

The environment and health inequalities: problems and solutions

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ABSTRACT

Tremendous gains have been made in advancing life expectancy around the world; however, marked disparities persist across socioeconomic gradients within countries and among countries globally. Exposure to disease-causing environmental agents also varies markedly by socioeconomic indicators; indoor and outdoor air pollution are exemplary in that regard. An ever-increasing body of evidence links environmental contaminants to diseases and poor health across the lifespan. This presentation addresses how the environment contributes to disparities in health and the potential to reduce disease burden through environmental management. The focus is on air pollution, but other examples will be explored, giving emphasis to the potential for prevention and the policies that are needed to do so.

KEY WORDS: ambient air pollution, health disparities, tobacco smoking.

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INTRODUCTION

Economic inequality and its consequences for health have long been recognised and studied extensively by economists and the many disciplines concerned with population health. In most countries, health care providers recognise the links between the incomes and educational levels of their patients and their health status. These links have received substantial attention from epidemiologists and social scientists in recent decades, as efforts have been made to understand the pathways by which socioeconomic status is inversely associated with indicators of health and disease. The topic of health inequities has now been investigated extensively, with thousands of relevant publications annually identified with a simple search of the biomedical literature. Comprehensive and authoritative reports have been prepared at the national and international levels to guide policy-makers towards decisions that will address the origins of health inequalities and their consequences [1, 2].

This paper, based on a presentation at the June 2019 Calisia World Conference on Family Health, addresses

how environmental factors contribute to health inequalities generally and then explores more specifically the roles of two powerful exposures: outdoor or ambient air pollution and tobacco products, both ubiquitous in countries at all income levels. First, a reminder that health and risk for disease are driven by factors that extend from the molecular, e.g. the genome and epigenome, to the global, e.g. the multinational tobacco industry, and that these factors may act across the full lifespan, even having effects that start *in utero* [3]. Continuing with the example of tobacco, genetic factors are related to susceptibility to nicotine addiction; family and peer dynamics can support or thwart use of tobacco products; neighbourhood characteristics, including retailers and local tobacco control measures, play a role; state and national tobacco control regulations affect the tobacco control environment; and the actions of multinational corporations, like Philip Morris International, may have far reaching consequences.

Health disparities arise across groups as exposures to multi-level arrays of determinants of health are influenced by people's characteristics, including socioeco-

conomic status (Fig. 1). In this model, characteristics of people are linked to diverse environmental exposures, access to health care, and the quality of health care available, including preventive services. The consequences of such disparities can be profound. For example, a study of mortality in New York City, conducted three decades ago, showed that mortality for Black males in Harlem was as poor as that for men in Bangladesh [4]. Now, in the United States, life expectancy is declining for middle-aged people in Appalachia and elsewhere, as so-called “deaths of despair”, driven by fatal drug overdoses, rise rapidly [5]. The trends of health inequalities are more optimistic for Europe, where they have lessened in recent decades in most countries.

THE ENVIRONMENT AND HEALTH DISPARITIES

Introduction: The Global Burden of Disease project provides insights into the drivers of morbidity and premature mortality [6]. Central to the estimation of burden is the concept of the “counterfactual”, i.e. a comparison of the burden with the current profile of exposure to an agent with a non-existent counterfactual scenario in which the exposure is reduced or eliminated. For tobacco smoking, for example, the comparison is between the current prevalence of smoking and the clearly non-existent, but hopefully achievable, counterfactual of no smoking. The burden itself depends on how widespread the exposure is, and the increased risk associated with exposure.

Using this methodology, the Global Burden of Disease project periodically provides estimates of the burden attributable to various factors. Burden is measured in two ways: disability-adjusted life years lost (DALYs), the sum of years lived with disability with the years of life lost

through premature death; and years of life lost. Table 1 provides the estimates of burden for tobacco smoking, ambient particulate matter air pollution, ozone pollution in outdoor air, and household air pollution. For tobacco smoking and air pollution, the associated burdens are large, and both are among the leading causes of avoidable morbidity and mortality.

Tobacco smoking: Given the lengthy list of diseases caused by smoking tobacco, the prominence of smoking as a cause of avoidable morbidity and premature mortality is hardly surprising and long-documented. As early as 1938, Raymond Pearl at Johns Hopkins described lower life expectancy among smokers compared with nonsmokers, in terms of years for “heavy smokers” compared with nonsmokers [7]. Since the linkage of smoking to lung cancer in the early 1950s, the scientific evidence showing that smoking causes diseases of most organs has grown immensely, and epidemiological studies show that more recent types of cigarettes have higher risk than earlier products [8].

Smoking is a potent contributor to disparities (Table 2), acting through multiple pathways. The smoking-related disparities begin with targeted marketing and ready access for those lower educated populations at greater risk, ties to cultural norms around smoking, and the challenges of communicating risks of use of tobacco products. Disparities continue with regard to access to prevention programs and cessation services, including pharmacological aids to cessation that have proven efficacy. For those with lower incomes, the costs of tobacco products affect household microeconomics, and unfortunate trade-offs may be made if a substantial component of household income is expended on tobacco

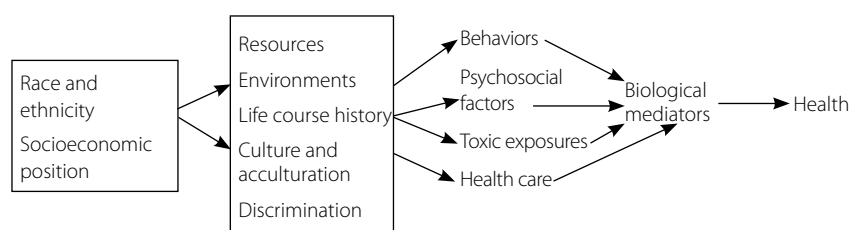


FIG. 1. Pathway model for health disparities (based on Ana V. Diez Roux. *Annu Rev Public Health* 2012; 33: 41-58). Genetic model

TABLE 1. Disease burden from air pollution and smoking in Poland and globally, 2017

Factor	DALYs per 100,000*		Deaths per 100,000*	
	Poland	Global	Poland	Global
Ambient air pollution	1266.7	1086.9	55.2	38.4
Ozone	53.7	96.4	3.5	6.2
Household air pollution	152.5	778.4	6.3	21.5
Smoking	5348.8	2378.9	92.5	198.8

*Both sexes, All ages, 2017

Source: GBD Compare <https://vizhub.healthdata.org/gbd-compare/>

products. Also, smokers and their families may be faced with the costs of smoking-caused diseases, including lost wages and health care costs.

There is ample documentation that smoking contributes to health disparities. Fortunately, smoking is declining in Poland, making it a lesser contributor to health disparities [9]. A study of 14 countries in Europe, spanning 1990–2004, showed that declines in smoking in men had led to a narrowing of inequities among men, but to a lesser degree in women [10]. Tobacco control has been enhanced in many European countries by regulations of the European Union, e.g. smoke-free regulations and graphic pack warnings, and by the World Health Organisation's Framework Convention on Tobacco Control. However, progress is threatened by the wave of new electronic cigarettes, which have proven attractive and addictive for youths and young adults.

Considering the pathways by which smoking causes disease (Fig. 2), there are multiple points for intervention at multiple levels. At the global level, the Framework Convention on Tobacco Control has broad impact as a vehicle for establishing the state-of-practice for tobacco control and for handling the multi-national tobacco corporations to the extent possible. The Framework Convention also sets guidelines for what nations should do. Much activity has always taken place at the local level, where the influence of the industry may be less powerful than nationally. At all levels, consideration needs to be given to the diversity of populations in their vulnerability to the tobacco industry and the specific challenges around fostering tobacco control in specific populations, particularly those with lower educational levels, who are universally at risk.

The Environment: Here, consideration is given to environmental exposures that harm human and ecosystem health, acknowledging the connection of the health of populations to the state of the environment and ecosystem services generally. Table 3 provides a general list-

TABLE 2. How tobacco causes health disparities

Targeted marketing and access
Ties to cultural norms
Links to education level
Access to health care and cessation services
Overlooked in prevention programs
The costs of tobacco products
The costs of tobacco-related diseases

ing of how environmental exposures contribute to health inequities. As with tobacco products, there are multiple ways that pollution harms health; above all, the potential for harmful exposures depends on the characteristics of populations. The total burden is large: the 2018 *Lancet Commission* on pollution estimated that 9 million deaths worldwide per year can be attributed to pollution – about one in six of all deaths [11]. Viewed globally, the burden is spread unequally, being highest in low- and middle-income countries, particularly those of Sub-Saharan Africa, India, and some countries in Central and Eastern Europe. Air pollution contributes the largest proportion of the burden associated with the environment, followed by water pollution, occupational exposures, and then contamination of soils, chemicals, and metals.

Figure 3 provides estimates of deaths (rate of attributable deaths) from environmental and occupational exposures for Poland compared with global estimates. The high burden in Poland for air pollution is notable, reflecting the persisting pollution from industry, motor vehicles, and burning of coal for residential heating for a substantial proportion of households. Fortunately, the burden of premature deaths from air pollution in Europe has been falling in the last three decades, but to a lesser extent in Poland.

Climate change reflects a global form of air pollution: emissions of greenhouse gases at a rate that exceeds the

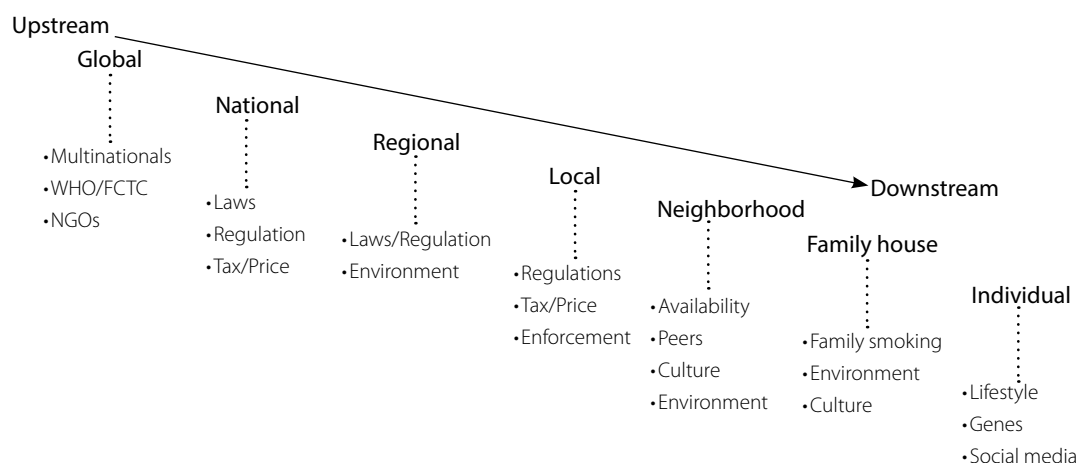


FIG. 2. Smoking and disease

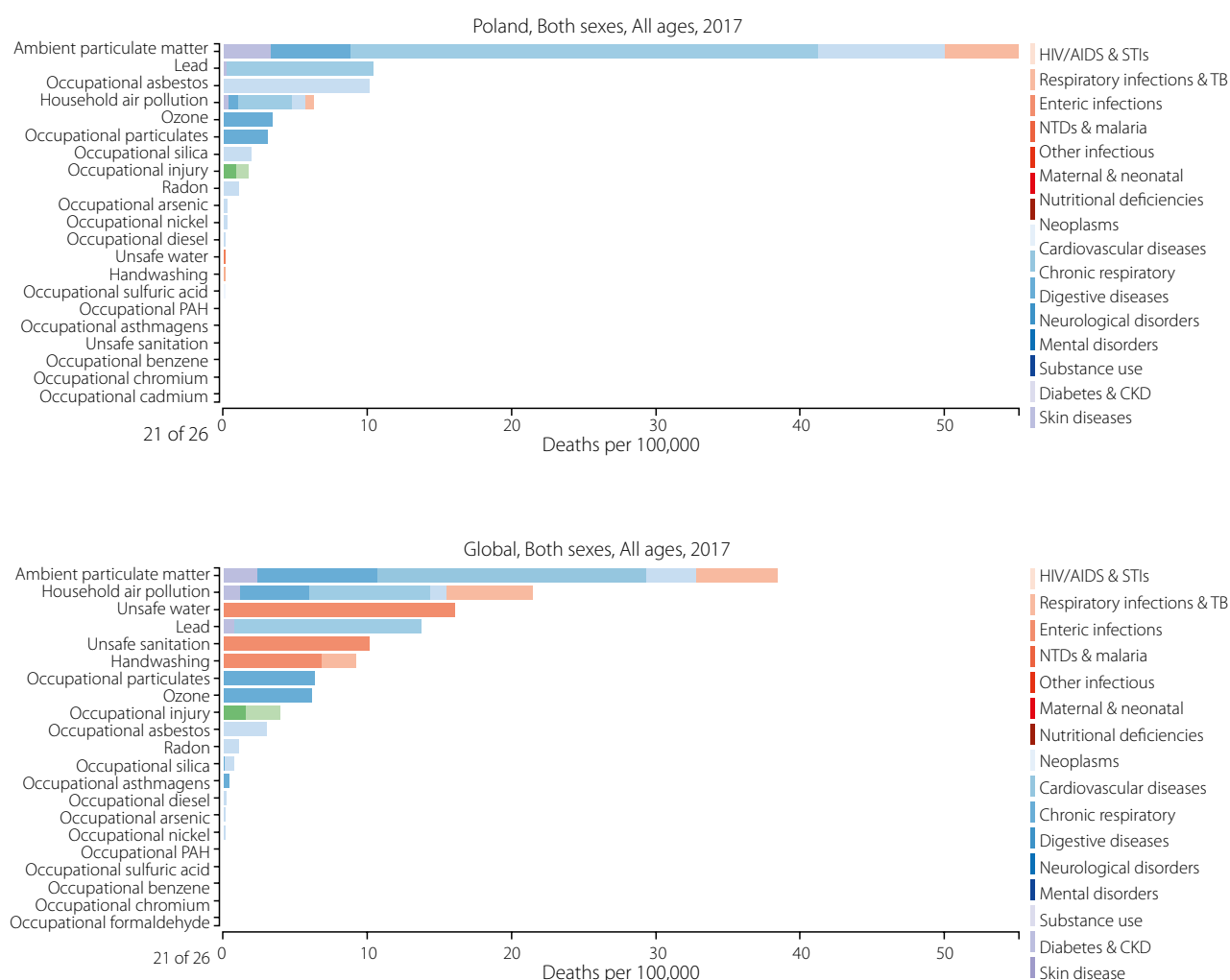


FIG. 3. Deaths attributable to environmental and occupational exposures, Poland vs. global, 2017 (GBD, 2017) [6]

TABLE 3. How does the environment cause health disparities?

Pollution exposure is not equal within communities, across countries, and among nations
Exposure inversely links to socioeconomic level
Regulations may not protect everyone equally
Those more exposed often have lower quality housing and health care
Pollution reduces potential (lead)
Costs of pollution-caused poor health

capacity of the planet to contend with them. The leading emitters of greenhouse gases are high-income countries, like the United States, and the rapidly industrialised countries with growing economies, particularly India and China. Yet, the health burden of air pollution will fall disproportionately on low-income countries that have limited resources for adaptation, e.g. using air conditioning to deal with rising temperatures and heat waves.

Air pollution, like tobacco control, requires global and local measures for its control (Fig. 4). National, state, and local regulations are needed to control polluting industries, reduce emissions from motor vehicles,

and control such ubiquitous sources as burning waste. Reducing exposures from household burning related to biomass fuel burning has proved challenging; alternatives include low-emission stoves and replacement of highly polluting fuels with cleaner alternatives. Addressing polluting fuels used for cooking and space heating reduces exposures indoors and also the contribution of household fuel burning to outdoor air pollution.

CONCLUSIONS

The 2019 Calisia World Conference on Family Health focused on factors that can be addressed to

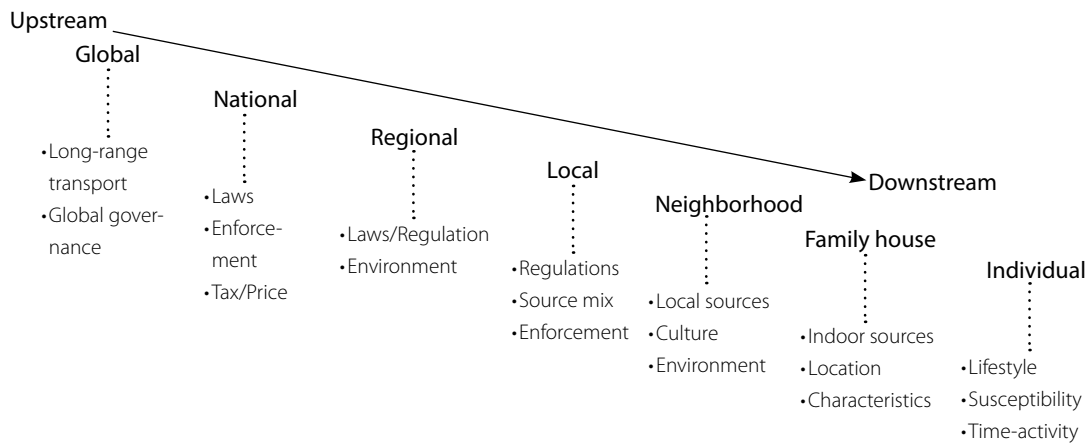


FIG. 4. Air pollution and disease

improve population health. We have known the risks of tobacco smoking for nearly 70 years, and the scientific evidence on smoking, addiction, and disease has motivated multi-component approaches to tobacco control. Over time, the gradients of smoking by measures of socioeconomic status have persisted, but the contribution of smoking to health disparities has lessened as smoking rates have declined. The new tobacco products and the seemingly emboldened tobacco industry pose threats that need to be addressed.

We have also known for decades that air pollution threatens population health. Indeed, the London Fog of 1952, causing more than 10,000 extra deaths in one week, was a sentinel event that motivated research on air pollution and health and control strategies. Air pollution persists as a leading cause of morbidity and mortality, reflecting rising concentrations in low- and middle-income countries. Its health consequences affect the less affluent and less educated. There are myriad other pollutants harming health.

There are ways to reduce the disease burden and health inequities associated with smoking and pollution. Solutions need to be at multiple levels, extending from the community to the global level. This conference provided a useful venue for discussing these solutions.

DISCLOSURE

The author reports no conflict of interest.

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Jonathan M. Samet, a pulmonary physician and epidemiologist, is Dean of the Colorado School of Public Health and Professor in the departments of Epidemiology and Environmental and Occupational Health. Dr. Samet received a bachelor's degree in Chemistry and Physics from Harvard College, an MD degree from the University of Rochester, School of Medicine and Dentistry, and a master's degree in Epidemiology from the Harvard School of Public Health. His research has focused on the health risks of inhaled pollutants – particles and ozone in outdoor air and indoor pollutants including second-hand smoke and radon. He has also investigated the occurrence and causes of cancer and respiratory diseases, emphasising the risks of active and passive smoking. For several decades, he has been involved in global health, focusing on tobacco control, air pollution, and chronic disease prevention. He has served on and chaired numerous committees of the National Academies of Science, Engineering, and Medicine, and he chaired the Clean Air Scientific Advisory Committee (CASAC) of the U.S. EPA and the FDA's Tobacco Products Scientific Advisory Committee (TPSAC). Dr. Samet has served as editor and author for Reports of the Surgeon General on Smoking and Health since 1984, receiving the Surgeon General's Medallion in 1990 and 2006 for these contributions. He was the Senior Scientific Editor for the 50th Anniversary 2014 report. Dr. Samet received the 2004 Prince Mahidol Award for Global Health awarded by the King of Thailand, the Edward Livingston Trudeau Medal from the American Thoracic Society/American Lung Association, the Luther L. Terry Award for a Distinguished Career from the American Cancer Society, and the Fries Prize for Health. He received the Alumni Award of Merit from the Harvard School of Public Health and was named Distinguished Alumnus of the Year by the University of Rochester School of Medicine and Dentistry. He was elected to the National Academy of Medicine (Institute of Medicine) of the National Academy of Sciences in 1997 and received the Academy's David M. Rall Medal for his contributions in 2015.



Professor Jonathan Samet has participated in tobacco control collaborations with Polish researchers since the 1990s. Together with Prof. Tony McMichael, a pioneering researcher in the realm of environmental pollution and public health, Prof. Samet was involved in a number of studies on the health consequences of indoor and outdoor air pollution in Poland, and in Central and Eastern Europe. They have yielded several academic publications (see list of articles below). In 2009 Prof. Samet received the Golden Lungs Award of the Polish Health Promotion Foundation from the Foundation's Honorary Chairman, Primate Cardinal Józef Glemp (see photos below).

The Award is attributed to individuals who have made a significant contribution in support of the Foundation's activity towards improving the health of Poles, and for their personal input towards shaping healthy lifestyles in Poland.

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