

Profile of Anthony J. McMichael

Smoking causes lung cancer. Diets high in fat and cholesterol clog arteries. Exercise is good for the heart. These links between behavior and disease represent the end products of epidemiological studies involving thousands of people that have taken years, even decades, to complete. But what happens when health issues crop up without a clear cause, or when the causes are too numerous to parse out? Traditionally, epidemiologists have steered clear of such relationships. By doing so, however, they ignore many of the world's most pressing public health problems, says Anthony McMichael, head of the Environment, Climate, and Health research program at Australian National University in Canberra. Look, he says, at obesity. "You can't get a single-factor explanation for why levels of obesity are rising," he says. "It simply is not a smoking-causes-lung-cancer type relationship."

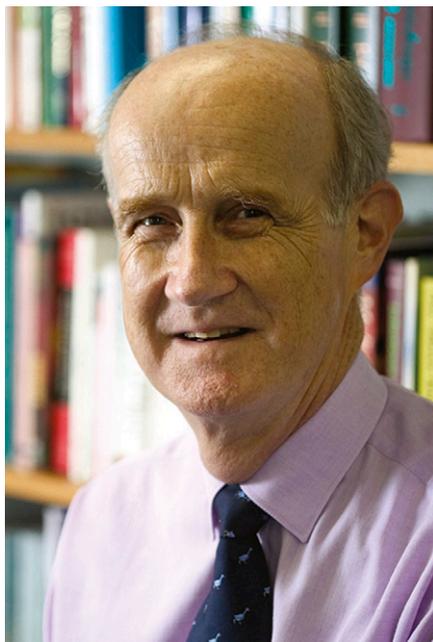
McMichael, elected in 2011 to the National Academy of Sciences, is a strong proponent of expanding epidemiology research from individual- to population-level studies. To this day, researchers focus more on the environmental and economic repercussions of a warming world than on how such changes might affect human health—a potentially dangerous distraction, he says.

To remedy that oversight, McMichael's Inaugural Article explores how major climatic events over the past 12,000 years have influenced human health and survival, and how even mild to moderate climate change can lead to the disruption and collapse of societies (1). With the global temperature likely to increase by 3 °C to 4 °C over the next 100 years—considerably more than the fraction-of-a-degree fluctuations that influenced the outbreak and spread of the bubonic plague in mid-14th century Europe—the risk to human health is graver than we realized, he says. "Climate change is not just about disruptions to the local economy or loss of jobs or loss of iconic species. It's actually about weakening the foundations the life support systems that we depend on as a human species."

From Stethoscopes to Laboratory Coats

Born to an architect and homemaker during World War II in Adelaide, Australia, McMichael describes his childhood as idyllic. Life was spent outdoors on bicycles, on beaches, and exploring woodlands. He excelled academically early in life, finishing first in his primary school class at age 7 and leading his high school class as head prefect.

In 1961, McMichael entered the University of Adelaide in South Australia



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to study medicine. Following an older classmate's lead, McMichael spent a summer volunteering at a leprosy colony in New Delhi, India. The patients in the colony were outcasts, he says, even though they were no longer contagious. McMichael and his fellow volunteers became committed to dispelling the prejudice, and the experience made it clear that he did not have to become "a stethoscope-carrying doctor" to contribute to people's health. The following year, McMichael went on a similar service trip to Papua New Guinea—a serendipitous choice. On that trip, he met social sciences student Judith Healy, whom he married shortly after graduation.

Training in Classic Epidemiology

Unsure of how to proceed, McMichael took a gap year upon graduation, serving as president of the National Union of Australian University Students in Melbourne. There, he met up with Basil Hetzel, a professor he had admired at Adelaide University. Hetzel had recently been appointed to launch a department of social and preventive medicine at Monash University in Victoria and invited McMichael to become one of his doctoral students. McMichael accepted the offer and began studying factors that influenced the mental health of undergraduate students—a project that required recruiting incoming freshmen and developing questionnaires to track their wellbeing.

While that work taught McMichael how to conduct a classic epidemiological study,

his readings challenged him to view the field through a broader lens. He recalls being deeply influenced by Paul and Anne Ehrlich's book *Population, Resources, Environment* (2). The Ehrlichs, McMichael says, were among the first to ask how long the earth could sustain the growing human population and their living habits. By chance, McMichael discussed the book with a former university classmate who had become the editor of a national newspaper, *Nation Review*. The editor asked McMichael to write a book review, a gig that led to a regular newspaper column. As a columnist, McMichael rapidly became an expert in the emerging field of ecoepidemiology. "I called the column Spaceship Earth to make the point that it's a closed system with limited resources, and if you throw rubbish around, it all collects inside the station," he says.

By the time McMichael finished his doctorate in 1972, he had become fascinated by the ideas of Pulitzer Prize-winning author and microbiologist René Dubos. Dubos was among the first to use the phrase "think globally, act locally," which encourages responding to global problems in a local context. McMichael wrote Dubos a letter inquiring about a possible job. Dubos replied saying he had recently retired but had passed the letter on to a colleague. The letter would change hands several more times before arriving at the School of Public Health at the University of North Carolina (UNC) in Chapel Hill. By chance, UNC had just landed a major contract with the United States Rubber and Tire Manufacturing Industry and Union, and needed medically qualified epidemiologists to study the health of workers in the tire industry. They asked McMichael to begin immediately.

At UNC, McMichael became interested in evaluating illness and death rates in a large population of tire workers. He found that, despite the occupational exposure risks the workers faced, their health indices always looked statistically better than that of the larger population. McMichael realized that that misconception arose because, in many studies, the workers were being compared with a general population, including mentally or physically ill individuals who could not hold down a job. McMichael described this misleading comparison and its result as the "healthy worker" effect (3). The term soon led to spinoffs—such as the

This is a Profile of a recently elected member of the National Academy of Sciences to accompany the member's Inaugural Article on page 4730 in issue 13 of volume 109.

“healthy migrant” and “healthy parent” effects—and remains an active area of study to this day.

In 1976, McMichael reconnected with Hetzel, who offered him a job as a research scientist with the Division of Human Nutrition, Commonwealth Scientific and Industrial Research Organization in Adelaide. McMichael jumped at the opportunity to collaborate with his old advisor while allowing his two young children to grow up near their grandparents in his old hometown.

Broadening Relationships

The job was initially straightforward. McMichael supervised doctoral students studying the links between diet and health ailments such as breast cancer and cardiovascular disease. However, he soon got drawn into another project, one that would extend over the next decade. An acquaintance working for the South Australian Health Department was trying to figure out why so many women experienced stillbirths in the town of Port Pirie, home to the largest lead smelter in the southern hemisphere. He asked McMichael and Commonwealth Scientific and Industrial Research Organization to help solve the puzzle.

Scientists already knew that lead could cause reproductive problems in rodents and other mammals, and historic documents showed that lead had traditionally been used as an abortion agent (4, 5). McMichael's task was to determine if Port Pirie's smelter was indeed to blame for the town's high number of stillbirths. He and colleagues recruited pregnant women from in and around the town and monitored their blood lead levels. The researchers then tested the umbilical cord blood of babies carried to term and observed their physical and intellectual development until age 12 years.

In a seminal paper published in 1988, the researchers analyzed 537 children born between 1979 and 1982 in Port Pirie and showed that the subset of children with elevated blood lead levels scored, on average, 7.2 points lower on a general cognitive test than children with lower lead levels (6). The public health community was galvanized into action. McMichael's findings triggered a massive cleanup effort in Port Pirie and influenced the tightening of lead exposure guidelines worldwide.

McMichael's work in Port Pirie solidified his interest in studying the intersection between health and the environment. His timing was impeccable. In 1987, the Montreal Protocol established guidelines for reducing atmospheric ozone depletion. More than an environmental catastrophe, McMichael realized that ozone depletion could also compromise human health. “If

humans are exposed to more ultraviolet radiation because of ozone depletion, skin cancer rates were going to go up, as were cataracts of the eye,” McMichael surmised. Climate change was also beginning to emerge as a looming problem. The United Nations established the Intergovernmental Panel on Climate Change in 1988.

That confluence of events prompted McMichael, then a professor of occupational and environmental health at the University of Adelaide, to begin work on his first book, *Planetary Overload* (7). In that book, McMichael focused on five major environmental problems arising from unrestrained population growth and intensified economic activities—climate change, ozone depletion, land degradation and impairment of food production, loss of biodiversity, and burgeoning cities—and how those factors could impede human health.

The book was ahead of its time. “I got a devastating letter from the health sciences editor at Oxford University Press saying that they weren't at all interested and it all seemed rather speculative and a bit fantasy-like, the sort of thing that could only be written from the vantage point of a privileged society member, one who didn't have to see children dying from diarrhea and malarial disease every day,” McMichael recalls.

Luckily, on a trip to London, McMichael met up with Andrew Haines, another public health researcher studying the link between climate change and human health. Haines had recently been asked by Cambridge University Press to write a book on the topic but did not have the time, so he suggested that McMichael look into taking on the project. Today, *Planetary Overload* remains a decisive work on the topic and is often assigned reading for college students. It also positioned McMichael as a leader in the field. In 1993, the Intergovernmental Panel on Climate Change asked him to chair the health risk assessment chapter team for its second assessment report (8).

Urging Uptake Among Colleagues

By the 1990s, McMichael had begun encouraging current and future epidemiologists to broaden the scope of the field (9). In a paper titled “Prisoners of the Proximate,” McMichael urges epidemiologists to look beyond problems close at hand and focus on larger, underlying issues (10). McMichael also engaged in active research to explore why populations living closer to the poles have higher rates of multiple sclerosis, an autoimmune disorder. A case in point: multiple sclerosis rates are four to five times lower in Queensland than Tasmania, which is 20 degrees closer to the South Pole. McMichael and colleagues honed in on a likely cause: UV radiation.

Previous studies had shown that rodents exposed to higher UV levels have suppressed immune systems (11). Moreover, UV exposure is greater the further you are from the poles. That suggested populations living closer to the Equator have lower rates of MS because UV exposure lessens immune system activity, including misdirected “autoimmune” attacks on the body tissues (12).

That type of work influenced the theme of McMichael's second book, *Human Frontiers, Environments and Disease* (13). In that book, McMichael evaluates how technological and environmental changes have already altered historic patterns of disease and how those changes could be amplified in the future.

Honing in on Climate Change

In 2001, McMichael moved back to Australia to direct the National Centre for Epidemiology and Population Health at the Australian National University. That same year, the World Health Organization asked him to head an effort to estimate the annual global burden of disease attributable to climatic changes that had occurred by the year 2000. That enormous undertaking made McMichael and his team aware of ailments that could—and could not—be included in such a calculation. For instance, it was possible to estimate climatic influences on malnutrition, starvation, and the spread of certain infectious diseases, but not heat-wave impacts in poorly housed populations, suicide rates, or mental health problems. The team concluded that tens of thousands of people were dying each year from climate-induced flooding, malnutrition, and infectious diseases (14). “The real numbers will be a lot higher,” McMichael says, “but this was the first paper to make an estimation of how many deaths from at least a subset of climate-sensitive health outcomes are attributable to climate change.”

In 2007, McMichael stepped down as Centre Director to head the Environment, Climate and Health Research Program within the same center. In that role, he has been studying a widening range of health risks from climatic changes, modeling likely future risks, and developing a research program to evaluate strategies populations can adopt to cope with such changes.

One groundbreaking study evaluated how greenhouse gas emissions from livestock production could be reduced if people in richer countries ate less meat, a shift that could potentially improve their health. “When I grew up in the 1950s, Australians typically ate three meat meals a day: lamb chop for breakfast, cold meat sandwiches for lunch, and roast beef or equivalent in the evening. That was just taken for granted,” McMichael says. To lock in emissions at 2005 levels, McMichael and colleagues

