Epistemology of complexity

Health, science, and complexity

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It is of fundamental importance that economic and power interests should not take precedence over public health needs.

"Multidisciplinarity". "Integration". "Context". That these have become key terms in public health vocabulary and core features of the health systems can be seen in the multidisciplinary approach to biomedical research and clinical medicine and in the increasing interest in "alternative" medicine.

What these changes have in common may be related to the concept of complexity and what could be defined as a shift in the epistemiological paradigm, away from the reductionist approach of Modernity. From Descartes and Newton to Russell and Popper, the development of knowledge has been characterised by the opposite of complexity—that is, reducing the complexity of the real to the simplicity of laws and explanations. This heuristics of parsimony has been the driving force behind empirical and speculative research.[1] The paradigm of Modernity, which is rooted in a mechanistic view and in logical and mathematical thought, has above all developed around the search for an absolute and rational method capable of definitively separating scientific knowledge from pseudo-knowledge, including that of social disciplines. However, in the second half of the 20th century, Modernity underwent a crisis[1–3]: quantistic physics, Einstein's Theory of Relativity, and the principle of indeterminacy of Heisenberg had shaken its foundations. As observed by Russell, just when the man on the street started to trust science absolutely, the scientist began to distrust it.

What has emerged is an anti-reductionistic tendency, which has paved the way for an epistemological movement, the "theory of complexity", viewed by some as a revolution of paradigm.[4 5] The signs of change have become visible in the past several decades not only in science and philosophy but also in many other fields of knowledge, including architecture, the arts and literature, social and political sciences, and ecology. Whatever the field, the esprit of the post-modern era is complexity, at least in its largest sense: a combination of determinism and chance, a tolerance of heterogeneity and uncertainty, and renewed attention placed on context and practicality, to the point that it is considered as utopian to believe that a "view from nowhere"[6] might exist, in that the character of knowledge is irreducibly temporal and local.[7]

Of particular interest to us is the manifestation of this shift in cultural mood in a variety of biomedical disciplines. With specific regard to epidemiology, a heated debate has arisen around its role and the methods used. The modern approach focuses on assessing the decontextualised association between exposure and outcome in single individuals. As stated by Susser, some consider this discipline to be "similar to the physical (theoretical) sciences in its search for the highest level of abstraction of universal laws".[8] Yet it has been argued that this approach perpetuates the idea that risk is determined at an individual rather than at a population level, whereas social context is pivotal in determining behaviours and, ultimately, health.[8 9] Accordingly, the need to model group level characteristics has led to the re-evaluation of ecological studies and to the use of hierarchical analysis for multilevel studies. Moreover, the remarkable growth of social epidemiology, including the study of the health effects of income inequality, life course approach, and psychosocial determinants, is underpinned by the conviction that socioeconomic and biological experiences during a person's lifetime are woven together.[10]

In genetic epidemiology, attention has recently been placed on the "mistakes made in the past by underestimating the effect of environment and overestimating the effect of gene".[11]

In biostatistics, the re-evaluation of Bayesian methods can also be considered as a shift in paradigm, in that these methods explicitly take into account the weight of context and prior knowledge.[12] Complexity has also flourished in the evolution of evidence based medicine. As recently proposed,[13] the assessment of the quality of evidence should focus not only on study design and internal validity but also on the consistency and transferability of results to the context of interest. In fact, the role of observational studies has been re-evaluated: randomised controlled trials are no longer considered as the gold standard for answering all types of clinical questions, and the choice of the most suitable study design depends on the specific objective.[14] Moreover, it has been proposed that qualitative research be integrated into systematic reviews.[15] Attention has also been placed on trials that are pragmatic,[12] including cluster randomised trials that take into account the population effect of interventions and for which an extension of the CONSORT statement has been released.[16]

Health technology assessment also possesses features of complexity: from the multidisciplinary approach to the brokering of scientific knowledge to serve decision making and practical action. In international public health, primary health care has come "back to the future", with its seminal principles—equity, community involvement, intersectoriality, and appropriate technology—being rooted in complexity.[17] In medical education, Dewey's pragmatism has been rediscovered in problem based and experiential learning. Finally, the field of medical humanities aims to direct clinical practice more towards people rather technology and is emblematic of the healing of the schism between science and humanistic knowledge.

Although we obviously cannot predict future scenarios, complexity will assumedly continue to gain strength as the current *Zeitgeist*, potentially fostering a variety of changes in biomedical disciplines, including, ideally, the primacy of humanism, multiculturality, and equity in health care and research. Although this may also lead to the re-emergence of modernist approaches, such as the renewed focus on the quantitative paradigm,[18] what is of fundamental importance is that complexity should not drift towards unbridled relativism, with economic and power interests taking precedence over public health needs.

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Environment

The physical environment and physical activity: moving from ecological associations to intervention evidence

Adrian Bauman

Can we improve population levels of physical activity? Focusing research efforts on improving the evidence base from (whole community) interventions is a necessary first step.

Recent interest in the physical environment is reminiscent of the pre-individualist era of 19th century public health, when sweeping environmental changes, particularly around sanitation, hygiene, and food supply produced large scale population health effects.[1] Current interest in the environment and its role in chronic disease prevention has positively influenced the tobacco control agenda, and more recently, been shown to be associated with population obesity, inappropriate nutrition, and physical inactivity rates.

One driver for environmental research is interest in the causal role of community level variables in health promotion; these include measures of social capital, urban connectedness, social isolation, health literacy, and poverty. This has pervaded recent public health investigation at the community and small area level.[2 3]

Another reason is scientific curiosity to better understand the determinants of physical activity and obesity. In the 1980s, researchers examined individual cognitions, beliefs, and motivations around diet and exercise. This comprised correlational studies that identified associations between behaviours and a range of theoretical variables derived from social learning theory, the theory of planned behaviour, and motivational readiness to change (self efficacy, behavioural intention, stage of change variables). This resulted in a plethora of cross sectional analytical papers that showed small associations with diet and physical activity, without really ''striking gold'' in terms of identifying the solve-all correlate(s) that could really improve public health interventions. For example, population physical activity levels in most developed countries were comparatively static or declined during the 1990s, with the exception of Finland and Canada.[4] The new epidemiological evidence for health benefits of moderate intensity physical activity[5] has stimulated further interest in using social ecology frameworks to describe walking and other ''active living'' behaviours and their correlates.[6 7]

A third reason is that this research provides opportunities for new data collection and analytical methods. These include attributes of the environment, using measures of urban residential density, street connectivity, location of shops, schools, and green spaces, and each dataset can be combined in layers to assess community level attributes. The analytical challenges are to use multilevel analytical techniques that permit the inclusion of data at an individual level (from surveys or other individual measurement) and include supra-individual data in the same statistical models.[8]

The paper by Li and colleagues[9] in this issue covers all of these innovative attributes. It shows clear relations between built environmental attributes and walking in a sample of elderly adults. These associations remain strong despite methodological limitations in terms of self report walking measures used, and small numbers of responders in each geographical area. Further investigation of these associations will feed the technophile epidemiologist; physical activity and environment researchers are now preoccupied with improving geographical mapping (GIS measures), objective physical activity measurement (using pedometers or accelerometers) and in combination with global positioning satellite (GPS) devices, so that neighbourhood walking can be objectively quantified. However, I would speculate that future research with better measurement and analytical methods will simply reinforce these associations with walking and physical activity, and perhaps show better evidence of causality through longitudinal studies.

As a technical aside, on the road to estimating the design (clustering) effect in this study, Li reported that 28% of the variability in walking was attributable to between neighbourhood variation[9]—this is important, because compared with many intraindividual level variables, environmental level variables make a large contribution to explaining physical activity variation.

The paper also contributes to the debate around subjective (perceptions) compared with objective measures of