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The Importance of Clean Air

Sometimes just a single spark of curiosity can be the beginning of a successful scientific career, says **Prof. Lidia Morawska**, Professor at the Queensland University of Technology and Director of the International Laboratory for Air Quality and Health (ILAQH).

How does pollution affect the risk of respiratory infections?

LIDIA MORAWSKA: Your question is an interdisciplinary one, and I can answer it only from the perspective of a physicist, not that of a physician or an epidemiologist. My research revolves around human exposure to harmful particles in the air. The key takeaway from my work is that pollutants pose a threat to every system in the human body. The respiratory system is especially vulnerable, but other systems are impacted as well, because pollutants can reach them via the circulatory system. For instance, if lead, a heavy metal, gets into the brain via the bloodstream, it can cause mental retardation. Other systems are also greatly affected by harmful particles, making pollution a factor that affects every aspect of the functioning of living organisms.

What motivated you to explore the field of air pollution research?

Ever since I was a young girl, I had always dreamed of becoming a nuclear physicist. That dream became a reality when I earned a degree in nuclear physics from the Jagiellonian University. During my undergraduate work I found myself particularly drawn to environmental radioactivity, and my research interests shifted away from reactor physics to the study of radon, a radioactive noble gas. Radon undergoes radioactive decay, producing short-lived progenies, which are heavy metals and also radio-

active. This became the focus of my doctoral dissertation, and I later explored it further at the University of Toronto. I had no doubt that the presence of radon in the air poses a threat to our health. However, I wasn't sure if there was much more that science could add to our already advanced understanding of radon and its progeny in the air. While at the University of Toronto, I had the opportunity to work with cutting-edge devices for studying the concentration and size distribution of ultrafine particles. Their presence in the air affects the fate of radon progenies because if they attach to ultrafine particles, they can potentially stay airborne longer . This was the focus of my research, which involved measurement studies in a chamber. Once, out of curiosity, I put a sampler of this device outside a window, and it detected a very high concentration of particles varying in sizes. Although air pollution is expected in a big city, I was surprised by the lack of published studies on ultrafine particles in the air.

How small are the particles we are talking about?

Very small, molecule-size particles – they are very interesting scientifically, and also extremely important because we breathe these particles in. At my current workplace, the Queensland University of Technology, I set up a research group to study this issue. It is known as the International Laboratory for Air Quality and Health (ILAQH).

During the SARS outbreak back in 2003, the WHO invited me to help unravel a scientific puzzle. The task was to understand how one infected individual within Hong Kong's Amoy Gardens housing complex managed to infect 300 others, overnight, although those people had had no direct contact with one another. Epidemiologists were unable to provide an explanation, and so a group of experts on aerosols (airborne particles) was set up, hopefully to shed light on how a virus could be transmitted through the air without even indirect contact among individuals. Retrospective research and modelling pointed to airborne spread of the virus from a faulty toilet system through the window and then, by movement of outdoor air, around the building complex and into numerous apartments through open windows. This experience prompted me to explore the existing literature on the particles emitted by people when they breathe and speak. It turned out that we knew very little about them, which is why I decided to study this important topic .

What about the air we breathe on the streets of big cities? What does it contain?

That depends on the city. Let's consider Brisbane, where I live and work. With a population of approximately two million inhabitants, it is a city of considerable size, though not on the scale of the world's largest metropolitan areas. Brisbane has very good air quality – due to the fact that it sprawls over a large area, like many New World cities. This allows the dispersion of particles and gaseous emissions from cars, resulting in their lower concentrations and thus contributing to better air quality. But if we turn our attention to cities in Europe, including Poland, the air quality there turns out to be very poor. The most commonly found gaseous air pollutants are nitrogen oxides, sulfur dioxide, carbon monoxide, and volatile organic compounds, most of which are hydrocarbons.

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LYNDON MECHIELSEN

The innovative rooftop ventilation system at the Queensland University of Technology in Brisbane

Air pollution is primarily caused by emissions from combustion in various sectors, transportation, industrial processes, and power plants.

What kind of air do we breathe indoors?

To a large extent, the same air as is found outdoors, because it finds its way into buildings, even when windows are closed. We do not think really about it, but this fact is obvious. Without this exchange, we would have no air to breathe indoors. Consequently, the pollutants that exist in the outdoor air are also present indoors. But indoor environments pose additional challenges due to other pollutants, many of which originate from our own bodies. They include exhaled carbon dioxide to pathogens, viruses, and bacteria. While the pathogens we emit can also be found outdoors, they are less concentrated and therefore create lower infection risk. At any time, but particularly when infection rates peak, we should take care to regularly ventilate our apartments and houses to expel pathogens outside. If such ventilation is not possible, the presence of bacteria and viruses emitted by human beings entails a higher risk of infections. Therefore, indoor air quality is affected not only by harmful particles but also by pathogens.

What can we do to safeguard ourselves from air pollution?

We can address this question on two levels: one individual, the other societal. A huge role is played by awareness – not only being knowledgeable about how we should protect ourselves but also refraining from harmful practices like smoking cigarettes. Sadly, when I visit Poland, I always quickly notice a significant difference in the number of smokers and the prevalence of smoking. Australia, where I live, has long implemented laws that prohibit smoking not only indoors but even anywhere near buildings, which is fundamentally important.

But there are limits to what we individuals can do in isolation to safeguard ourselves. We can do a lot more as a community. The most important thing is to curb all emissions, which means that our societies need to switch to clean energy. Additionally, future building designs should strive to keep outdoor pollutants at bay and ensure good ventilation for what we generate indoors. A simple solution like opening up the windows only works when the air outside is clean and when the outside temperature is acceptable. If we close them, the indoor space will be poorly ventilated. Please note that I'm not really talking about any outlandish, futuristic building designs and technologies. The technologies that we need already exist, but the greatest challenge lies in overcoming people's mental and awareness barriers as well as political barriers against indoor air regulations. Above all, we must recognize the importance of breathing clean air. Given that we take an average of 12 breaths per minute, we continually expose our bodies to polluted air, over and over again. So this is an absolutely fundamental problem. We must understand the importance of clean air for our health at the most fundamental level.

Interviewed by **Justyna Orłowska, PhD**