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Epidemiology for Sound Public Health Policy

Prof. Klim McPherson,
London School of Hygiene and Tropical Medicine

Public health is about the complex interaction between individual health and health beliefs and the intricate features of populations: their social, political, environmental and economic realities. Public health policy must begin with measuring the burden of ill health and then concern itself with the solutions, be they biological, social, economic or all of these. To develop the Public Health policy agenda more effectively, the following issues have to be considered:

- What are the major social/structural factors influencing health? What is the evidence base?
- What are the main public policy sectors that influence these factors?
- How can the process of policy change be measured to identify the real factors that improve health?
- What are the negotiating strategies that work for improving the population's health?
- How do these vary by population aggregation, jurisdiction level or sector?
- How should 'public health' position itself between the multiple sectors with public health influence?
- How can techniques of health impact assessment be made more reliable and useful?
- How can the actual contributions of improved population health to economic and social development be reliably assessed?

Epidemiology helps us address these issues. It is the basic science that provides the scientific foundation for the practice of Public Health. The word 'epidemiology' comes from epidemic, which translated from Greek literally means 'upon the people'. The practice of epidemiology is the scientific process that detects, investigates, and analyzes health problems, and then applies this information to prevent or control these problems. For this, the health problems should be the subject of public health surveillance, epidemiological investigation, and analysis.

Epidemiology aims to determine and understand the environmental factors—including political, social, and economic, among others—that influence the burden of ill health. It helps us understand the evidence base, the plausible mechanisms, the limits of uncertainty and the interactions and the potencies of these factors relative to known individual lifestyle, genetic and other biological risk factors. The findings when linked to health policy can lead to control and prevention programs aimed at resolving the health problem.

The epidemiologist employs different tools. These may involve a clinical, immunological, microbiological, pathological, demographic, sociological or statistical approach or a combination of two or more of these. The use of these approaches in specific ways with particular objectives constitutes the epidemiological method. The practicing epidemiologist has a responsibility for clear and persuasive communication of his scientific findings to the public, the policy makers, and the program personnel. He/she also has the responsibility for participating in evaluation of control and prevention activities. Table 1 illustrates how the various approaches of epidemiology help in providing knowledge for public health policy formulation, implementation, and evaluation.

Table 1

Knowledge required for public health policy	Role for epidemiology
1. Burden	Descriptive
2. Causes	Analytical
3. Determinants of causes	Socio/analytical
4. Role for prevention	Policy/experimental
5. Intervention	RCT
6. Outcome	Measurement

A Historical Perspective

The observational insights that drive epidemiologic inquiry span centuries. The long and varied history of epidemiology shows some of the strong roots and tenets that distinguish this important field today. Greek miasmatic theories of disease transmission linked some febrile illnesses with environmental conditions ("marsh fever"); the Romans recognized the symptoms of plumbism to be associated with wine sipped from lead-glazed pottery. Even in the absence of large prospective cohort studies, Maimonides[17] and Dickens[4] suggested that a physically active lifestyle conferred health benefits.

Early epidemiologists were preoccupied with infectious disease epidemics like malaria, cholera, and plague; they also considered environmental hazards like lead and climate, occupational risks for disease, and chronic diseases like cancer and heart disease. The roots of clinical epidemiology can be traced to the controlled studies conducted by James Lind in 1753, which demonstrated the value of citrus fruits in preventing scurvy. [16]

The public health giants of 19th-century Europe melded their quantitative skills and techniques with social concerns and public health action. Prominent in this lineage are John Graunt, William Farr, John Snow, Pierre Charles-Alexandre Louis (who developed "la méthode numerique"), Pierre Laplace, Johann Peter Franck (who developed the concept of "medical police") and Rudolf Virchow (the investigational genius and socio-political activist). These pioneers saw the vast potential for improving health that could be generated by linking accurate calculations to effective communication and intervention.

Progress in the 20th Century

Epidemiology has played a major role in the public health triumphs of the last 100 years. Eradication of smallpox is one such signal achievement. The Centers for Disease Control and Prevention in Atlanta, Georgia, USA has compiled and published a number of such accomplishments in their Morbidity and Mortality Weekly Report[3], which clearly shows the role of epidemiology.

Disease surveillance and epidemiologic investigation have been the major pillars for our successes over vaccine-preventable diseases. While clean water, sewage disposal, better hygiene, and antibiotics were prominent among the measures for the control of communicable diseases, there was also reliance on outbreak investigations and the identification of major risk factors. Goldberger used an epidemiologic approach to decipher the nutritional deficiencies behind pellagra.[8]

Clinical epidemiology today provides an increasingly broad interface between clinical medicine and epidemiology. The efforts of Kerr White, the McMaster group, and Alvan Feinstein have greatly contributed to strengthening this area of epidemiology.[7,21,27] A large number of epidemiologic studies have demonstrated risk factors for cardiovascular disease, and pointed to the need for marked lifestyle changes for effecting a decline in cardiovascular disease mortality. Efforts for curbing tobacco use and the associated morbidity and mortality can be traced to the epidemiologic studies by Doll and Hill, Wynder and Graham, and others.[5,6,32] Through his study on asbestosis, Selikoff was able to demonstrate a conclusive linkage between a substance, occupations, and adverse health outcomes.[22]

Thus, different facets of epidemiology have contributed to achievements in public health by calculating disease trends and probabilities, communicating findings to the public and policymakers, and designing and implementing interventions based on the data. In the second quarter of the 20th Century, public health visionaries, like Major Greenwood in Great Britain and Wade Hampton Frost in the United States, brought together diverse aspects of epidemiology into a more coherent discipline, creating Schools of

Public Health and a professional cadre for the application of epidemiologic principles.

Epidemiological analysis involves identification and logical separation of the component parts of a health problem, followed by careful study of each using statistical analysis and logical interference. These analyses have been greatly facilitated by advances in statistical methods, such as logistic regression, multi-linear analysis, and in survey techniques. The modern facilities for computer storage and retrieval of health-related information has also considerably enhanced the power of analysis to reveal significant associations between exposures and outcomes. Routine analyses of health statistics and epidemiological studies using existing records have contributed significantly to the knowledge about many causal relationships. Important among these are the association between rubella and birth defects, cigarette smoking and cancer, exposure to ionizing radiation and cancer, adverse drug reactions such as the thrombo-embolic effects of the oral contraceptive pill, excessive child deaths due to use of certain antihistaminic drugs, and increased risk of hypertension in middle age among low birth weight and premature infants.

Applications of Epidemiology in Public Health

Epidemiology is essential for developing scientifically responsible public health policy. Epidemiological approaches help nations in identifying new approaches to policy development, focusing on countrywide health objectives and priorities. Epidemiologists are actively engaged in various activities, such as surveillance, investigations, analysis and evaluation. Applying epidemiology to control epidemics is of contemporary public health relevance. The various other policy directions from applied epidemiology include:

- Tackling the roots of health and disease
- Addressing life-cycle issues
- Focusing attention on settings
- Taking action in many sectors and beyond those boundaries typically thought of as being health-related
- Working in both public and private domains
- Measuring success of health policy in terms of health of populations

The extensive epidemiologic studies that have been conducted and are in progress on (i) breast cancer and (ii) the relationship between cholesterol and coronary heart disease are good examples.

The relative frequency of the ten most common cancers in selected Asian populations based on population based cancer registries in Mumbai city of India and the Osaka Prefecture in Japan shows breast cancer to be the second most common cancer among women in both the groups. Studies in England and Wales have clearly shown that the incidence and mortality rates for breast cancer increase exponentially as the age advances and are highest in the age group 70 years and above. The age-wise distribution of mortality among women due to this condition in various developed and developing countries also supports this view.

Many positive changes in breast cancer management have occurred in recent years, particularly for women with an early-stage diagnosis. Improvements in medical technology, a better understanding of how breast cancer develops and spreads, and the assertiveness of those concerned with women's health have been responsible for these changes.

The biology of breast cancer is extremely complex and still poorly understood. However, well-conducted epidemiological studies have made significant contributions to the body of knowledge on the disease. Epidemiological studies have helped uncover several genetic, hormonal, and environmental risk factors for breast cancer, although none of these can reliably predict which women will develop the disease. Although numerous epidemiological risk factors for breast cancer have been reported,[11] most of them are not clinically meaningful, as they involve low levels of relative risk (less than 2.0). Such low levels of relative risk are considered "weak associations" even when statistically significant and may well

reflect simple chance.

Among known risk factors, having a first-degree relative (mother, sister, or daughter) who has been diagnosed with breast cancer, a previous history of cancer in one breast, and certain hyperplastic lesions have been shown to be highly correlated with breast cancer[12]. Women with these characteristics are at least twice as likely to develop breast cancer as their counterparts. Moderate to high doses of radiation to the chest particularly among women exposed before 40 years of age, biopsy-proven atypical epithelial hyperplasia (and possibly sclerosing adenosis), and lobular cancer in situ have also been shown to increase the risk for breast cancer.[12] The long-term effects of low doses of radiation, such as those from occupational exposures or medical diagnostic procedures, have not yet been established.

Some reproductive risk factors are nulliparity, late age at first full term pregnancy, and early onset of menarche, menstrual history of more than 30 years, and late menopause (onset after age 55). The relationship between breast cancer and reproductive history suggests a crucial role of ovarian hormones in the development of breast tumors. Obesity in postmenopausal women has also been associated with a higher risk for breast cancer, whereas in pre-menopausal women, obesity seems to be associated with a lower risk.[12] There are contradictory reports on the impact of breast-feeding but, at most, not breast-feeding is a low-level relative risk factor. Protective effects of regular physical exercise[2] and a healthy diet have also been postulated, although the link between diet and breast cancer has not yet been firmly established.[9,28] Differences in breast cancer risk detected by demographic factors have been useful in formulating etiologic hypotheses and suggesting new research leads. For example, increasing age, high socio-economic status, and urban residence are demographic factors shown to be associated with a higher risk for breast cancer. [12]

The various 'modifiable' risk factors for breast cancer with their respective Population Attributable Risks (Table 2) are obesity (12%), late pregnancy (7%), early menarche (9%), fatty diet (5%), genes (5%), alcohol (2%), and culture/ill-defined factors (70%). From a public health standpoint, the identification of groups at higher risk for breast cancer is essential for directing preventive efforts to these groups. Information on race/ethnic and regional disparities in breast cancer incidence and mortality are helpful in surveillance and for planning health education programmes on breast cancer.

The lifetime risk of developing breast cancer is a statistic frequently cited in the press. However, there is a concern that lifetime risk has been misinterpreted by many as a short-term probability, rather than a long-term projection. Estimates of risk over shorter time periods may be more accurate and easier to understand.

Routine breast cancer screening can diagnose cancers at an earlier stage, when the likelihood of survival is higher. The value of screening mammography in women over 50 years of age is undisputed. For women between 40 to 49 years of age, the potential benefits of routine mammography are still controversial. In USA, the Federal government's Healthy People 2000 goal has set a target of at least 60% of women 50 years and older receiving a screening mammogram in the two previous years.[25]

Early diagnosis increases the likelihood of surviving breast cancer. Follow-up on breast cancer cases reported to the US National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) Program from 1986 to 1991 show that, among women diagnosed while the tumor was still confined to the breast tissue, 96% were alive after five years.[15] In contrast, only 20% of women diagnosed after the cancer had metastasized to distant parts of the body survived the first five years.[15]

Another area that has been much researched is the relationship between certain blood lipoproteins, atherosclerosis and the incidence of Coronary Heart Disease (CHD). Clinical, experimental and epidemiological evidence has shown this to be strong, consistent and congruent. There is a wide variation amongst populations of the mean levels and distribution of serum cholesterol and other blood lipids.[13,14,26] There is a strong consistent association between mean population levels of total serum cholesterol and measured incidence of CHD.[13,14] In case of migrants, Marmot, et al,[18] have shown that the mean and distributions of their

total serum cholesterol rapidly approaches those of their adopted country. Studies in healthy adult cohorts have shown a continuously rising individual risk of CHD according to the entry levels of total serum cholesterol (and Low Density Lipoprotein) at least until middle age.[10,24] Calculations of the population risk attributable to blood cholesterol levels indicate that the majority of excess CHD cases occurs in the central segment of the population distribution (i.e., 220 to 310 mg/dl), while only 10% derive from values above [30,31]

Studies on the Global Burden of Disease have shown that of the estimated 1,379 million Disability Adjusted Life Years (DALYs) lost in 1990, industrialised countries accounted for just 7 per cent. Of these, 81 per cent were attributable to non-communicable diseases.[29] Developing countries, which accounted for 93 per cent of the global disease burden, had a rather different disease profile. Except for countries in Europe and Central Asia, nearly half of the DALYs lost in developing countries were due to communicable diseases, mainly among children. Over the next three decades, developing countries will undergo a major demographic and epidemiological transition, with significant increase in the burden of injuries and non-communicable diseases. [29] While together they formed 53% of the burden of disease in developing countries in 1990, it is estimated that in 2020, they will account for 79%. These findings have major implications for health services.

Table 2 summarizes the major modifiable risk factors of some common chronic diseases.

Table 2: Chronic diseases and their risk factors

Disease	Major modifiable risk factor	Population attributable risk (%)
Lung Cancer	Smoking	87
Cervical Cancer	Sexual partners	38
	Smoking	32
Breast cancer	Obesity	12
	Late pregnancy	7
	Early menarche	9
	Fatty diet	5
	Genes	5
	Alcohol	2
	Culture / Ill-defined	70
CHD	Cholesterol	43
	Exercise	35
	Blood pressure	25
	Smoking	22
	Obesity	17
Stroke	Blood pressure	26
Cirrhosis	Heavy alcohol	65
Hip fracture (F)	HRT	19
	Thin body build	18
	Smoking	10

Effective Communication for Informed Public Health Policy

Epidemiology's full value is achieved only when its contributions are placed in the context of public health action, resulting in a healthier populace. The epidemiologists' role is not only to collect and analyse data but also to interpret them so that they have meaning for the public, for clinicians, and for policy makers. Epidemiologists must meaningfully communicate findings about risks to health, balance methods and applications, and incorporate social contexts into our understanding of the health of populations. Snow determined the who, where, and when of the outbreak (calculation), removed the pump handle (intervention), and posted a notice (communication). [23] Goldberger [8] did exhaustive studies, promoted dietary change, and communicated his findings to the health and welfare establishments, donors, foundations, and the lay public - persevering against many who opposed his ideas and conclusions. Tobacco epidemiologists like Wynder[31] and Peto[19] had documented the health hazards of tobacco consumption, actively communicated the results of stud-

ies in easily understandable terms, and advocated tobacco control and prevention.

Challenges for the 21st Century

While the field of epidemiology has achieved notable successes in public health, it faces some significant challenges in the 21st Century. Descriptive epidemiology and demography should form the basis of good Public Health policies. Through population-based medicine, community assessment and diag-nosis can be made for determining the need for health services. Epidemiologists can make useful contributions on methodological issues, and by planning and carrying out large population studies, field investigations or clinical studies. Epidemiological evaluation of practices, such as low-dose acetyl salicylate administration on myocardial infarction, will help lengthen life expectancy. Molecular epidemiology holds promise for linking genetic biological markers to health conditions, thereby opening up new potential approaches for intervention. Epidemiological methods also need to be applied effectively for evaluating the health services.

While improved tools and techniques have allowed exploration of new health questions, making conclusions and interpretations has become much more difficult than in the days of John Snow. Present indications suggest expanding potential and an exciting future for epidemiologists. They must collaborate with at least the health, home and local government departments. At the very least, this requires good enumeration of populations, some reliable estimates of the amount and extent of the burden, and reliable information about causation. Public Health policy must begin with measuring the burden of ill health and then concern itself with the solutions – be they biological, social, economic, or all of these. Prioritization of research endeavor could, then, be seen as related to lives of communities. Clearly, easy solutions can be implemented more quickly than difficult solutions to more important problems.

Analyzing and understanding the influence of social contexts on the health of individuals and populations poses yet another challenge. Ongoing research on social capital, shows that these contexts can be measured; more importantly, there are ways of changing these contexts to improve the health of individuals and populations.[11,32] Our focus should always be on health promotion and disease prevention. The prospect of saving lives and preventing misery for populations through analytic approaches is sure to attract more persons to this field in the coming years.

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