

Exposure to these ‘Old Friends’ seems to be a strong predictor of lowering risk to inflammatory and psychiatric-associated disease. This can be demonstrated, especially in immigrant populations where the birth country was a low/middle-income region and the adopted country was high-income. Children from low-income countries adopted into Swedish families showed a prevalence of asthma, allergies and eczema that was highest in those who were adopted when they were less than 2 years old. This was also seen in children who immigrated from Mexico, as compared to those who were born in the USA and it was found the prevalence of asthma decreased as the age at immigration increased.<sup>1,21</sup> Overall, the longer a person lived in a low- to middle-income country — with higher exposure to a diversity of microbes — prior to moving to a country of a higher economic status, the lower the prevalence of asthma, allergy and eczema.

Autoimmunity has shown a similar pattern as we have seen with migration studies on individuals leaving Iran for Sweden. The risk of multiple sclerosis (MS) is doubled for Iranians immigrating to Sweden versus if they stayed in their country of origin. Yet, second generation or beyond ethnic Iranians born in Sweden, who return to their parents’ country of origin (Iran) retain the susceptibility to MS found in those born in Sweden. Conversely, individuals born in the United Kingdom who migrate to South Africa maintain an increased risk for MS, rather than the lower risk found in those born in South Africa. Genetics and environmental factors such as diet and smoking do not explain these immigration patterns. The pattern is also seen in psychiatric disorders. For Mexicans, Cubans and African-Caribbean, who were born in the USA or immigrated before the age of thirteen, they had a 2-3 fold increase in the likelihood of depression, as compared to those who immigrated after the age of thirteen. This was found in immigrants from Eastern Europe, as well, but not from individuals coming from Western Europe.<sup>1,21</sup>





## The Role of Helminths

Although it may be unsettling to the general public and health care providers alike, humans have co-evolved and were colonized with helminths.<sup>24</sup> Paleoparasitological samples dating back 10,000 years show that infections with multiple types of nematodes (roundworms), cestodes (flatworms including tapeworms) and trematodes (flukes) were common.<sup>1</sup> Less than one hundred years ago, almost all humans were colonized with helminths, but modern sewage treatment, changes in agriculture and the food industry and urban city design in high-income cities has eliminated lifecycle pathways required to maintain their presence. In less-developed countries, human infections with helminths remains more common – with just *Ascaris lumbricoides* (giant roundworm) and *Trichuris trichiura* (human whipworm) alone infecting 1.2 billion and 795 million respectively worldwide.<sup>25,26</sup>

Whereas our desire to eliminate pathogenic infections is understandable given our modern take on hygiene, epidemiological studies are beginning to demonstrate the benefit of our colonization by helminths, namely, protection against some immune-related disease. In numerous studies, exposure to helminth colonization showed signs of lowered symptoms of asthma and allergy. Less wheezing was found in *A. lumbricoides* infections compared to those without,<sup>27</sup> Gabonese children infected with *Schistosoma hematobium* had decreased skin-test positivity to dust mites versus those without colonization and children treated for *T. trichiura* and *A. lumbricoides* had increased dust-mite skin responses versus those untreated.<sup>28,29</sup>

Support for the epidemiological evidence for the immune benefits from co-evolution with helminths is found in animal studies. Exposure to helminths may prevent or reverse colitis in animal models of inflammatory bowel disease (IBD). And preliminary studies in humans have shown high remission rates in IBD patients treated with *T. suis*.

Colonization with helminths can induce specific immune regulatory circuits in the gastrointestinal tract that decrease an over response of gut inflammation. Interestingly, the conditions studied have seemingly disparate immune responses — conditions such as IBD, MS and type 1 diabetes are thought to result from a dysregulation of Th1 responses, unlike asthma which is considered to be an overacting Th2 response. As helminths can induce Th2 response, it could be predicted to make asthma worse, yet helminths can also upregulate IL-10 and TGF- $\beta$ , along with T cells, preventing airway inflammation in response to allergens.<sup>1,30</sup>

Our co-evolution with helminths, epidemiological studies, human trials and experimental animal models, are all showing a picture that our evolutionarily recent loss of exposure to helminths may be increasing our susceptibility to some non-communicable diseases. Whereas certain helminths may be too virulent, others may be part of returning us to the immune-modulating benefits of some of our 'Old Friends' that were historically abundant and shaped the human immune system.<sup>31</sup>

## Conclusion

Is our lack of microbial diversity, disconnect from nature and lack of understanding of the microbial environment in, on and around us compromising the health of our species? Is it making us sicker and increasing mortality? How much evidence do we need to recognize that our 'Old Friends' matter? The loss of exposure to the natural environments and all of its organisms — seen and unseen — is almost assuredly contributing to the overall increased risk of NCDs including allergies, asthma, auto-immunity, depression and other mental health risks.<sup>32</sup>

The evidence is mounting; a collection of experimental and epidemiological research demonstrates that our loss of interaction with the natural environment is changing our health. Some of this can be described in a straightforward way, through visual and auditory senses that change stress reactions. The benefits of natural environments can also be explained by their ability to encourage physical activity and build social capital. Then we have microbes; our interactions with the hundreds of trillions of microbial inhabitants that otherwise guide, train and shape our health.

Epidemiological studies, animal models, human trials, paleofecal samples are demonstrating that our co-evolution with microbes has recently changed and it is rapidly changing our health. These studies suggest that loss of contact with microbial biodiversity could be increasing our susceptibility to many of our diseases of affluence. One could further argue this loss of contact may permanently alter our evolutionary trajectory.<sup>3,11,33</sup>

It is with this in mind that we conclude with a firm statement: as naturopathic doctors, are we doing all we can, individually and collectively, to consider our 'Old Friends' in clinical recommendations and as a unified profession? Do we have the tools and knowledge necessary to guide our patients? The advanced research on the human microbial environment may be in its infancy; however, there is enough available research for naturopathic doctors to become thought leaders and start making the connections for our communities on the need for biodiversity both in, on, and around us. The interrelatedness of external and internal ecosystems is yet another reason to explore the medicinal aspects of natural environments. Microbes provide more evidence concerning how and why we should be 'prescribing' nature to our patients. 🍂

## About the Authors

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# Nature Rx: Health Benefits of Spending Time in Nature

Dr. Cyndi Gilbert, ND, and Dr. Katie Smith, ND

The historical origins of naturopathic medicine and its earliest predecessors and proponents understood the importance of nature exposure in health and healing. The word naturopathic itself comes from the root word ‘nature’, a reminder of our profession’s roots in nature cure.

This early historical emphasis on the health benefits of water, air, sunshine, diet, and herbs amongst historical natural doctors such as Sebastien Kneipp, Vincent Preissnitz, and Arnold Rikli<sup>1</sup> and the guiding principle of the *vis medicatrix naturae* has been reignited by current scientific research into the health benefits of nature. The body of research examining the health benefits of spending time in nature is vast, reflecting the complex, multifaceted interaction we have with our larger ecosystem. It is also challenging, as there are many confounding variables in both our environment and in people which must be taken into account when looking at study methodology and design. Although we are just beginning to tease out the various impacts these connections and interactions have on our health and wellbeing and how we are tied to the rhythms of the planet, we can begin to make sound recommendations and good use of *docere* to help our patients understand and reap the benefits. It is the hope that this article will provide some food for thought and help to inform our practices in ways that will bring the healing power of nature more to the forefront.

## Stress response

Early research into the beneficial effects of nature exposure and green spaces found that natural views provided relaxation, increased positive self-reported emotions, and improved recovery from stress.<sup>2-3</sup> Studies in Japan have explored the relationship between nature exposure and stress in greater detail. Research on the practice of *shinrin-yoku*, walking and/or staying in a forest to promote health, has shown that it can to lower salivary cortisol and subjective stress levels.<sup>4</sup> Studies have also found that the greater the baseline stress levels, the more benefit may be derived from *shinrin-yoku*.<sup>5</sup>

Small controlled studies from Japan have found that forest environments promote lower concentrations of cortisol, pulse rate, blood pressure, and heart rate variability, as well as greater parasympathetic nerve activity, and lower sympathetic nerve activity

compared to city environments.<sup>6-7</sup> Other studies investigating the effects of short term forest bathing on the stress response have shown similar results. A small study conducted in China, comparing the effects of spending two nights in either a forest or a city environment, found that subjects exposed to the forest environment showed reduced oxidative stress and pro-inflammatory levels compared with the urban group. Serum cortisol levels and the concentration of plasma ET-1, a vasoconstrictor peptide positively correlated to cardiovascular disease, were both significantly lower in subjects exposed to the forest environment.<sup>8</sup>

A larger study performed in Scotland examined the effects of green space and stress on people in socioeconomically deprived urban communities. The study found overall that higher levels of green space, defined as parks, woodlands, scrub and other “natural environments” in proximity to a person’s residence, were correlated with lower cortisol and stress levels. A gender sub-analysis found that women in areas with a lower percentage of green space showed higher levels of stress compared to men. Additionally, they found that women living in areas with a high percentage of green space had healthier diurnal cortisol profiles. These effects on cortisol secretion patterns were not significant amongst the men in the study.<sup>9</sup>

## Immunity

Several studies have investigated the impact of forest bathing on immunity and specific immune system markers. In vitro studies have shown that the phytoncides (antimicrobial allelochemic volatile organic compounds) released by trees may increase natural killer (NK) cell activity. In one study, the essential oils from Japanese cedar (*Cryptomeria japonica*) and cypress (*Chamaecyparis obtuse*) significantly increased the cytolytic activity of NK cells, measured through the induction of intracellular release of granulysin, granzyme A, and perforin.<sup>10</sup> NK cell activity increased in a dose-dependent manner, even in cells exposed to organophosphorus pesticide.

Human studies in forest settings have confirmed the in vitro findings. A small Japanese study including healthy men, evaluated immune markers after 3 days and 2 nights in a forest. Participants walked 2.5 km on day 1, followed by two 2.5 km walks on day 2. NK cell counts and activity significantly increased from the baseline measurement, as did the levels of perforin, granulysin, granzyme A and granzyme B.<sup>11</sup> A similar study in healthy female nurses also showed significant increases in NK cell counts and activity, with the effects lasting for at least 7 days after the trip had ended.<sup>12</sup>

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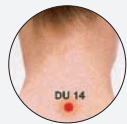
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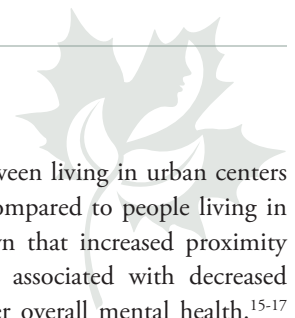
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Other immune markers have been less well studied. A study of healthy male university students in China measured cytokine and lymphocytes after 2 days of gentle walking (1.5 hr twice daily), randomized to either a forest or urban setting. While inflammatory cytokines were not significantly different between the two groups at baseline, both IL-6 and TNF- $\alpha$  were significantly decreased in the forest group compared to the urban group after 2 days. Decreases in C-reactive protein and T-suppressor cells, as well as increases in B-, T-helper lymphocytes and NK cells were found in the forest group but the differences were not significant.<sup>8</sup>

## KEY FACTS

- Nature cure is part of the historical basis for naturopathic medicine
- Nature exposure may reduce both the physiological and psychological experience of stress
- Forest bathing among conifers may improve immune system functioning
- Proximity to green space is associated with increases in self-esteem, mood, and vitality
- Spending time in nature may also decrease rumination
- Inverse relationships have been identified between proximity to green space and obesity or ADHD in children
- Tree canopy cover is associated with better birth outcomes
- Access to green space is associated with greater life expectancy and lower risk of cardiovascular disease
- Health benefits may be greater in women and those with lower socioeconomic status
- Benefits may not be consistent across different climates, cultures, or in developing countries

## Mood

Studies have shown an association between living in urban centers and increased rates of mental illness compared to people living in rural areas.<sup>14</sup> Other studies have shown that increased proximity to and use of urban green spaces is associated with decreased anxiety and mood disorders, and better overall mental health.<sup>15-17</sup> One study found that this relationship was statistically significant amongst women but not for men.<sup>18</sup> Although it is nearly impossible to identify all the factors that contribute to this association, some researchers have speculated that urban tree cover and access to natural environments are an important cofactor. Evidence also shows that intentional exposure to nature is associated with better mental health outcomes. Some studies have shown improvements in mood with simply a view of green space in a picture<sup>19</sup> or from a window.<sup>2</sup>

Exercising in nature, also known as green exercise, may have additional benefits on mental health. A meta-analysis of 10 non-controlled studies, including 1252 participants, found that green exercise significantly improved both mood and self-esteem. Measured using the Rosenberg Self-Esteem Scale and the Profile of Mood States (POMS), green exercise improved self-esteem by approximately 45% and mood by over 50%.<sup>20</sup>

Forest bathing studies from Japan and China have supported these findings. In small, controlled studies, gentle walking in a forest setting has been found to significantly improve mood compared to walking in an urban environment. POMS scores on tension/anxiety, fatigue and confusion were significantly decreased, while sense of vigor was increased after the forest visit compared to baseline measurements. In contrast, walking in an urban area increased fatigue and decreased vigor compared to baseline.<sup>21</sup> Another study found that forest exposure decreased tension/anxiety, depression/dejection, and anger/hostility compared to the urban exposure control group.<sup>8</sup>

More recently, researchers have begun to explore the mechanisms behind the improvements in mood found in earlier studies. In a study conducted at Stanford University, researchers compared subjective levels of rumination and subgenual prefrontal cortex (sgPFC) brain activity (an area shown to be more active with rumination and negative self-talk) in 38 healthy participants, randomized to a 90 minute walk in either a natural or urban environment. Compared to baseline levels, the participants on the nature walk showed a significant decrease in self-reported level of rumination after their walks, while those on the urban walk did not. Corresponding to subjective findings, blood perfusion in the sgPFC area significantly decreased after the nature walk but not after the urban walk. sgPFC activity was also significantly different between the two groups.<sup>22</sup> More research is needed to elucidate whether or not improvements in mood found in these studies would also be seen with people who have been diagnosed with specific mental health conditions.

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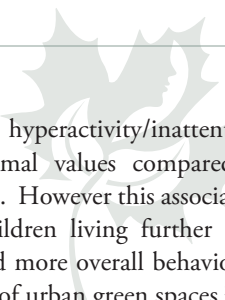


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## Pediatric health considerations

### ***Green Space and Obesity:***

A longitudinal study conducted in Australia following children from age 6 to 13 found an inverse relationship between body mass index (BMI) and access to greenspace. The beneficial effect emerged more strongly as the children grew older.<sup>23</sup> A higher density of trees (the 75th versus the 25th percentile) has been associated with a 12% lower prevalence of obesity in New York preschool children from low income families.<sup>24</sup>

This effect may be related to findings of another study which examined physical activity in children and greenspaces, including treed areas and meadows. This study found that meadows were not associated with higher physical activity outcomes. However, for each additional 5% increase in the proportion of neighborhood land covered by treed areas there was a corresponding 5% increase in the relative odds of increasing free-time physical activity outside of school hours.<sup>25</sup>

A cross-sectional study examined the risks and benefits of green spaces for children. It looked at sedentary behaviour, obesity, asthma and allergy. The authors found that an interquartile range increase in residential surrounding greenness was associated with 11-19% lower relative prevalence of overweight/obesity and excessive screen time, but was not associated with current asthma and allergic rhinoconjunctivitis. Residential proximity to forests was associated with 39% and 25% lower relative prevalence of excessive screen time and overweight/obesity, respectively, but was not associated with current asthma. In contrast, living close to parks was associated with a 60% higher relative prevalence of current asthma, but had only weak negative associations with obesity/overweight or excessive screen time.<sup>26</sup>

### ***Green Space and ADHD:***

A study conducted in Barcelona looked at the impact of contact with green spaces and blue spaces (beaches) on indicators of behavioural development and symptoms of attention deficit/ hyperactivity disorder (ADHD). They discovered statistically significant inverse relationship between green space, playing time and Strengths and Difficulties Questionnaires (SDQ) total difficulties, emotional symptoms, and peer relationship problems. The same relationship was found between residential surrounding greenness and SDQ total difficulties and hyperactivity/inattention and ADHD/DSM-IV total and inattention scores; and between annual beach attendance and SDQ total difficulties, peer relationship problems, and prosocial behavior. There did not seem to be a relationship between beach attendance and ADHD symptom scores. The most important factor was that children interacted with the spaces. Effects of residential proximity to green spaces were inconclusive.<sup>27</sup>

In a study conducted in Munich, the authors found that the distance between a child's residence and the nearest urban green space was

positively associated with the odds of hyperactivity/inattention, especially among children with abnormal values compared to children with borderline or normal values. However this association was only significant among males. Children living further than 500m away from urban green spaces had more overall behavioural problems than those living within 500m of urban green spaces.<sup>28</sup>

### **Pregnancy Outcomes:**

Studies have been conducted linking stress levels to pregnancy outcomes<sup>29</sup> and this has been examined in the context of neighborhood level economic deprivation<sup>30-31</sup> and social capital<sup>32</sup>. Recently there have been a number of studies examining the link between proximity to green space and pregnancy outcomes.

Some of these studies have examined the connection between proximity to green space, tree cover, and birthweight outcomes. Living within 50m of a canopy cover and access to a private open space reduced the risk of babies being born small for gestational age. However this effect could be a manifestation of higher socioeconomic status as women with greater access to urban trees were more likely to be non-hispanic white, younger, have fewer previous births and live in newer, more expensive houses closer to private open space.<sup>33</sup>

A study conducted in Vancouver found an interquartile increase in greenness, measured using satellite images and the Normalized Difference Vegetation Index (NDVI), was associated with higher term birth weight and decreases in the incidence of small for gestational age, very preterm (< 30 weeks), and moderately preterm (30-36 weeks) births. These associations remained after controlling for variables such as air pollution, noise exposures, neighborhood walkability and park proximity.<sup>34</sup> Another study found that an interquartile increase in green space resulted in statistically significant increases in birth weight and a decrease in low birth weight. Very low birth weight also decreased but did not reach statistical significance. This study found no association between pre-term delivery and very pre-term delivery and green space. The effects were more pronounced for mothers of lower socio-economic status.<sup>35</sup>

This association however, appears to vary between ethnic and socioeconomic groups. A study conducted in the UK examining ethnicity and individual and neighborhood socioeconomic status and pregnancy outcomes found an overall positive association between birthweight and surrounding residential greenness. However this effect was more pronounced with white participants. The correlation was not shown for participants of Pakistani descent. Furthermore, it was found that larger areas of greenness (500m to 1000m) had a more pronounced effect on birthweight in participants with lower education and those living in more socioeconomically deprived neighborhoods versus smaller areas of greenness (50m - 200m) in the same populations. The authors did not speculate as to the reasons for the discrepancies and stated that more detailed studies were needed to better understand this effect.<sup>36</sup> An earlier study conducted in Spain found no association between proximity to green space and



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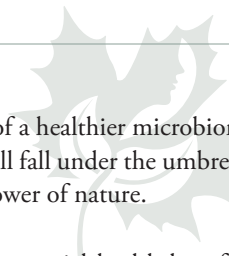
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pregnancy outcomes until they adjusted for maternal education and found that proximity to green space was associated with higher birth weights in women with the lowest educational level.<sup>37</sup> Overall the greatest benefit of proximity to green space seems to be derived from women of low socioeconomic status.

### Life Expectancy and Mortality:

Access to parks and forests may have a positive impact on life expectancy. There is evidence that people living in counties with higher natural resource amenities have higher life expectancies at birth than counties with lower amenities after controlling for socio-demographic and economic factors, medical facilities and risk factors.<sup>38</sup> Researchers investigating the impact of walkable green streets have also found significant increases in the 5 year survival of senior citizens living in Tokyo.<sup>39</sup>

Other studies have found that having 10 more trees per city block is associated with improved health perception comparable to an increase in annual personal income of \$10,000 and moving to a neighborhood with \$10,000 higher median income or being 7 years younger; having an average of 11 more trees per block was associated with decreases in cardiometabolic conditions comparable to an increase in annual personal income of \$20,000 and moving to a neighborhood with \$20,000 higher median income or being 1.4 years younger.<sup>40</sup>

### Discussion

The health benefits of spending time in nature have the potential to be extensive, and have positive impacts on the whole person, in mind, body and spirit. Studies not reviewed here have found associations between nature exposure and cognition, blood pressure and other cardiovascular variables, blood sugar and insulin resistance in diabetics, subjective pain ratings, circadian rhythms, and many more health parameters.

The standardized extract or active constituent of time spent in nature is elusive. It is difficult to parse out the factors involved in the health benefits derived from the interplay between person and environment. While Japanese researchers have primarily attributed these salutogenic effects to the volatile oils released by trees (especially conifers), there are likely many other contributing factors. The pollution removal that trees perform has large impacts on human health, in particular air quality within urban centres.<sup>41</sup> Research in environmental psychology has suggested that green spaces have positive health effects through stress reduction, feelings of safety, and increased social integration and healthy behaviours including exercise.<sup>42</sup> Sensory stimulation, visual focus and field of view are theorized to be salient factors, in particular in the research regarding children and ADHD. Increased exposure to sunlight and vitamin D as people spend more time outside are also likely involved. Nature exposure may also impact health through the development of, or changes to, our microbiomes. Drawing from the hygiene hypothesis, Alan Logan has theorized that grey space in urban centres promotes dysbiosis, while increased exposure to nature may

inversely be related to the development of a healthier microbiome.<sup>43</sup> Synthesized together, these factors may all fall under the umbrella of the *vis medicatrix naturae*, the healing power of nature.

Much of the research available on the potential health benefits of spending time in nature has been in small-scale poorly designed trials. Field studies are very difficult to reproduce, due to the variability of weather, temperature, humidity and other factors that are not controllable. Additionally, study participants from the majority of the Japanese studies were healthy men in their early 20s attending university. The homogenous and limited demographic group makes it difficult to extrapolate findings to other people, most notably women. Many larger, population-based studies have been primarily conducted in temperate regions of Europe and North America. Studies in tropical climates have not yielded similarly positive results.<sup>44</sup> The majority of studies have attempted to account for socioeconomic status, and it seems that the benefits may exist independent of this particular factor. Populations of low socioeconomic status may, however, derive a greater magnitude of benefit from access to green spaces. The mechanisms for this effect, have not been fully explored as the studies are correlational and would require further large-scale research to flesh out the connections. While the research overall is very promising, more studies are needed to more definitively inform clinical recommendations to patients.

Nonetheless, the potential harm of spending time in nature is quite limited, especially with education around physical exercise, safety and environmental considerations. In other words, there is very little downside to nature exposure and broad potential benefits. Proximity to and use of green space may help provide a buffer against the negative effects of acute and chronic stress<sup>45</sup>, reduce cardiovascular risk<sup>16</sup> and obesity, and may have beneficial effects on birth weight and aid in decreasing symptoms of ADHD.

In spite of the limited scientific evidence available, clinicians should encourage their patients to get outside into nature where possible, for stress management, mental health promotion, overall health promotion, and to a connection to the *vis medicatrix naturae*. Just as Aldoph Just once advocated for a “Return to Nature!” with his book title of the same name, today’s naturopathic physicians should also advocate for greater access and use of green spaces for overall health promotion. 🌿

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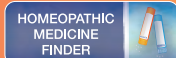
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Dr. Smith currently resides in Toa Baja, Puerto Rico with her son and partner, where she hopes to begin practice once she completes her maternity leave. She has a special interest in community health, chronic pain and pediatrics. She also has an interest in global health and has traveled to Haiti to volunteer with Naturopaths Without Borders and Mama Baby Haiti, and has been a speaker for AMREF (African Medical and Research Foundation).

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# Urban energy: The Effects of Sound and Light Exposure On Sleep and Overall Health — Research Review

Dr. Melissa Lee, ND and Dr. Katie Rothwell, ND



According to Brown et al. (2015), there is a global shift of urbanization from the developed to the developing world. As the urbanization of our larger cities continue to expand, we are constantly inundated with various stimuli. Specifically an excess and variety of light forms and sound exposures have significantly increased for those who live in urban landscapes. This paper outlines where the sources of light and sound pollution come from, how this type of pollution may impact our health, and how this can be addressed.

## Light Exposure in an Urban Landscape

### Sources of light pollution

Light pollution is defined as the excessive or inappropriate use of artificial light that has the ability to cause adverse effects on ecology, human health, and the natural environment.<sup>1</sup> In urban centres, street lighting alone accounts for approximately 40% of light pollution. Other contributors include security lighting for homes, businesses, and commercial buildings as well as floodlights and display lighting for advertisements, billboards, and sporting venues.<sup>1</sup> These various sources form different types of light pollution, as seen in Table 1. Since the early 20th century artificial light has become ubiquitous in our society, most notably in urban centres. Currently, 99% of the population in the United States and Europe are exposed to light pollution, and the use of light at night continues to increase by 6% each year.<sup>3</sup> This exposure has been long overlooked and considered a benign side effect of modern life, however current research is shedding light on its deleterious effect on many physiological processes.

### Impacts on human physiology

The primary concern in regards to light pollution is its disruption of our natural circadian rhythm and the resulting effect on neuroendocrine physiology and the HPA axis.<sup>2</sup> Circadian rhythm is a biological process that operates on a 24-hour cycle and controls sleep, hormone production, metabolism, and gene expression.<sup>4</sup> The

**TABLE 1: Types of Light Pollution<sup>2</sup>**

<b>Sky glow</b> Light 'glow' or halo that is seen over large towns and cities at night
<b>Glare</b> Escaped horizontal light from unshielded sources such as street lighting
<b>Over illumination</b> Excessive use of artificial light for signage or buildings
<b>Light intrusion or trespass</b> Stray light or unwanted light from floodlights or streetlights entering into homes or bedrooms

superchiasmatic nucleus (SCN) is a small area of the hypothalamus that controls the circadian rhythm, and thus the above biological processes as well. It is directly affected by light exposure through specialized retinal ganglion cells that project from the retina to the SCN.<sup>4,5</sup> The SCN also controls proper melatonin production via the pineal gland, although nervous pathways also exist between the SCN and other organs including the heart, pancreas, adrenal glands, adipose tissue and liver.<sup>6</sup>

The majority of research conducted on whether light exposure at night affects disease, has focused on shift-worker populations. This is beyond the scope of this article as we are most interested in incidental and low levels of nocturnal light exposure. However, a growing body of research is now focusing on light pollution as a risk factor and has shown that even exposure to dim light at night can affect disease progression.<sup>3,8,9</sup> Additional human studies have shown a clear dose dependent response between exposure to light (in regards to both intensity and wavelength) and melatonin suppression.<sup>10,11</sup> Thus, the concept of melatonin suppression and chronodisruption on disease progression can also be cautiously extrapolated to the deleterious effects of light pollution on human physiology.

### Cancer

Light pollution has recently been identified as a risk factor in the development of cancer in humans due to its unfavourable effects on circadian rhythm and decreased melatonin production.<sup>17</sup> Melatonin is a powerful antioxidant that is consumed by the body during



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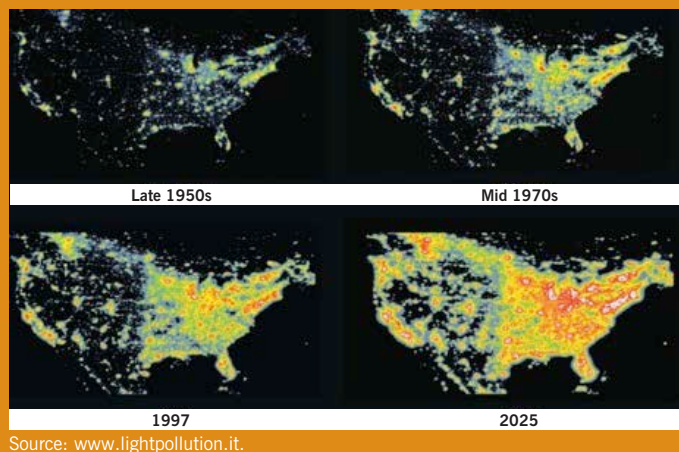


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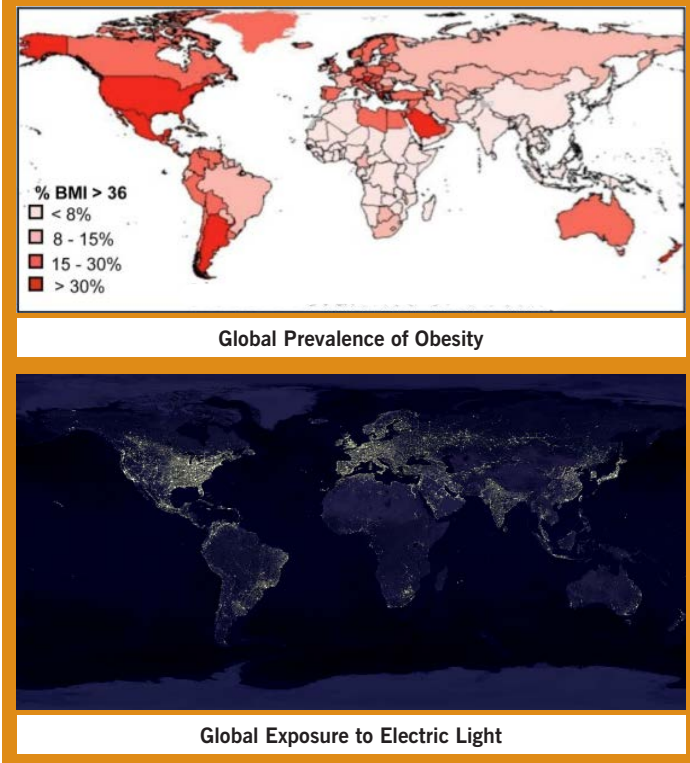
FIGURE 1.



the day and replenished at night by the pineal gland.<sup>6</sup> However, the anti-cancer effect of melatonin goes beyond its well known antioxidant properties. *In vivo* studies have shown melatonin to directly inhibit cancer growth by decreasing tumor uptake of linoleic acid (LA), whose metabolites are necessary for tumor metabolism and growth.<sup>13,14</sup> Furthermore, melatonin suppression has been linked to increases in estrogen levels, which is a known risk factor for estrogen dependent cancers such as endometrial and breast cancer.<sup>17,18</sup> Although breast cancer has historically been the most well researched cancer type with regards to light exposure, additional studies suggest that light pollution may be also be affecting rates of colorectal, prostate, and endometrial cancer.<sup>12-14,18</sup> A 2010 study showed a strong positive correlation between global exposure to light pollution and incidence rates of breast cancer, but no relationship with lung, liver, or colorectal cancer.<sup>19</sup> Clearly more research is needed to investigate the degree to which light pollution affects the development of cancers worldwide.

### Metabolism and Obesity

Exposure to light pollution at night can also impact metabolism and lead to weight gain and obesity via alterations in hormone signaling, disruption of the circadian clock, and impairment of sleep.<sup>11</sup> Hormones such as glucagon, insulin, and leptin are all released in circadian rhythm, along with genes that control the metabolism of sugars and biosynthesis of cholesterol.<sup>11</sup> Rodent studies have shown that a disruption of circadian clock genes in both central and peripheral tissues causes increased susceptibility to metabolic syndrome and obesity, including impaired glucose regulation and defective insulin production.<sup>11</sup> In addition, mice exposed to only dim light at night exhibited an increase in adipose tissue and weight gain.<sup>20</sup> In humans, a recent study concluded that light exposure at night in the home was associated with higher body weight, elevated BMI, increased waist circumference, and elevated cholesterol levels.<sup>21</sup> There also exists geographical epidemiological data that shows the parallel relationship between increases in light pollution and obesity rates worldwide,<sup>11,22</sup> however these results could be due to confounding factors such as lifestyle and diet habits also found in industrialized nations that predispose the population to obesity.

FIGURE 2. Geographical colocalisation between increased BMI and exposure to artificial light.<sup>22</sup>

### Cortisol and HPA Axis Disruption

Cortisol is another important hormone released in a diurnal pattern, with levels lowest around midnight that build and peak in early morning in response to daylight.<sup>23</sup> This rhythmic secretion is directly controlled by the SCN's modulation of the HPA axis as well as through sympathetic innervation of the adrenal gland.<sup>24</sup> Thus, light exposure that disrupts circadian rhythm via the SCN can also have a negative effect on cortisol levels and lead to chronically high cortisol levels. Abnormal pulses of cortisol can also occur throughout the night in response to frequent waking, a common side effect of exposure to light pollution.<sup>25</sup> This disruption of cortisol rhythm and the HPA axis has far reaching health effects that include mood disorders such as depression and anxiety, chronic stress and adrenal fatigue, as well as insomnia and sleep disorders. The link between circadian disruption and mood disorders has been documented in numerous studies, however specific research in regards to light pollution is lacking.<sup>26</sup> A 2012 study concluded that rodents chronically exposed to dim night during the night exhibited depressive-like behavioural changes,<sup>27</sup> however no human studies to date have replicated these findings.

### Not all light is created equal

It is not just the overall presence of light pollution that needs to be considered, but also the intensity and wavelength of the light we are exposed to. Blue light with wavelength from 430nm-510nm has the largest effect on circadian rhythm disruption as well as melatonin



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suppression compared to other wavelengths.<sup>28</sup> Energy efficient LEDs as well as electronic screen displays are two of the most popular sources of blue light and are both heavily used. In regards to intensity, current studies have determined that less than 100 lux (a measure of illuminance) is enough to disrupt molecular circadian rhythm and cause melatonin suppression. This intensity is comparable to urban sky glow and is commonly found in sleeping areas during the night.<sup>8,11</sup> Furthermore, there is a clear dose dependent relationship in regards to light intensity and melatonin suppression, where high intensities of light suppress melatonin levels more severely than lower intensities.<sup>29</sup> These findings have numerous practical implications in regards to reducing light pollution and protecting against its detrimental effects as seen below.

**TABLE 2: Comparison of Lux Illuminance Levels From Various Sources**

Light Source	Approximate lux
Dim candle light	1.5
Night time sidewalk or parking lot	50
Dim room lighting	100
Overcast day	1000
Full daylight	10 000

#### ***Reducing light pollution exposure in your environment***<sup>2,3,30</sup>

- Avoid the use of exterior globe lights or floodlights, which produce a large amount of wasted light. Use timers, dimmers, or sensors in order to shut off lights when they are unneeded.
- Lower the wattage of outdoor lighting and choose warm white bulbs in place of bright white LEDs.
- Reduce your exposure to blue light after dark and before bedtime by limiting use of TVs, laptops, cellphones and other electronic displays. Alternatively, color temperature apps or blue light filters are now available that can reduce blue light emitted from devices.
- Ensure a dark bedroom by using blackout curtains and turning off all unnecessary lighting such as hallway and bathroom lights.
- If night-time waking is common, use warm light fixtures with dimming capability to reduce the intensity of exposure and melatonin suppression.
- If exposure to light pollution is unavoidable, properly timed supplemental melatonin may help offset the detrimental effects.<sup>12,13,17</sup>

A growing body of research is showing that light pollution does not only prevent us from viewing the stars and galaxies of the night sky, but has a wide range of detrimental effects that affects humans as well as wildlife and ecology. As the world population and urban centres continue to grow, exposure to light pollution and its detrimental effects will only become more ubiquitous.

#### **Noise Pollution in an Urban Landscape**

Noise pollution is also a growing concern, especially in the developing urban landscapes of Canada. Various factors such as urbanization, increased population density, increased economic growth and increased motorized transportation are major contributing sources of environmental noise.<sup>31</sup>

Specifically, the urban soundscape (noise environment) is shaped by a combination of noises from transit systems (road, rail and air traffic), construction and industry noises, population density (neighbours, radio, television, bars and restaurants) and other sources.<sup>32-35</sup> As humans, we are particularly susceptible to sound exposure because we cannot switch-off our auditory system;<sup>32</sup> and now we are understanding how noise affects our health in a number of ways.

#### ***What is Sound?***

Noise as environmental pollutant, is measured as an A-weighted sound, expressed as dB (A) (decibels A-weighted). This measurement considers the rate of sound pressure levels at different frequencies in a way that is comparable to the human ear. Although sound levels fluctuate throughout the day, sound levels are measured over a period of time (16-hour days or 8-hour nights).<sup>36</sup> Noise in the urban landscape is measured at maximum noise weighted levels, and not measured by the human experience of noise.<sup>37</sup>

Examples of dB (A) measurements include: sound at the threshold of hearing is 0dB (A), sound of falling leaves is 10-20dB (A), vacuum cleaner is 55-65dB (A), location close to a main road or highway is 70-80 dB (A), pop music concerts is 100-110 dB (A), while sound at 130dB (A) will cause pain.<sup>38, 39</sup>

Currently Health Canada does not have enforceable noise guidelines or thresholds,<sup>36</sup> but guideline sound thresholds have been proposed by the Environmental Protection Agency (EPA), and the World Health Organization (WHO). Most urban policies and provincial suggestions regarding sound exposure follow the EPA or WHO recommendations.

In 1974, the EPA established that the upper limit outdoor noise levels which adversely affect health and welfare are at 70dB (A) over a 24-hour exposure (for example, to avoid hearing loss). For constant sound exposure, 55dB (A) outdoors and 45dB (A) indoors were set as upper limits to prevent activity interference and annoyance.<sup>40</sup> Since then, the WHO has also suggested that outdoor environmental noise should not exceed 45dB (A) and 50dB (A) for daytime and nighttime periods to prevent a potential psychosocial effects.<sup>35, 40, 41</sup>



**TABLE 3: Upper Limit Threshold Guidelines for Noise Exposure<sup>35,36,38</sup>**

Health effect	Threshold/Guidelines
<b>Annoyance*</b>	
Moderate annoyance, outdoor living area	50 L <sub>Aeq</sub> , 16 h <sup>35</sup>
Serious annoyance, outdoor living area	55 L <sub>Aeq</sub> , 16 h <sup>35</sup>
Annoyance, school playground	55 L <sub>Aeq</sub> , 16 h (During Play) <sup>35</sup>
Annoyance, difference between baseline and project	>6.5% difference in % HA <sup>36</sup>
<b>Sleep Disturbance</b>	
Sleep pattern	<60 L <sub>Aeq</sub> , 8hr (23:00-07:00hr) <sup>38</sup>
Subjective sleep quality	40 L <sub>Aeq</sub> , 8hr (23:00-07:00hr) <sup>38</sup>
Mood next day	<60 L <sub>Aeq</sub> , 8hr (23:00-07:00hr) <sup>38</sup>
Increased average movement when sleeping	42 L <sub>Aeq</sub> , 8hr (23:00-07:00hr) <sup>35</sup>
Self-reported sleep disturbance	42 L <sub>Aeq</sub> , 8hr (23:00-07:00hr) <sup>35</sup>
Use of sleep aid drugs and sedatives	40 L <sub>Aeq</sub> , 8hr (23:00-07:00hr) <sup>35</sup>
Environmental insomnia	42 L <sub>Aeq</sub> , 8hr (23:00-07:00hr) <sup>35</sup>
Sleep disturbance, outside bedrooms	45 L <sub>Aeq</sub> , 8hr (23:00-07:00hr) <sup>35</sup>
Sleep disturbance, night noise guidelines	40 L <sub>Aeq</sub> , 8hr(23:00-07:00hr) <sup>35</sup>
Sleep disturbance, interim target	55 L <sub>Aeq</sub> , 8hr (23:00-07:00hr) <sup>35</sup>

\*Annoyance defined as: feeling of resentment, displeasure, discomfort, dissatisfaction, or offense when noise interferes with someone's thoughts, feelings or actual activities.<sup>35,36,38</sup>

***Common Sound Decibels found in an Urban Setting***

Now that we know what the upper limit sound exposure guidelines are, it is important to answer the question: What are the sound levels currently in an urban landscape?

McAlexander et al. measured the variations in noise levels on the street at 60 locations across different times of the day in Manhattan, New York. These areas were chosen to reflect regions of low, medium and high street-level noise. Although variations varied between boroughs, time of day, traffic level and nearby conditions, the majority of noise measurements were >70dB (A) of ongoing sounds. When there were additional sounds like emergency vehicles (sirens), or ongoing construction, sound levels were in excess of 80dB (A). Overall, it was found that more than 90% of the chosen areas exceeded the recommended exposure limits, therefore these levels have the potential to cause auditory and non-auditory health effects.<sup>33</sup>

Brown et al. also assessed noise pollution in Hong Kong. Hong Kong has one of the world's highest population densities with the most of the population living in high rise buildings, including buildings of 50 storeys or more, surrounded by high intensities of road traffic.<sup>43</sup>

In Canada, the guidelines have only been established around occupational exposure limits. To give you an idea of occupational limits, here are the levels of noise allowed:

**TABLE 4: Upper Level Exposure Limits in an Occupational Setting<sup>42</sup>**

	Continuous Noise		Impulse/Impact Noise	
	Maximum Permitted Exposure Level for 8 Hours: dB(A)	Exchange Rate dB(A) +	Maximum Peak Pressure Level dB(peak)	Exchange Rate dB(A) +
<b>Canada (Federal)</b>	87	3	-	-
<b>British Columbia</b>	85	3	140	-
<b>Alberta</b>	85	3	-	-
<b>Saskatchewan</b>	85	3	-	-
<b>Manitoba</b>	85	3	-	-
<b>Ontario</b>	85	3	-	-
<b>Quebec</b>	90	5	140	100
<b>New Brunswick</b>	85	3	140	-
<b>Nova Scotia</b>	85	3	-	-
<b>Prince Edward Island</b>	85	3	-	-
<b>Newfoundland and Labrador</b>	85	3	-	-
<b>Northwest Territories</b>	85	5	140	100
<b>Nunavut</b>	85	3 or 5	140	-
<b>Yukon Territories</b>	85	3	140	90

Exchange Rate: as sound increases, the time exposure allowed decreases. Therefore for every 3dB(A) increase, the allowed time exposure is halved. For example, one would be allowed to be exposed to a 90db(A) for a 4-hour exposure time according to the Federal Jurisdiction.

In 10,077 dwellings, the daytime sound exposure was found to be between 30-80dB with a mean of 58.5dB, and median of 59dB. Nighttime noise exposure ranged from 42-69dB.<sup>44</sup>

There is no city in Canada that can compare to the urban landscapes of New York and Hong Kong, however the bigger cities are moving in this direction. For example, in 2013, the City of Toronto had done a noise assessment in downtown Toronto to assess the potential health impacts of the proposed Billy Bishop Airport expansion.

The results of their assessment are found in the table below. The current calculated noise levels that exist in downtown Toronto in wards 14, 18, 19, 20, 27, 28, 30 and 32 are listed in Table 5:



**TABLE 5: Health Impact Assessment. Proposed Expansion to Billy Bishop Toronto City Airport.<sup>45</sup>**

LOCATION	Evaluation of Annoyance (Daytime Exposure)		Evaluation of Sleep Disturbance (Nighttime Exposure)	
	L <sub>day</sub> (dBA)	L <sub>day</sub> with Airport close by	L <sub>night</sub> (dBA)	L <sub>night</sub> (dBA) with airport close by
<b>2m Elevation</b>				
Stadium road	55	61	46	51
Toronto Music Garden	64	65	55	56
Harbour Square	58	59	49	50
Ward's Island	47	51	39	41
Harbour Side Co-op Homes	61	62	51	52
Windward Co-op Homes	56	62	47	52
Little Norway Park	57	62	48	52
<b>15m Elevation</b>				
Stadium road	57	64	49	53
Toronto Music Garden	67	67	58	58
Harbour Square	60	61	51	52
Ward's Island	48	52	39	41
Harbour Side Co-op Homes	58	63	50	53
Windward Co-op Homes	60	62	50	52
Little Norway Park	60	64	51	54
<b>70m Elevation</b>				
Stadium road	62	65	53	55
Toronto Music Garden	72	72	64	64
Harbour Square	65	65	56	56
Ward's Island	48	51	40	41
Harbour Side Co-op Homes	69	69	60	61
Windward Co-op Homes	64	66	56	57
Little Norway Park	66	67	58	58

Likely to Cause Annoyance  
Likely to Cause Sleep Disturbance

### Impact of Noise on our Health

#### Impact of Noise on Sleep

The impacts of noise on health has mainly been studied in laboratory settings which mimic exposure to noises caused by aircrafts, railways and road traffic. What has been found is that the main health burden of noise is annoyance and sleep disturbance.<sup>46,47</sup> Annoyance refers to the feeling of resentment, displeasure, discomfort, dissatisfaction or offense when noise interferes with someone's thoughts, feelings or actual activities.<sup>35,36,38</sup>

Humans recognize, evaluate and react to environmental sounds even while asleep.<sup>48</sup> While asleep, chronic low grade noise particularly affects the autonomic nervous system (ANS). One non-invasive way to measure ANS function is through heart rate variability (HRV).

Sim et al. investigated the effects of different types of noise on the ANS by measuring HRV pre and post noise exposure to background traffic, speech, and mixed noise (~50dB(A)) in resting adults. HRV before and after low frequency sounds increased HRV indicating a higher sympathetic nervous system arousal with acute noise level.<sup>49</sup> By having a higher sympathetic activation during noise exposure, the body reacts to handle this stressor. For example, a person experiences increased heart rate, blood pressure, disrupted restorative power of sleep, awakenings/arousals, less deep sleep and rapid eye movement sleep, early awakenings in the morning.<sup>35,49,50</sup> Consequently, sleep disruption can have negative effects on waking psychomotor performance, memory consolidation, poor work or school performance and increased risk of accidents.<sup>35</sup>

Many studies have also demonstrated a dose-response relationship between noise exposure and sleep disruption. Bodin et al. studied the impact of how different levels of exposure affected sleep and noise annoyance; and whether having access to a quiet side (bedroom faces green space versus the road) affected sleep and noise annoyance. What they found was that there was a positive relationship between combined noise exposure (road traffic and railway noise) and self-reported poor sleep quality for each 5dB (A) increase. They also found that approximately 50% of those with no access to a quiet side were annoyed at noise levels of 50-54dB (A), while those that had windows facing a green space did not reach annoyance until >60dB (A). Having a bedroom towards a green space was associated with lower risk of poor sleep quality (p=0.048). However the benefit of having a window face a green space did not make a difference in overall sleep disturbance.<sup>51</sup>

#### Effect of Noise on Cardiovascular Health

Many studies have also demonstrated the effects of noise exposure on cardiovascular health. These studies have demonstrated noise exposure can increase blood pressure, heart rate and increase the risk of hypertension, ischemic heart disease and myocardial infarction (MI).<sup>52-56</sup>

From a cellular perspective overnight noise exposure can negatively impact blood vessel function. Schmidt et al. investigated the impact of overnight airport noise on endothelial function and morning

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plasma adrenaline levels. Schmidt et al., exposed men and women to nighttime noise in the form of a recording of the same aircraft noise. The first aircraft noise was played back after 39.5 minutes to facilitate sleep onset, and the last aircraft noise was played at 415 minutes. The overall groups were Control (noise exposure of 49.6 dB (A)), Noise 30 (noise exposure of 59.9 dB (A)), and Noise 60 (noise exposure of 50.9dB (A)). What Schmidt et al found was a dose-dependent decrease in minimum PTT after noise nights, which had a trend of mirroring changes in systolic blood pressure (p=0.11). With increasing number of noise events, subjects reported a greater deterioration in sleep quality (p=0.001). Specifically with venous function, they saw flow mediated dilation of the endothelial tissue was blunted in a dose dependent manner to noise exposure (p=0.02). Therefore the more severe the noise, the greater the endothelial dysfunction (blood vessel constriction). A marked increase in plasma adrenaline concentrations were also seen between control and noise groups (p=0.0099).<sup>52</sup>

Fuks et al. conducted population based, prospective cohort study in a highly urbanized Ruhr area in western Germany with a total of 4,814 men and women 45-75 years of age. They wanted to investigate how long term exposure to urban background particulate matter and traffic noise on blood pressure and hypertension in a population-based sample. They found a trend that residential proximity to high road traffic was linked to elevated systolic and diastolic blood pressure with higher point estimates and linear trend in subjects living close to heavy-duty traffic. Long-term road traffic noise exposure >60dB at the residence was linked to higher blood pressure.<sup>53</sup>

Lastly, Babisch et al. studied the risk of road traffic noise and incidence of myocardial infarction in a hospital-based case control study in Berlin. With each patient, outdoor traffic noise was determined via noise maps of the city. They found specifically in male subjects who lived in the streets with an average noise exposure during the day of more than 70dB (A) had an increased risk of MI compared to those who lived in the street with levels less than or equal to 60 dB (A). Once again a dose response relationship was seen where higher risk was seen with increasing traffic noise. Noise levels of 65-70dB (A) outdoors have been considered to have adverse health effects of noise.<sup>35,36</sup> No higher MI risk was found in women with respect to traffic noise level.<sup>56</sup>

Overall, noise pollution from an urban landscape can range anywhere between 55-70dB(A) and with Canadian urbanization, these noise levels will most likely increase and eventually reach levels similar to Netherlands, Sweden, New York and Hong Kong. At these levels noise impacts our ANS first, which contributes to our sleep disturbance and cardiovascular risk.

Below is a summary of nighttime noise exposure ranges and health effects in those limits provided by the WHO.<sup>35</sup>

**TABLE 6: Nighttime Noise Exposure ranges and Health Impact**

L <sub>night, outside</sub> (time 23:00-07:00)	L <sub>night, outside</sub> (time 23:00-07:00)
<30 dB(A)	<ul style="list-style-type: none"> <li>Individual sensitivities</li> <li>No substantial biological effects are observed</li> </ul>
30-40 dB(A)	<ul style="list-style-type: none"> <li>Increased: body movements, awakenings, self-reported sleep disturbance and arousals.</li> <li>Intensity of effects depends on nature, source of, and number of events.</li> <li>Vulnerable groups are more susceptible</li> <li>Biological effects are modest</li> </ul>
40-55 dB(A)	<ul style="list-style-type: none"> <li>Adverse health effects are observed</li> <li>Must adapt lifestyle to cope with noise at night</li> <li>Vulnerable groups more severely affected</li> </ul>
> 55 dB(A)	<ul style="list-style-type: none"> <li>Situation is considered increasingly dangerous for public health</li> <li>Adverse health effects occur frequently</li> <li>Sizable proportion of population is highly annoyed and sleep disturbed.</li> <li>Cardiovascular risk increases.</li> </ul>

**Finding a Solution: What we can do to mitigate the harmful effects of our environment**

We have all learned about the concept of nature cure and more studies are confirming the importance of “green living spaces” in an urban environment. Kaplan et al. emphasized the importance of having access to urban nature: nearby trees, opportunities for gardening and places for taking walks, for the well-being of urban residents.<sup>57</sup> Gidlof-Gunnarsson et al. found that green-area availability also moderates a resident’s noise response. They found that when residents have “better” availability to green areas in an urban environment, fewer of them perceive noise as a neighborhood problem, have less annoyance with traffic noise, were more likely to walk and exercise in their neighbourhood, and experienced less stress related psychosocial symptoms (feeling “stressed,” “tired,” or “irritated/angry”).<sup>58</sup>

In terms of prevention of the negative health impact of noise exposure, we as naturopathic doctors can assist patients in implementing several relevant lifestyle changes, which include:

**1. Address the Autonomic Nervous System:** Focus on maintaining homeostasis in the ANS with your modality of choice. By implementing botanical medicines, acupuncture, nutritional changes in combination with self-care practices of breathing, mindfulness, or meditation, we can ultimately modulate the stress response to sound exposure and assist the body in regulating its circadian rhythm, neuroendocrine, and hormonal systems.

**2. Focus on Nature Cure:** educating about the importance of incorporating components of urban nature in all parts of our environment, from the office, to our homes, green rooftops and more. Nature overall contributes to restorative processes. Restorative

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environments (specifically natural ones) provide relief and help individuals recover from cognitive mental fatigue when the information process or attentional capacity has been overused. Natural environments are important for recovery or recharging of this capacity.

**3. Address dietary and lifestyle concerns as obstacles to the healing process:** Vitamin C supplementation has been shown to negate endothelial dysfunction that occurs with noise exposure.<sup>52</sup> A diet rich in fruits and vegetables can provide a natural source of antioxidants, flavonoids, and phytonutrients to offset the oxidative stress associated with noise pollution.

## Conclusion

With a global shift towards urbanization from the developed to developing worlds, we cannot help but be exposed to increased levels of light and noise pollution. As naturopathic doctors we can empower and educate our patients on what the sources of these pollutants are, how they affect our body and how to mitigate the health impacts. 🌱

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# Research Review: Health Consequences of Living Near Wind Turbines and Solar Panels

Dr. Shannon Morgenstern, ND



Many people are searching for healthier and safer alternatives to fossil fuel; however, concerns have surfaced about the adverse effects associated with both wind turbines and solar panel use in and around homes. Below, we will investigate and sift through recent scientific literature to determine where current research about the potential risks and adverse effects of wind and solar energy sits and whether or not any conclusions can be drawn.

## Wind Turbines

Wind turbine placement and development has increased recently to utilize renewable energy. Many people living near and around wind turbines or around proposed sites are concerned about their health and safety. Noise, annoyance, shadow flicker, EMFs and infrasound are the most common concerns.

The Ontario community-based, self-reporting health survey found the most common symptoms to be an altered quality of life, sleep disturbance, excessive tiredness, headache and stress/distress, however many other symptoms have been reported (Table 1).<sup>1</sup> Unfortunately, there is an overall lack of scientific peer-reviewed consensus about whether these health concerns are indeed caused by living in proximity to wind turbines.<sup>1,4</sup> Two small studies coined the terms: “Wind Turbine Syndrome” and “Vibro-Acoustic Disease” as purportedly caused by exposure to wind turbines, however it has been argued that rigorous scientific peer review has not occurred. Concerns included the fact that, both studies were missing noise measurements, had no statistical representation of potential health effects, used small study numbers and may have created bias by asking about people’s concerns in an un-blinded way.<sup>4</sup> Evidence is insufficient to suggest that typical exposure, even when in close proximity can lead to VAD, but there may be more-vulnerable people who could be susceptible.<sup>5</sup>

Health effects are too often discounted because “direct pathological effects” or a “direct causal link” has not been established. However, studies conducted have only looked for direct links to human health, finding little.<sup>29</sup> Indirect impacts on health also need consideration.<sup>1</sup>

**TABLE 1: ADDITIONAL SYMPTOMS IDENTIFIED BY SUBJECTS LIVING NEAR WIND TURBINES THROUGH SELF-REPORTED QUESTIONNAIRES<sup>1</sup>**

Fatigue	Annoyance/stress	Vertigo/dizziness
Insomnia	Vomiting	Panic episodes
Headache	Palpitations	Grief/anger/injustice
Tachycardia	Ear pressure	Depression/anxiety
Visual blurring	Internal pulsations	Cognitive dysfunction

In 2011, McMurty proposed a case definition to diagnose “Adverse Health Effects in the Environs of Industrial Wind Turbines” (AHE/IWT), however it was found to lack scientific support from peer reviewed literature and have very poor specificity.<sup>8</sup> The problem with the specificity is that there were nearly 40,000 ways to meet diagnostic criteria once the non-specific first-order criteria were met, meaning that false positive assessments and many missed diagnoses could occur very easily.<sup>8</sup>

### Issues related to Annoyance, Noise, EMFs, Infrasound and Shadow Flicker from Wind Turbines

When it comes to EMFs, it appears that precautionary measures are not needed at extremely low frequencies (ELFs), which occurs with wind turbines. According to the official position of Health Canada there is no evidence of harm from wind turbines. Health Canada has noted that EMF readings found around wind turbines were lower than levels found inside homes and that these levels were much lower than daily exposure from common household electrical devices.<sup>6</sup>

Shadow flicker is another problem area for local residents, in terms of creating annoyance. There is a belief that this may even induce seizures. Shadow flickers were found to be more annoying in areas where there was a greater perception of noise.<sup>4</sup> Beyond the annoyance factor, Knopper et al report that wind turbines have specifically been designed not to pose a risk of photo-induced epilepsy by limiting the hours of shadow flicker per year at any one residence. Other literature on the effect of shadow flicker and turbines is lacking.<sup>4</sup>

The noise created by the turning blades of a wind turbine has been described as sounding like a constant airplane overhead. This sound is characterized as piercing, preoccupying and continually surprising, as

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well as often irregular in intensity, depending on wind conditions.<sup>1,5</sup> The audible portion of the sound is around 300Hz, which easily penetrates the walls of homes and other buildings.<sup>5</sup> Audible and low-frequency acoustic energy from turbines is sufficiently intense to cause extreme annoyance and inability to sleep, or disturbed sleep in people living nearby.<sup>5</sup> It was noted that noise emissions were found to disturb sleep, cause daytime sleepiness and impair mental health for residents within 1.4 km of two turbines.<sup>1</sup> Although newer turbines are touted as being quieter than older turbines, the increased size of the newer multi-MWatt turbines, and especially their blades, have been associated with more complaints of adverse health effects that cannot be explained by auditory responses alone.<sup>5</sup>

Another issue is the increased perception of noise from wind turbines at night. It was found that wind turbines are 10-20dB louder at night than during the day.<sup>7</sup> Unfortunately, it's financially unlikely that the industry would consider stopping nighttime-operation as an option.

A number of studies have found that turbine noise was significantly more annoying than other environmental nuisances, including road traffic noise.<sup>3,10-13</sup> Not surprisingly, they also found that the closer wind turbines were and the higher sound pressure levels caused increased annoyance. Interestingly, subjects who see wind turbines as a negative aspect of their environment perceive noise from them as more annoying compared to other respondents.<sup>3,10-13</sup> A perceived negative attitude toward turbines, and those with increased annoyance outdoors, reported higher frequency of feeling nervous, tense or stressed out on a weekly, and even daily basis.<sup>3,10-13</sup> Respondents whose self-assessment of their own health as "poor" were also more annoyed by them in general. Further studies suggest that reported ill effects on health from wind turbines are more likely attributed to a number of environmental stressors that result in an overall greater relative annoyed/stressed state in that exposed population.<sup>4</sup>

Insomnia is higher for those in which the turbine induced noise levels were 40-45dB compared to 35-40dB.<sup>3</sup> Some jurisdictions, like Ontario, have set a maximum sound-level of 40dB to protect the public and vulnerable populations.<sup>4</sup> Subjects living closer to wind turbines, at distances of 400-800m, believed that wind turbines had a negative impact on humans, the landscape and the environment as compared to those living 800-1200m away. Interestingly, direct economic benefits derived from wind turbines significantly decreased annoyance by respondents. However, paid lease agreements often include a gag-clause, ensuring that people aren't able to speak out or write anything unfavorable about wind turbines on their property.<sup>5</sup>

Interestingly, annoyance has been correlated with noise, but annoyance was more strongly related to visual impact, attitude about wind turbines and sensitivity to any noise in general.<sup>4,10-13</sup>

Infrasound, which includes sound waves at frequencies that occurs at a level below the limit of audible sound (which is approximately

16Hz), is another area of concern. Crichton et al conducted a study to see if positive or negative expectations of harm from infrasound influenced symptoms experienced. Any perception of environmental hazard created symptom expectations, and a priming effect, whereby subjects were more likely to notice sensations and symptoms and attribute them to the infrasound.<sup>2</sup> Crichton's study involved exposure to 10-minutes of infrasound compared to 10-minutes of sham 'sound' in groups who had both high expectancy of symptoms, and low expectancy of symptoms. Subjects presented with a body of lay-information commonly found on the Internet and in the media linking sound exposure and health effects, did in fact increase their report of symptoms in both sham and infrasound groups. It is likely that information alone about potential harm may be enough to create health concerns and trigger symptom reporting, even in the absence of inherent objective risk.<sup>2</sup> Implications are that people near turbines may seek out the Internet and media opinions on the safety and health effects that may in the end bias them. However the study lacked a control group and exposure periods that are typical of people living near wind turbines in the real world. In fact, biological and harmful effects have indeed been noted with infrasound, but at much greater sound pressure levels than those created by wind turbines.<sup>4</sup>

Recently, 23andme, Inc., found a correlation in European populations between the snp Rs2937573 and misophonia, which is a condition known to trigger severe irritation to noise.<sup>9</sup> Further investigations with these populations and their negative health effects when living in close range to wind turbines would be interesting to consider.

It is also important that patients presenting to physicians about health concerns related to wind turbines not be further victimized by a doctor with a lack of knowledge or understanding of the situation.<sup>1</sup>

In 2011, an Ontario environmental review tribunal decision acknowledged: "...the debate should not be simplified to one about whether wind turbines can cause harm to humans. The evidence presented to the tribunal demonstrates that they can, if facilities are placed too close to residents. The debate now has evolved to one of degree."<sup>1</sup>

## Solar Panels

Photovoltaic solar panels are another area where consumers and industry alike are trying to move further away from traditional fossil fuel use and find ways to harness renewable resources, like sunlight.

There have been very few studies conducted concerning the safety and potential impact of solar voltaic panels on human health. The majority of the studies that have been conducted though suggest that there are currently minimal health and safety hazards associated with their presence or operation.<sup>15-17</sup> The majority of environmental, health and safety hazards are associated with the use of hazardous chemicals in the manufacturing process.<sup>15-17</sup> The benefits to solar energy use may outweigh the risks compared to conventional fossil fuel technology and its associated harms.<sup>15</sup>



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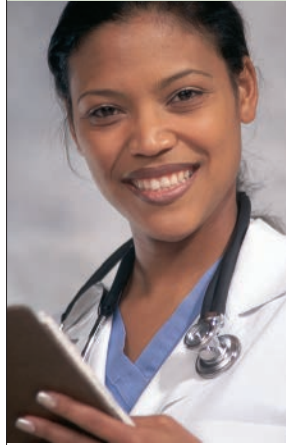
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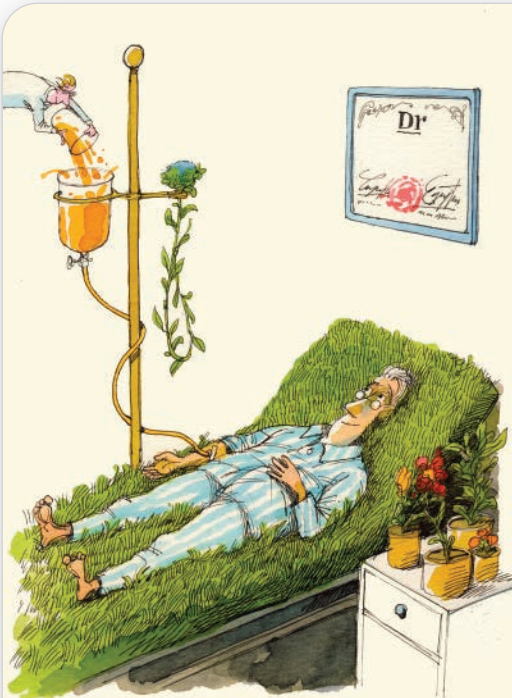


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## KEY FACTS

## Wind Turbines

- perceived annoyance to wind turbines increases reported health concerns
- patients sensitive to noise or those with poor health may see more adverse risk
- no conclusive evidence on wind turbines direct impact on health effects

## Solar Panels

- manufacture and disposal of solar panels have increased toxicity risk
- patients very sensitive to EMFs may be affected by solar panels and batteries

Highly toxic chemicals and materials are used in the manufacturing process of photovoltaic cells. Silica sand, kerf dust, heavy metals like arsenic, lead, cadmium, gallium and copper, and solvents such as nitric acid, sodium hydroxide and hydrofluoric acid are used and are known to impact health. Silica dust exposure has been linked to silicosis, COPD, rheumatoid arthritis, scleroderma, Sjogern's, lupus, renal disease and lung cancer.<sup>15</sup> Carcinogenic chemicals such as arsenic and cadmium are also concerns when proper safety precautions are not taken in the manufacturing process.<sup>17</sup> Critical to maintaining good health for individuals is a requirement on safe manufacturing processes, but once the product is finished and produced in a complete form, these risks become much less of an issue to the public at large.

Environmentally, there is risk of industrial accidents and the release of vapors and dust into the surroundings.<sup>15,17</sup> Through effective regulation, enforcement and vigilance by manufacturers and operators, dangers to workers, the public and the environment can be minimized.<sup>15</sup>

Of all steps, consumers appear to have the least amount of risk. Solar voltaic panels are enclosed and encased in heavy-duty glass or plastic, with little risk that small amounts of semiconductor materials will be released, except in explosion or fire.<sup>15-17</sup> Firefighters and first responders have struggled with accessing rooftops and risked electrocution when coming into contact with high voltage conductors that are still charging on solar panels.<sup>15</sup> There is currently no general recommendations or guidelines to address their concerns.

Disposal is another area of danger due to the hazardous elements and trace metals discussed above. Proper recycling programs will be an important follow up to ensure that leakage of trace metals into the environment doesn't occur.<sup>17</sup>

EMF exposure is another area of concern, however the current scientific consensus suggests that there is no causal relationship between exposure to the low-level power frequency EMFs emitted by

solar voltaic cells and adverse health effects.<sup>15</sup> The strength of EMFs do not begin to approach levels set by the International Commission on Non-ionizing Radiation Protection and small EMFs produced by solar panels diminish rapidly and are indistinguishable from normal background levels within several yards.<sup>15</sup>

Many of us have, however, had patients present who are very sensitive to EMFs, and as with wind turbine noise, there is likely a small proportion of the population who may find EMF exposure from solar panels to be troubling and contribute to health concerns.

Overall, consensus about the safety, annoyance and health risks of both wind turbines and solar panels has not been reached and further studies should be done in order to assess whether many people may be negatively affected or if there's a small identifiable minority that needs protection from them. 🌱

## About the Author

**Shannon Morgenstern, ND** is a licensed naturopathic doctor practicing in Calgary, Alberta. As a naturopathic doctor, trendsetter and guide, she helps patients to challenge the status quo, inspire change and live a cleaner, greener existence. Her mission is helping moms and moms-to-be remove toxins from their homes to give their families the healthiest, happiest lives possible.

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# What are the Health Effects of Living Near Mobile Phone Base Stations?

Dr. Michael Mason-Wood BSc, ND

Is society's current understanding of the health effects of electromagnetic exposure parallel to society's understanding in the 1970s of the health impacts of cigarette-smoking? Decades ago, the tobacco industry created doubt and controversy about the proposed health risks of smoking; however, with more research and the passing of time, there is now evidence of several health risks associated with smoking. The mercury found in dental fillings has a similar history and continues to be analyzed by the medical community. The author encourages you to ponder whether or not electromagnetic exposure is following a similar path.

A position paper by The American Academy of Environmental Medicine calls into question the safety of cell phones and cell phone towers (know also as mobile phone base stations — MPBS), putting these in the same category as smoking and mercury.<sup>1</sup> What is different about exposure to electromagnetic energy is that it has become fully integrated into our environment. If and when it is confirmed there is a health risk associated with electromagnetic exposure, will it be too late and what will be our options? As we become increasingly aware of the health risks posed by electromagnetic radiation, will we find solutions?

The result of the increase in public awareness and research is a growing concern about the safety of living near MPBSs. Several short term studies, ranging from several months to three years have concluded there is no consistent evidence demonstrating associated risks of living near MPBSs, yet these results have led to an increased concern and recommendations for further investigation.<sup>2,3,10,14,15</sup> For example, a study conducted by Shahbazi-Gahrouei et al. indicated that those individuals living a distance of greater than three-hundred meters from an MPBS showed a statistically significant decrease in symptoms, such as nausea, headache, dizziness, irritability, discomfort, nervousness, depression, sleep disturbance, memory loss and lowering of libido compared to individuals that lived closer to the MPBS.<sup>21</sup> Some argue that distance is not a reliable measure because the power output of each MPBS can be different, leading to different distances at which they may impact health. Analyzing the health impact is further complicated by the fact that exposure at ground-level distance from different base stations may differ by four orders of magnitude because of base station parameters and environmental scattering,<sup>6</sup> and there is a growing consensus that children are more susceptible to exposure, hence the emphasis on the placement of MPBSs away from daycares and schools.<sup>28</sup>

As naturopathic doctors (NDs) our focus is preventative health care and it is in our nature to look at the potential for risk and harm. The author proposes that NDs consider the long-term impacts to health, especially seeing as the current evidence suggesting the lack of long-term health effects is primarily based on short-term studies.

Limited evidence of harm does not mean we should turn a blind eye and not proceed with further studies, particularly when it comes to our children's health and the health of future generations.

Consider the growth of the mobile phone industry; in 1987, there were only 100,000 cell phones in Canada and by the end of 2010 there were more than 24-million. The increasing number of cell phones require more MPBSs to accommodate the volume of cell signals. A rise can be seen in MPBSs as well; in 2008 there were about 8,000 MPBSs<sup>29</sup> and currently there are over 820,000 MPBSs in Canada.<sup>25</sup> Mobile phone transmitter power-levels range from 0.6 to 2.0W, while MPBS transmitter power levels range from a few watts to >100W.<sup>6</sup>

MPBSs exist as either stand-alone structures (monopoles) or they can be on the top of existing structures, such as churches, water tanks and other building types. Property owners have the option to rent space on top of an existing structure to mobile-phone service providers. The height for coverage ranges from ten to one-hundred metres. In many cases, the transmitter may go unnoticed (see the link at the end of this article to find out whether there are any MPBSs located in your neighbourhood). As mobile-phones use rises, there is greater demand for coverage (signal availability and strength) and adequate capacity (number of channels)<sup>17</sup>. Companies may also co-locate on a structure,<sup>17</sup> with two or three companies sharing a tower for their antennas.

Twenty-four studies since 1973 have identified adverse effects associated with exposure to non-thermal microwave electromagnetic radiation (EMR) or hypersensitivity (EMH).<sup>23</sup> These effects include both neuropsychiatric symptoms<sup>16</sup> and other generalized symptoms. Symptoms that are believed to be associated with EMR exposure range from various cancers, headaches, fatigue, decreased learning, ADD, autism spectrum disorder, decreased memory, hormone imbalances,<sup>20</sup> infertility, dementia, autoimmune disease, diabetes and heart problems.<sup>4,5,8,11,16,23</sup> Other data shows that children, women<sup>26</sup> and the elderly<sup>27</sup> are more susceptible to physical symptoms such as tiredness, headaches, sleep disturbances, irritability, depression loss of memory, dizziness, libido decrease, nausea and visual perturbations. Multiple chemical sensitivity has been associated with EMH.<sup>9</sup>

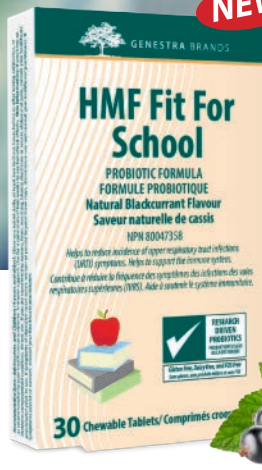
While the mechanism of action of low-level electromagnetic radiation exposure is still to be determined and more studies are needed, there are a number of proposed mechanisms of action:

- **Increase in Intracellular Calcium:** Martin Pall, Professor Emeritus of Biochemistry and Basic Medical Sciences at Washington State University, studies the influence on voltage across a cell's plasma membrane. His research shows that the activation of the voltage-gate calcium channels<sup>7</sup> leads to an increase in intracellular calcium,<sup>7, 8</sup> causing the release of



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neurotransmitters and hormones.<sup>23</sup> Pall's research suggests the nervous system is sensitive to MPBS proximity. Research shows that the increased intracellular calcium also stimulates osteoblasts and affects bone growth.<sup>7</sup> This rise of intracellular calcium was found to be almost instantaneous, occurring in less than five seconds in human fibroblast cultures.<sup>12</sup> Additional studies are needed to further explore the impact on voltage-gated calcium channels.<sup>13</sup> Prescribing calcium channel blockers to patients has actually been proposed as a way of managing this response.<sup>7</sup>

- **Rise in Nitric Oxide levels:** The correlation between electromagnetic exposure and increased nitric oxide levels has been known for more than 20 years and has been shown in over 20 studies. A rise in nitric oxide leads to increased oxidative stress.<sup>7</sup> This mechanism of action has recently been re-examined by Dr. Martin Pall.
- **Rise in Cortisol and Salivary  $\mu$ -amylase:** Studies have shown that exposure leads to a rise in cortisol and salivary  $\mu$ -amylase in humans,<sup>19</sup> which could account for symptoms associated with electromagnetic exposure, including irritability, a 'tired but wired' or 'burnt out' feeling, weight gain at the waist, a loss of muscle mass, bone loss, high blood pressure, insulin resistance, low sex drive, impaired memory and loss of scalp hair.

A 1973 Russian study on mice, rats and rabbits found that many of the physiological changes affecting the nervous system, heart and testis were reversible if the exposure was stopped within a brief period of time; however, with repeated or longer exposure they found that these changes were not reversible.<sup>24</sup> This is a very alarming finding that has not been further tested, proved or disproved.

One concern with conducting studies regarding the health impact of MPBSs is the 'nocebo' effect. That is, when subjects have an awareness of the potential negative impact of increased exposure to MPBSs, it may influence the development of symptoms, such as fatigue, headaches and insomnia.<sup>22</sup> Another challenge is the increasingly common universal exposure to MPBS, creating difficulty in finding controls that have no exposures.<sup>23</sup>

On a positive note, although manufacturers and developers of EMR and MPBS equipment refuse to acknowledge any harm in these technologies, they are in the developmental stages of creating Li-Fi (a form of wireless Internet). This new technology will decrease EMR exposure because it uses light to transmit Internet signals. It could replace Wi-Fi and Bluetooth<sup>18</sup> and has the advantages of having less interference issues and higher security, as signals do not go through walls as Wi-Fi does. The goal is to decrease the body's overall exposure to EMR, as certain exposures we cannot realistically avoid. This is a step in the right direction, but there is still the question about the impact of the current technology on human health.

How can we limit our exposure to electromagnetic frequencies? We cannot choose the air we breathe; however, we can choose where we live, whether to use a microwave oven, for example, or whether to hold a mobile device close to our head or body.

Mobile phone technology and towers are here to stay. As a naturopathic doctor, I encourage my colleagues to consider electromagnetic exposure when determining the root cause of a patient's concerns. If the health impacts of mobile device technology follow the same path as smoking, lead exposure and mercury dental fillings, we are going to

be in trouble. The author, therefore, encourages readers to be aware of what is happening in their community and cautious about the placement of MPBSs in residential areas, schools and daycare centres.

## Resources

Enter your address and locate how many cell towers are in your area: [www.ertyu.org/steven\\_nikkel/cancellsites.html](http://www.ertyu.org/steven_nikkel/cancellsites.html).

Dr. Magda Havas, an associate professor of environmental and resource studies at Ontario, Canada's Trent University: [www.magdahavas.com](http://www.magdahavas.com).

## About the Author

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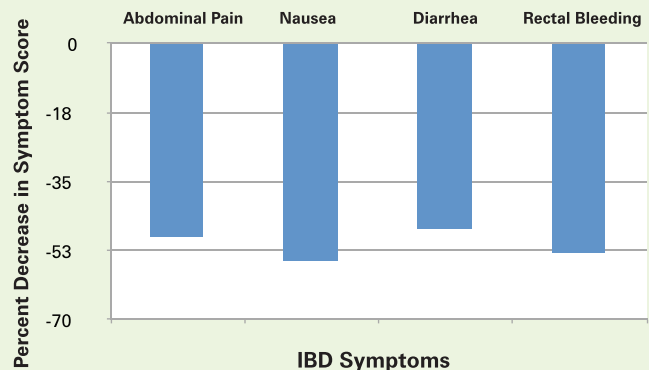
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# High-Rise Living: Impacts of Living on Higher Floors

Dr. Mark Fontes BSc, ND

High-rise buildings are becoming a primary choice among those people living in urban areas as they provide a more economical option for a proportion of the population who cannot afford the rising costs of traditional semi-detached or detached homes in major cities like Vancouver, Calgary and Toronto.

Worldwide, high-rise buildings are increasing both in number and in height as major city urban developers look for affordable and profitable options as land space becomes sparse. Not surprisingly, New York City has the greatest number of total high-rises among cities worldwide, with 6069 (see Table 1). The Greater Toronto Area (GTA) in 2014 led North American cities with 130 high-rise building projects, most of which were condominiums. The GTA is also a leader in terms of the percentage of high-rises (buildings that are at least 12 stories in height) in the city that are residential in nature.<sup>1</sup>

**TABLE 1. List of high-rises (12 stories or greater) in major cities as of 2014**

City	Number of High-rises	City Population
New York City	6069	8,175,000
Toronto	2005	2,615,000
Shanghai	1202	13,523,000
Tokyo	1185	8,583,000
Chicago	1150	2,833,000
Kiev	970	6,994,500
Mexico City	762	8,694,753
Vancouver	664	616,537
Montreal	619	1,649,519

What is largely unknown are the health effects, if any, of living in these high-rise buildings, some of which can be 40 or more stories in height.<sup>2</sup> This review aims to summarize the current literature that explores these health effects.

Housing is an important determinant of health, and has attracted considerable interest in public health research and policy. The World Health Organization (WHO) has identified inadequate housing conditions as an important factor contributing to injuries and preventable diseases such as respiratory, nervous system and cardiovascular diseases and other chronic conditions, including cancer.<sup>3</sup> Housing conditions may affect health both directly and indirectly. Direct effects on health might operate through the biological, chemical or physical characteristics of buildings such as the presence of radon, asbestos or pests, unsafe heating systems, overcrowding or indoor pollution.<sup>4,5</sup> Indirect effects might act through individual characteristics and exposures related to the socio-economic position of those living in a building and neighborhood.

If the GTA is taken as an example of the population boom occurring in some major cities — the GTA population is expected to increase by more than 44 percent (to 9.2 million people in the next 25 years) — cities are looking for more sustainable housing planning.<sup>6</sup> Currently, it is estimated that about 70 percent of those living in high-rise buildings are in structures that are at least 13 stories in height.<sup>6</sup> Ultimately more patients that naturopathic doctors see will be living in these buildings, and it may aid us to understand the health effects of living in these structures and how doing so may contribute to illness.

## The Switzerland Study

A review of research databases reveals that there are few articles published on the health effects of living in high-rises. Most studies of high-rise housing and health have focused on structural features of high-rise buildings or characteristics of their neighborhoods.

A team of researchers conducted an interesting study in Switzerland that was published in in 2013 in the *European Journal of Epidemiology*.<sup>7</sup>

Panczak et al utilized information from the Swiss National Cohort (SNC), a longitudinal study based on the linkage of the December 2000 census with mortality and emigration records from 2001-2008, to examine the association of the floor of residence in high-

risers on all-cause and cause specific mortality in Switzerland. The SNC includes more than 7.2 million people who participated in the 2000 census.

For the analysis the researchers excluded 858,843 (11.8 %) persons younger than 30 years and 1,247 (0.02 %) individuals older than 95 years at the time of census. 4,081,484 (56.1 %) residents of buildings with fewer than four floors and 357,971 (4.9 %) individuals with missing information on the floor of residence were also excluded. The study population ultimately consisted of 1,500,015 persons.

Upon analysis, the researchers discovered that the floor of residence was associated with all-cause and cause-specific mortality. Table 2 shows fully adjusted hazard ratios (HR) of death from all causes comparing residents of the eighth floor or higher with residents living on lower floors. Mortality decreased with increasing floor: residents on the ground floor had a 22% greater hazard of death from any cause compared to residents on the eighth floor and above. Interestingly, the gradient was steepest between ground floor and fourth floor and leveled off from the fourth floor upwards.

**TABLE 1. List of high-rises (12 stories or greater) in major cities as of 2014**

Cause	No. of Deaths	Hazard Ratio and 95% CI
All causes	6069	8,175,000
Cardiovascular diseases	2005	2,615,000
Myocardial infarction	1202	13,523,000
Stroke	1185	8,583,000
Respiratory diseases	1150	2,833,000
Stomach cancer	970	6,994,500
Lung cancer	762	8,694,753
Breast Cancer	664	616,537
Prostate cancer	619	1,649,519

The association was strongest with respiratory diseases (HR 1.40; 95 % CI 1.11–1.77), stroke (HR 1.36; 95 % CI 1.07–1.74), cardiovascular diseases (HR 1.35; 95 % CI 1.22–1.49) and lung cancer (HR 1.22; 95% CI 0.99–1.50). There was little evidence of an association with other causes of death. The HR was 0.41 (95 % CI 0.17–0.98) overall.

An association with floor of residence was evident with causes associated with specific behaviors, such as smoking. The association

of floor of residence with causes of death such as stroke or lung cancer may be explained by differences in health-related lifestyles and behaviors. A limitation in this study is insufficient data comparing lifestyle habits of those living on higher floors to ground floor residents. Panczak et al commented that those living on higher floors may have consumed diets higher in fruits and vegetables, consisted of more non-smokers, had higher levels of physical activity and higher income (which was not included in the SNC).

Environmental exposures may also play a role, for example the higher levels of airborne pollutants, including particulate matter, polycyclic aromatic hydrocarbons or carbon monoxide at lower floor levels.<sup>8</sup> There is research to support that residents of low-floor apartments are exposed to elevated levels of vehicle exhaust and their volatile organic compounds compared to high-floor apartment residents.<sup>9</sup>

Aside from this Swiss study, few other studies report on the effects that floor of residence has on health outcomes. We can expect as greater numbers of people reside in high-rises in the future, that we see more research investigating these issues.

## Radon Exposure

Radon is an invisible, odourless radioactive gas that is produced with the natural process of uranium decay. It is found in soil and rock in all parts of North America. Radon can be found in all types of housing and buildings throughout the United States and Canada. If radon is present in the soil or rocks of the buildings foundation, it can seep into the building. Radon commonly is introduced through homes through cracks or drains in the foundation. The Environmental Protection Agency (EPA) recommends testing all homes below the third floor for radon.<sup>10</sup> As most indoor radon is produced from naturally occurring radon in the foundations soil and rocks, the highest indoor levels are most likely to exist below the third floor. However, in the cases of high-rise buildings, radon has been found at floors above the third floor, possibly due to radon movement through elevators or airshafts in the building.

Radon exposure can have a significant impact on overall health. Studies have demonstrated that residential radon exposure is the second most important risk factor for lung cancer and the first among never-smokers.<sup>11</sup> The damaging effects may be greater in current and past smokers. The province of Nova Scotia surveyed 719 homes in 75 communities, finding average radon concentrations of 2.9 pCi/L (picocuries/litre). Four pCi/L is the American standard for radon above which remediation may be recommended. The Canadian standard is 20 pCi/L, and 22 homes out of the 719 surveyed exceeded that standard.<sup>12</sup>

Homeowners or tenants can test for radon with a variety of radon measuring devices that can be purchased. A professional can also be hired to test your living space. If high radon levels are discovered, improving the exposure typically involves repairs to the building. The building owner/tenant should be informed.



## Electromagnetic Fields

Electromagnetic fields (EMF) of all frequencies represent one of the most common and fastest growing environmental influences, on which much research is now being focused.<sup>13</sup> Electric fields are strongest close to a charge or charged conductor, and their strength rapidly diminishes with distance from it. Conductors such as metal block EMFs very effectively, however, building materials are less effective. In contrast to electric fields, a magnetic field is only produced once a device is switched on and current flows. Magnetic fields are strongest closer to their origin and rapidly decrease at greater distances from the source. Common materials such as the walls of buildings do not block magnetic fields.<sup>14</sup>

Environmental exposure to man-made electromagnetic fields has been steadily increasing with growing electricity demand and ever-advancing technologies, which have created more and more artificial sources. Higher levels of EMF exposure has been found in high-rise buildings when compared to other types of homes.<sup>14</sup> This is most likely due to the proximity to other units and being exposed to the EMFs from nearby high-rise buildings.

Canada has no national guidelines for occupational or residential exposure to EMFs.<sup>15</sup> The Federal Provincial Territorial Radiation Protection Committee (FPTRPC) that met to review the literature concluded that epidemiological studies have not provided sufficient evidence to provide an association between exposure to EMF and development of cancer in adults. In contrast to this, the European Council recommends that member countries adopt exposure limits to EMFs. Countries that have adopted some precautionary elements include Italy, Netherlands, Switzerland, and Slovenia.<sup>15</sup> The focus in these countries has been on 'sensitive areas' where people may be exposed for a prolonged duration to EMFs: schools, hospitals, workplaces and high-rises.

It is not disputed that electromagnetic fields above certain levels can trigger biological effects. Experiments with healthy volunteers indicate that short-term exposure at the levels present in the environment or in the home do not cause any apparent detrimental effects.<sup>15</sup> Exposures to higher levels that might be harmful are restricted by national and international guidelines. The current debate is centered on whether long-term low-level exposure can evoke biological responses and influence people's well being. Large-scale studies are currently underway in several countries and may hopefully help resolve these questions.

## Conclusion

With high-rise buildings becoming a primary choice for housing in major cities across North America, it is likely that many more patients we see will be living in these buildings. A review of the current available literature does not provide strong evidence of direct harm to inhabitants of these structures in the short-term, although radon exposure and electromagnetic field exposure are important factors to consider. As the Switzerland study examined, living on

higher floors may even be protective against the development of several conditions. More research is required at this time to specify exact health effects, if any, of living in high-rise buildings for a prolonged period of time. ☀

## About the Author

**Dr. Mark Fontes BSc, ND** is a graduate from the Canadian College of Naturopathic Medicine (CCNM) in Toronto, Ontario, Canada. He received additional training in naturopathic oncology and intravenous therapies during his clinical residency at CCNM. Dr. Fontes currently practices at Insight Naturopathic Clinic in midtown Toronto, where he strives to work alongside medical doctors and oncologists in order to provide patients with the best possible integrative care. He is also part-time faculty at CCNM where he supervises fourth-year interns and the intravenous therapy shift in the student teaching clinic. Dr. Fontes is the Ontario board member for the Canadian Association of Naturopathic Doctors and maintains an active membership with the Ontario Association of Naturopathic Doctors and the Oncology Association of Naturopathic Physicians. For contact information please visit [www.insightnaturopathic.com](http://www.insightnaturopathic.com).

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## The year in review & 2016

### Products & service

Scientific committee revamped entire line in 2013-14 to integrate most current & advanced knowledge in PNEI & latest in European & NA knowledge. Many were formulators for Italians.

HO moves to N Vancouver, new business office purchased Oct, now creative centre for company. Dec Montreal office expands to deal with growth. Both locations doing training.

York Downs increases compounded injectable offerings to 40 Viatrexx products, largest selection of injectables ever on the market.

Devices added: Medical & home ozone, UBI, PRP, Ointment mill, Via-Derm (solution for ND's with injection limitation or for staff without inj rights to do a meso like technique). More to come 😊

Our main goal has always been to be a creative centre for advanced naturopathic approaches and evolution, a leading edge company offering products, product development, devices, education and access to substances through pro-active work with the government, all focused to support these processes. We tried this by introducing various international companies to the market like Guna. Things aren't always what we expect, hence we are doing it under our brand & providing the environment which fosters intellectual & creative interplay. This is what we are supposed to do. 😊 Gotta listen to that Voice inside & loving it!!!

### Education & professional awareness

Monthly PNEI & biological med training in Montreal.  
National programs in place

April 1st annual Metabolic Factor / PNEI Bilingual conference, address cytokines, growth factors, hormones, neurotransmitters, allergens, emotional. Montreal. 2016 is set.

May Viatrexx approved by CNPBC (BC ND Board) for Aesthetic Meso and Aesthetic PRP certification, others in process.

July Dr Frasca (Italy) gives certification Meso training in Vancouver (Commits to 3 trips/yr)

Oct: Dr Quinn Rivet's 2-day naturopathic nephrology training (Montreal)

2016 training schedule for west released  
Notable instructors: Drs Nicoletta Frasca, Christoph Kind, Andreanna Rainville RN & others. (Very interesting courses.)

Topics: Aesthetics, PRP, Ozone, UBI, Pain, Immunology, Detox & Drainage, Endocrine, Neurological & Brain, Emotional, Scars.  
See website Viatrexx.com



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