

# Roles and Responsibilities of Epidemiologists

DOUGLAS L. WEED, MD, PHD AND PAMELA J. MINK, PHD

Two distinct views of the roles and responsibilities of epidemiologists have emerged in a decades-long debate: one keeps professional practice constrained to science; the other adds active participation in public health policymaking. In defense of the narrower view are several claims: that epidemiologists lack expertise in policymaking; that advocating policy adversely affects scientific objectivity; that the limits of epidemiologic science work against translating results into policy; and that participation in policy can bring on personal attacks. In this study, each claim is addressed. Epidemiologists already participate fully in educational, research funding, and editorial policymaking and thereby have an experiential foundation in some of the basics of policymaking. Policymaking can enhance scientific objectivity because it requires not only the use but more importantly the improvement of empirical methods. Finally, the comforts of professional life are not the primary yardsticks of our responsibilities. Arguments in favor of active involvement in public health policymaking are presented. Epidemiologists have been mixing science and policymaking for a long time and there is a strong sense that the benefits of public stewardship outweigh the risks. The American College of Epidemiology's Ethics Guidelines support this view. Active participation in public health policymaking will, however, require curriculum changes in graduate training programs. With additional training and a broader recognition that public health policymaking is an appropriate professional pursuit, epidemiologists can look to a bright and challenging future in the science and practice of public health. *Ann Epidemiol* 2002; 12: 67–72. © 2002 Elsevier Science Inc. All rights reserved.

**KEY WORDS:** Advocacy, Epidemiology, Ethics, Science, Policy.

---

## INTRODUCTION

Now that the Millennial fireworks are over, it is time for all public health professionals to redouble their efforts to prevent disease and promote the health of communities. (1) Or so it would seem. Many epidemiologists do not see themselves in this role. For almost twenty years, in papers on the future of epidemiology (2–43) and related papers on advocacy and policymaking, (44–56) a debate has emerged regarding the appropriateness of our professional roles and responsibilities vis-à-vis public health. A recent account of this remarkable disciplinary rift reveals two very different views (43). One posits that epidemiologists are scientists whose responsibility to the public is no more than that of any other scientist or private citizen. The second view states that epidemiological research begins and ends with public health problems and that the epidemiologists' social

responsibility includes pursuing practical solutions to those problems. This dichotomy requires serious and scholarly consideration. The American College of Epidemiology, for example, has policymaking as one of its primary activities, and as its current President has pointed out, the use of epidemiology for policy is increasing rapidly (56). Furthermore, no one to date has directly countered the arguments of prominent epidemiologists who, consistent with the first view above, would keep epidemiologists away from policymaking (47, 50, 55).

Terminology is important. "Public health policymaking" here means making public health recommendations, implementing intervention programs, and participating as an advocate. What is common to these activities is that public health actions can be recommended, undertaken, and defended. For ease of understanding, we refer to these activities collectively as "policymaking," although advocacy will require some special considerations. A related concern, not discussed here, is policymaking related to the promotion of the profession.

After a brief background section outlining historical and ethical foundations, we critically examine the arguments warning epidemiologists away from policymaking. We then discuss implications of the view that the future of epidemiology should include both science *and* public health policymaking.

---

Division of Cancer Prevention, Office of Preventive Oncology, National Cancer Institute, Bethesda, MD, USA

Address correspondences to: Douglas L. Weed, M.D., Ph.D. Office of Preventive Oncology Division of Cancer Prevention National Cancer Institute 6120 Executive Blvd. Suite T-41 Bethesda, MD 20892 USA. Tel.: (301) 496-8640 Fax: (301) 402-4863 E-mail: dw102i@nih.gov

Received May 17, 2001; revised October 8, 2001; accepted October 8, 2001.

---

## History

### Epidemiology's Heroes

History is a good place to begin to illustrate how epidemiologists have played a prominent role in policymaking. Who does not know a few stories about how the great women and men of the past changed our understanding of the world, and how our world changed as a result? John Snow, who proposed public health measures to stop the spread of cholera is an obvious example (57, 58) but there are many others. Joseph Goldberger lobbied to improve the diets of pellagra-afflicted mill families, and Walter Reed recommended ways to control mosquitoes in his report on the etiology and transmission of yellow fever (59, 60). Janet Elizabeth Lane–Clayton, an early 20th Century epidemiologist, argued the benefits of disease prevention for women and children (61). Wade Hampton Frost described the relation of polluted water to public health and how to control tuberculosis (62, 63) and Jonathan Mann led the global response to the AIDS epidemic (64–66). These are our heroes, remembered because they *applied* the knowledge they had acquired through careful scientific study.

Other epidemiologists will be remembered for their contributions to theory or method or for their efforts to explain the distribution and determinants of a particular disease. Some will have been our finest teachers and mentors, and there are others whose organizational and fundraising skills are meritorious. But the *heroes* of epidemiology are those whose contributions included both etiologic science and preventive interventions.

---

## Ethics and Definitions

### Who We Say We Are and What We Say We Do

Ethics guidelines provide strong support for epidemiology's role in policymaking. There, epidemiology is described as a discipline whose scientific results are applied by epidemiologists (67–71). The ACE guidelines, for example, state that the “profession of epidemiology has as its primary roles the design and conduct of scientific research and the public health application of scientific knowledge” (71).

Published definitions of the discipline also support the view that epidemiologists should engage in policymaking. The definition of epidemiology, as it has appeared in every version of the Dictionary of Epidemiology since 1983 includes science and its application (72). Although it is possible to find more abbreviated definitions, especially in methodologically oriented textbooks, it is incorrect to surmise from this fact that epidemiology should be considered only a science because scientific study is a common item in all current definitions (55).

Although history and ethics support a policymaking role for epidemiology, the individual practitioner may not be

best motivated by abstract admonitions. We turn now to the specific arguments against such participation.

---

## Common Arguments Against Epidemiologists Participating in Policymaking

A familiar claim is that epidemiologists lack policy expertise (50, 55) another familiar claim is that our scientific objectivity is too strongly threatened by active participation in policymaking especially, advocacy (47, 50, 55). In addition, the limitations inherent in observational studies may make epidemiologists wary of making policy recommendations (73). Finally, there are other less formally noted concerns: e.g. that direct involvement in policymaking may bring “trouble” in the form of personal attacks on one's competence and integrity.

### Epidemiologists' Participation in Education and Research Policy

The claim that epidemiologists lack policy expertise in general is weak, given that we practice so many forms of policymaking in everyday professional practice; educational and research policy are two obvious examples. Epidemiologists in academia decide which courses will be required, who will be accepted as students, and what is required for tenure. Some of these policies are institutionally based, but we doubt university administrators carefully preclude “scientists” from their committees. Similarly, epidemiologists regularly participate in research policymaking when they set surveillance data collection standards or when they sit on the influential scientific advisory boards at the National Institutes of Health and other institutions.

Epidemiologists, including those whose prominent voices argue for science and only science (47, 55) also participate in editorial policies and policies affecting the organizations and societies to which most epidemiologists belong. The new editors of *Epidemiology*, for example, have maintained a written policy about where public health recommendations and other forms of policymaking may and may not appear in their journal (74).

The point is an obvious one: epidemiologists already participate in a wide range of policymaking activities that go well beyond the practice of science. We *do* policy. So, why *not* public health policy? Certainly, what epidemiologists lack in policy expertise should be supplemented by the experience and knowledge of others (75). But coparticipation does not imply that epidemiologists' voices at the policy table should be limited to dispassionate descriptions of study results. It is our responsibility to actively participate in decisions concerning the application of those results to the prevention and control of diseases.

### Objectivity, Values, and Advocacy

Another claim that may keep epidemiologists away from policymaking is that scientific objectivity is tarnished by

such participation, especially when advocacy is involved. It is our position that policymaking and advocacy can actually enhance objectivity. In order to reach that conclusion, we begin by carefully examining a familiar dichotomy, between the purely objective scientist and the advocate whose ideology—unfettered by conflicting evidence—drives public health activism (55). Asking epidemiologists to choose between these two extremes is both easy and pointless. We doubt, as Savitz et al. (55) suggest that most scientists are inherently flexible, responding immediately and easily to new information, changing their hypotheses and beliefs impartially. Scientific debates in epidemiology are often as partisan and ideological as any about public health policies. If by advocacy it is meant arguing for, defending, and maintaining a cause or proposal (76), then there is a whole lot of it in the science of epidemiology. For examples, one needs to look only as far as the debates on meta-analysis or to the clashing conclusions emerging from identical bodies of epidemiological evidence on the causal relevance of certain risk factors (77). Put another way, it is not only a proposition but an observable phenomenon that the practice of epidemiologic science contains elements of values, ideology and advocacy (54). The key question, therefore, for all epidemiologists is not “are you an impartial (objective) scientist or an ideological advocate?” but rather, “is it possible to participate in evidence-based public health policy decisions, even advocacy, without sacrificing objectivity?”

The answer depends upon our concept of objectivity in science. Scientific objectivity is widely conceived, even in philosophical circles, as a characteristic of the empirical methods used by the scientific community (54, 78). Methods provide the foundation for scientific practice, and every effort must be made to ensure that these methods are as rigorous as possible and that improvements are incorporated into practice. Epidemiologists, perhaps as much as any scientific discipline, work diligently to recognize the limitations of and to improve their methodologies (79). Values—some more scientific, others less so—play a role in applying these methods. The best example can be found in the methods used to make inferences about causation. These are some of most value-laden methods available to epidemiologists (77, 80). Nevertheless, as even their early champion, Austin Bradford Hill, recognized (81), these same methods can be used to support policy decisions about public health actions. Ways to improve these methods—e.g. by linking causal criteria to meta-analysis—are just beginning to emerge. If better policy decisions and advocacy positions can be linked to improvements in these interpretative methods, we can conclude that policymaking enhances rather than diminishes objectivity. Put another way, policymaking can be—should be—consistent with an ongoing assessment of the rigor and improvability of epidemiologic methods, precisely the conditions that define objectivity in contemporary science.

### The Limits of Epidemiology and Public Policymaking

We must also contend with the claim that epidemiology is limited in its capacity to inform policy. Bias is a primary concern that can contribute to the apparent inconclusiveness of some epidemiologic studies. Although bias can be a limiting factor, there are limits for any type of study. Laboratory studies are no exception. There, the universality of biological mechanisms is often questionable. Similarly, results from animal studies may not generalize to humans. Results from randomized, controlled, double blind studies may not generalize beyond the tightly regulated confines of the study protocol. All scientific studies have limits and yet can still contribute to the general body of knowledge important to public health.

### Personal Demands of Public Participation

The demands of public participation—specifically, the risks of personal attacks and harassment—cannot be easily dismissed. Anyone who has experienced these difficulties might reasonably think twice about sitting in the “hot” seat again. Nevertheless, participation for the profession itself should not, in our view, be contingent upon how comfortable we are, but rather with the extent to which we take responsibility for such participation. Here we note that professional societies have an important role to play in supporting epidemiologists in policymaking activities, perhaps by developing educational workshops or by sponsoring talks at national meetings on this topic.

---

### Opportunities for Practicing Public Health Policymaking

While we acknowledge that there are legitimate concerns associated with policymaking—no one should ever claim that it is easy to mix it with science—we are concerned that the arguments warning epidemiologists away from this important activity may have the unfortunate effect of excluding us from applying the scientific knowledge we so carefully acquire. In this section, we review the opportunities for such application. A wide range of activities fall under the umbrella of public health policymaking. Consider as a starting point the choice of a research topic. Whose epidemiologic research project doesn't relate (somehow) to public health? Or consider the results of a single epidemiologic study, perhaps an analytic case-control or cohort study. Reporting and interpreting the results of that single study to its participants and to the community from which they were selected (or selected themselves) is an opportunity to practice public health. We emphasize the word *opportunity*. We recognize the limitations of such a venture and emphasize that we are not suggesting that public health recommendations can easily or should typically emerge from the results of single studies. Nevertheless, in the future it may be important to consider what is the least amount of evidence needed to recommend such action.

Writing reviews of the literature and textbook chapters on diseases or categories of exposure is another opportunity for practicing public health as an epidemiologist. Again, we emphasize the word *opportunity*. It is not uncommon for literature reviews on exposure-disease associations to include public health policy recommendations. It is important to recognize the complexities of such decisions: their reliance upon the state of the scientific evidence, the costs and benefits of action (and inaction), and the beliefs and reactions of those who may be made aware of the published recommendations, including politicians, government officials, public representatives, the media, and the public itself.

Individual practitioners of epidemiology are often asked to participate in reviewing literature and making public health recommendations as members of review committees convened by the Institute of Medicine, the National Institutes of Health, the U.S. Surgeon General's Office, the World Health Organization, the International Agency for Research on Cancer, and a host of public and private institutions across the globe. In these activities, epidemiologists participate in the consensus that emerges (or not) from such groups. While it is generally true that the organization sponsoring the meeting or workshop determines the nature and scope of the decisions to emerge from the group—e.g. whether public health recommendations will be considered or not—epidemiologists in many such circumstances have, once again, an *opportunity* to add their voices to others at the table regarding the advisability of acting in the best interests of the public given the available scientific evidence.

Finally, epidemiologists may practice public health in the community itself (82). As just one potent example, consider the legions of young professional epidemiologists trained at the Centers for Disease Control as Epidemic Intelligence Service Officers for precisely the activities found in epidemiology's definitions and professional ethics guidelines: to do science and to apply that knowledge for the benefit of society.

---

## Recommendations

### Training and Education

There are many public health arenas within which epidemiologists may practice. What can be done to prepare ourselves for these activities? When experience and expertise are lacking, educational programs could be expanded and made more accessible. Courses on methods could be expanded to include the design, analysis, and interpretation of prevention and intervention studies. Interestingly, courses in public policy and public health applications of epidemiological studies are already offered at some schools of public health but these skills are not regarded as necessary for the professional practice of epidemiology. What is needed is a change in the culture of the discipline, wherein the com-

plexities and demands of contributing to policy decisions or undertaking public health advocacy are incorporated not only into existing curricula but also into the substance of scientific meetings and epidemiology journals. Ethics, cost-benefit analytic techniques, political science, and the processes involved in making decisions under conditions of uncertainty are a few additional topics that may be necessary.

### Epidemiology Encompasses Science and Policy

Science and policy walk hand-in-hand under the umbrella of epidemiology. But we are not somehow lesser epidemiologists if we are not “doing it all.” An epidemiologist who does etiologic research (and does it well) is, indeed, an epidemiologist in full. An epidemiologist who combines public health practice and policymaking with research activities is also an epidemiologist in full. An epidemiologist who spends most of his or her time making the public health system work to prevent disease and improve the health of the public is likewise a full-fledged epidemiologist. The key to our professional future is to embrace these choices and their overlapping responsibilities, learn what must be learned, and then make a difference in what we know about and what we do about improving the public's health.

---

The authors thank Betsy Foxman, Marie O'Neill, Carl Philips, and Jonathan Samet for helpful suggestions on an earlier version of this paper.

---

## REFERENCES

1. Bloom BR. The future of public health. *Nature* 1999;402(suppl.): C63–64.
2. Tuomilehto J, Puska P. The changing role and legitimate boundaries of epidemiology: community-based prevention programmes. *Soc Sci Med*. 1987;25:589–598.
3. Gordis L. Challenges to epidemiology in the next decade. *Am J Epidemiol*. 1988;128:1–9.
4. Vandenbroucke JP. Epidemiology in transition: a historical hypothesis. *Epidemiol*. 1990;1:164–167.
5. Muir CS. Epidemiology, basic science, and the prevention of cancer: implications for the future. *Cancer Research*. 1990;50:6441–6448.
6. Greenberg RS. The future of epidemiology. *Ann Epidemiol*. 1990; 1:213–214.
7. Nakajime H. Epidemiology and the future of world health—the Robert Cruickshank Lecture. *Int J Epidemiol*. 1991;20:589–594.
8. Terris M. The Society for Epidemiology Research (SER) and the future of epidemiology. *Am J Epidemiol*. 1992;136:909–915.
9. Wegman DH. The potential impact of epidemiology on the prevention of occupational disease. *Am J Pub Health*. 1992;82:944–954.
10. Wall S. Epidemiology for prevention. *Int J Epidemiol*. 1995;24:655–664.
11. Anthony JC, Eaton WW, Henderson AS. Looking to the future of psychiatric epidemiology. *Am J Epidemiol*. 1995;17:240–242.
12. Offord DR. Child psychiatric epidemiology: current status and future prospects. *Can J Psychiatry*. 1995;40:284–288.
13. Weed DL. Epidemiology, the humanities, and public health. *Am J Pub Health*. 1995;85:914–918.

14. Last J. Professional standards of conduct for epidemiologists. In: Coughlin SS, Beauchamp TL, eds. *Ethics and epidemiology*. New York: Oxford; 1996:53–75.
15. Lawson J, Floyd J. The future of epidemiology: a humanist response. (letter) *Am J Pub Health*. 1996;86:1029.
16. Shigematsu I. Epidemiology in Japan and future problems. *J Epidemiol*. 1996;6(Suppl):S3-S7.
17. Epstein FH. Cardiovascular disease epidemiology: a journey from the past into the future. *Circulation* 1996;93:1755–1764.
18. Susser M, Susser E. Choosing a future for epidemiology: I. Eras and paradigms. *Am J Pub Health*. 1996;86:668–673.
19. Susser M, Susser E. Choosing a future for epidemiology: II. From black box to Chinese boxes and eco-epidemiology. *Am J Pub Health*. 1996; 86:674–677.
20. Pearce N. Traditional epidemiology, modern epidemiology, and public health. *Am J Pub Health*. 1996;86:678–683.
21. Winkelstein Jr. W. Editorial: eras, paradigms, and the future of epidemiology. *Am J Pub Health*. 1996;86:621–622.
22. Koopman JS. Comment: emerging objectives and methods in epidemiology. *Am J Pub Health*. 1996;86:630–632.
23. Trichopoulos D. The future of epidemiology. *BMJ*. 1996;313:436–437.
24. Spitzer WO. The future of epidemiology *J Clin Epidemiol*. 1996;49: 705–709.
25. Shy CM. The failure of academic epidemiology: witness for the prosecution. *Am J Epidemiol*. 1997;145:479–484.
26. Walker AM. “Kangaroo court”: invited commentary on Shy’s “The failure of academic epidemiology: witness for the prosecution”. *Am J Epidemiol*. 1997;145:485–486.
27. Nasca PC. Current problems that are likely to affect the future of epidemiology. *Am J Epidemiol*. 1997;146:907–911.
28. Colditz GA. Epidemiology—future directions. *Int J Epidemiol*. 1997; 26:693–697.
29. Khoury MJ. Genetic epidemiology and the future of disease prevention and public health. *Epidemiol Rev*. 1997;19:175–180.
30. Putting public health back into epidemiology. *Lancet*. 1997; 350: 229.
31. Bracken MB. Alarums false, alarums real: challenges and threats to the future of epidemiology. *Ann Epidemiol*. 1998;8:79–82.
32. Gori GB. Epidemiology and public health: is a new paradigm needed or a new ethic? *J Clin Epidemiol*. 1998;51:637–641.
33. Pearce N, McKinlay JB. Back to the future in epidemiology and public health: response to Dr. Gori. *J Clin Epidemiol*. 1998;51:643–646.
34. McMichael AJ. Prisoners of the proximate: loosening the constraints on epidemiology in an age of change. *Amer J Epidemiol*. 1999;149: 887–897.
35. Schwartz S, Susser E, Susser M. A future for epidemiology? *Annu Rev Public Health*. 1999;20:15–33.
36. Saracci R. Epidemiology in progress: thoughts, tensions and targets. *IJE*. 1999;28(suppl.):997–999.
37. Wall S. Epidemiology in transition. *Int J Epidemiol*. 1999;28(suppl.): 1000–1004.
38. Adami H-O, Trichopoulos D. Epidemiology, medicine, and public health. *Int J Epidemiol*. 1999;28(suppl.):1005–1008.
39. Holland WW. What should be the concerns of epidemiology? *Int J Epidemiol*. 1999;28(suppl.):1009–1011.
40. Hunter DJ. The future of molecular epidemiology. *Int J Epidemiol*. 1999;28(suppl.):1012–1014.
41. Pearce N. Epidemiology as a population science. *Int J Epidemiol*. 1999;28(suppl.):1015–1018.
42. Susser M. Should the epidemiologist be a social scientist or a molecular biologist? *Int J Epidemiol*. 1999; 28(suppl.):1019–1021.
43. Discussion on the future of epidemiology. *Int J Epidemiol*. 1999; 28(suppl.):1023.
44. Terris M. Epidemiology as a guide to health policy. *Annu Rev Pub Health*. 1980;1:323–344.
45. Stallones RA. Epidemiology and public policy: Pro- and antibiotic. *Am J Epidemiol*. 1982;115:485–491.
46. Yankauer A. Science and social policy. *Am J Pub Health*. 1984; 74:1148–1149.
47. Rothman KJ, Poole C. Science and policymaking. *Am J Pub Health*. 1985;75:340–341.
48. Wynder EL. Applied epidemiology. *Am J Epidemiol*. 1985;121:781–782.
49. Foxman B. Epidemiologists and public health policy. *J Clin Epidemiol*. 1989;42:1107–1109.
50. Poole C, Rothman KJ. Epidemiologic science and public health policy (letter). *J Clin Epidemiol*. 1990;43:1270.
51. Gordis L. Ethical and professional issues in the changing practice of epidemiology. *J Clin Epidemiol*. 1991;44(suppl 1):9–13.
52. Weed DL. Science, ethics guidelines, and advocacy in epidemiology. *Ann Epidemiol*. 1994;4:166–171.
53. Beaglehole R, Bonita R. Challenges for epidemiology. In: Beaglehole R, Bonita R, eds. *Public health at the crossroads*. Cambridge: University Press; 1999:124–141.
54. Kreiger, N. Questioning epidemiology: objectivity, advocacy, and socially responsible science. *Am J Pub Health*. 1999;89:1151–1153.
55. Savitz DA, Poole C, Miller WC. Reassessing the role of epidemiology in public health. *Am J Pub Health*. 1999;89:1158–1161.
56. Samet JM. Epidemiology and policy: the pump handle meets the new Millennium. *Epidemiol Rev*. 2000;22:145–154.
57. Vandenbroucke JP, Rooda HME, Beukers H. Who made John Snow a hero? *Am J Epidemiol*. 1991;133:967–973.
58. Snow J. Snow on cholera. In: Frost WH, ed. *New York: The Commonwealth Fund, 1936*. [Reprinted from: *On the mode of the communication of cholera*. 2nd ed. London, United Kingdom: John Churchill, 1865].
59. Schultz MG. Joseph Goldberger and pellagra. *Am J Trop Med Hygiene*. 1977;26:1088–1092.
60. Reed W, Carroll J, Agramonte A. The etiology of yellow fever: an additional note. *JAMA* 1983;250:649–658 [reprinted from: *JAMA* 1901;36:431–440].
61. Lane-Clayton JE. *The child welfare movement*. London: G. Bell and Sons; 1920.
62. Frost WH. The sewage pollution of streams; its relation to public health. In: Maxcy KF, ed. *Papers of Wade Hampton Frost, M.D., A contribution to epidemiological method*. New York: Arno; 1977:287–301.
63. Frost WH. How much control of tuberculosis? . In: Maxcy KF, ed. *Papers of Wade Hampton Frost, M.D., A contribution to epidemiological method*. New York: Arno; 1977:601–612.
64. Mann J. Worldwide strategies for HIV control: WHO’s special programme on AIDS. *Law, Medicine, Health Care*. 1986;14:290–296.
65. Mann JM. AIDS—the second decade: a global perspective. *J Infect Dis*. 1992;165:245–250.
66. Mann JM, Tarantola DJM. HIV 1998: the global picture. *Scientific Am*. 1998;279:82–83.
67. Beauchamp TL, Cook RR, Fayerweather WE, Raabe GK, Thar WE, Cowles SR, et al., Ethical guidelines for epidemiologists. *J Clin Epidemiol*. 1991;44(suppl. 1):151–169.
68. International Epidemiological Association Guidelines on Ethics for Epidemiologists. Washington DC: American Public Health Association, Epidemiology Section Newsletter. Winter:1990.
69. Soskolne CL, Light A. Towards ethics guidelines for environmental epidemiologists. *Sci Total Environ*. 1996;184:137–147.
70. Bankowski Z, Bryant JH, Last JM. Ethics and epidemiology: international guidelines. Geneva: CIOMS; 1991.
71. American College of Epidemiology Ethics Guidelines. *Ann Epidemiol*. 2000;10:487–497.

72. Last JM. A dictionary of epidemiology. New York: Oxford; 1988.
73. Taubes G. Epidemiology faces its limits. *Science*. 1995;269:164-169.
74. Editors. Our policy on policy. *Epidemiol*. 2001;12:371-372.
75. Teret S. Policy and science: should epidemiologists comment on policy implications of their research? *Epidemiol*. 2001;12:374-375.
76. Webster's Third New International Dictionary. 1993:32.
77. Weed DL. Underdetermination and incommensurability in contemporary epidemiology. *Kennedy Inst Ethics J*. 1997;7:107-127.
78. Longino HE. Science as social knowledge: values and objectivity in scientific inquiry. Princeton:University Press; 1990.
79. Susser M. Epidemiology in the United States after World War II: the evolution of technique. *Epidemiol Rev*. 1985;7:147-177.
80. Weed DL. Methods in epidemiology and public health: does practice match theory? *J Epidemiol Commun Health*. 2001;55:104-110.
81. Hill AB. The environment and disease: association or causation? *Proc Roy Soc Med*. 1965;58:295-300.
82. Wynder EL. Applied epidemiology. *Am J Epidemiol*. 1985;121:781-782.