

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 epistemological 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 crisis¹⁻³: 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-reductionist 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, multiculturalism, 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 activity⁵ 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 colleagues⁹ 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 variation⁹—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

environments—as shown in this study, some individual level perceptions are correlated with walking whether objectively verified or not. Both perceptions and objectively measured environments are separately associated with different types of physical activity.¹⁰

Where does this leave us? The scientific imperative demands longitudinal research, better and more sophisticated GIS measures, and better assessment of walking and related behaviours. However, the underpinning rationale and discussion for this kind of study is to “improve physical activity levels, and thereby public health”. This is more challenging, as the need for testing interventions can be delayed for decades while the methods and measures are refined; this occurred with the individual level psychological correlates of physical activity, with many more published exploratory studies than population interventions.

Despite burgeoning correlational and measurement research around environments and physical activity, few opportunistic studies have evaluated the effects of environmental interventions on population physical activity levels,^{11–13} and the tentative impact of these quasi-experimental designed interventions has been modest. It is timely to prioritise these natural experiments and the opportunistic evaluation of environmental improvements; does manipulation of streetscapes, provision of bike lanes, and interconnected suburban design really change population physical activity and walking rates? Even tentative examples here will provide further evidence on

which to progress public health policy decisions.¹⁴

Finally, one should sound a note of caution with new areas of public health research. After the enthusiasm produced by “correlational significance”, the subsequent failure to find effective interventions may relegate physical environments to being another unfulfilled “great white hope”. It may be that much broader change is required, with substantive changes to social norms regarding sedentarism, and to increase cultural intolerance towards our toxic food and inactivity environments. With increased community understanding and support, one could imagine mobilising the political will and huge resources to really change the physical environments in important ways, to more effectively influence physical activity levels in populations.

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Environment

Building environment to promote health

Reid Ewing

The challenge is for the fields of planning and public health to learn from each other and combine the best practices of each to foster fruitful collaboration in the future.

I was asked to give an urban planner’s perspective on the article in this issue of the journal by Li *et al.*¹ What is most striking about this article is the fact it was written at all. It represents the engagement of two fields (heading toward marriage) that were hardly aware of each other 10 years ago, and barely speaking five years ago.

For about 20 years, the urban and transportation planning fields have been

researching the relation between the built environment and travel choices, including the choice to walk or cycle.^{2–4} The built environment has been measured in objective terms, using gross measures such as population density, land use mix, and street connectivity. In recent years, measurements have relied heavily on geographical information system (GIS) technology. The behaviour of interest to planners has been that of

trip making, purposeful travel from one place to another to engage in out-of-home activities. Travel has been measured subjectively, mostly based on self reported travel diaries. Travel frequency, distance, and mode have been related to environmental variables by means of multiple regression or logistic regression analysis. The use of multilevel modelling to properly account for individual and neighbourhood effects on individual behaviour has been unknown within the planning field.⁵

Meanwhile, the public health field has mainly focused its research efforts on physical activity for leisure or exercise.^{6–7} Utilitarian travel has been largely neglected, even when it entailed walking or bicycling to a destination. In physical activity research, there has been a concerted move toward objective measurement of physical activity via motion sensors (for example, accelerometers). The built environment has been treated as secondary to the social

and cultural environments, and measured mostly in terms of access to and quality of recreational facilities. It has been measured subjectively in most cases, based on self reports of facilities within respondents' neighbourhoods. Multilevel modelling has long been used in public health research to account for the dependence among respondents residing in a given place.

"Multilevel modelling..." is one of several examples of a new generation of studies that involve joint authorship across the fields of planning and public health.⁸⁻¹³ The content of this study reflects a blending of the two fields. Their measure of walking includes both walking for transportation and strolling for recreation. The neighbourhood environment is measured both objectively with GIS and through self reported measures from the resident survey. The objective measures include the amount of green and open spaces for recreation, as well as the more conventional planning measures of household, employment, and street intersection density. The authors cleverly test to see if objective and subjective neighbourhood variables interact to jointly influence walking activity. They use multilevel modelling to avoid the pitfalls of multiple regression when a data structure is nested as theirs is.

The authors are well aware of the study's limitations, limitations that we planners have been wrestling with for ages in our travel behaviour research. The first is the inability to infer causality from a cross sectional study design like theirs. We are seeing some planning studies now that use longitudinal data or quasi-experiment designs to get at the issue of causality. A related

limitation is the likelihood of self selection on the part of some respondents—that is, respondents who would be active anyway choosing to live in neighbourhoods that facilitate physical activity, as compared with the neighbourhood environment itself causing them to be more active. Planners are including attitudinal questions in our travel surveys to begin to control for these innate preferences. We are also estimating joint residential location-travel models to unravel the effects of residential choices from travel choices. A third limitation is the possibility of activity substitution. Planners have long studied the degree to which walk and bicycle trips substitute for car trips, and are beginning to explore two other types of substitution: the substitution of utilitarian walk trips for leisure time strolling trips, and the substitution of walking for other forms of physical activity. There is some evidence of substitution of both types. A fourth limitation is the lack of standardisation of built environmental variables used in this kind of research. This is an area where the public health community, with its emphasis on consistent and reliable measurement methods, has much to offer planning researchers.

The challenge for both fields, planning and public health, will be to learn from each other and combine the best practices of each to foster even more fruitful collaborations in the future.

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Social support

Social networks and health: it's time for an intervention trial

Anthony F Jorm

A randomised controlled trial is necessary to find out if intervention on social networks has a health benefit for older people and if this could be extended to the whole population.

Back in 1988, James House and colleagues reviewed a number of studies on social relationships and mortality. They concluded that "...the

theory and evidence on social relationships and health increasingly approximate that available at the time of the U.S. Surgeon General's 1964 report and

smoking and health...with similar implications for future research and public policy."¹ Since that time, the evidence has continued to accumulate. While not all studies have found an association, there is sufficient confirming evidence to take it very seriously. These findings raise three issues: Is the association causal? If it is causal, what is the mechanism? And can we use this finding to improve the health of older people?

The evidence base consists of prospective studies of social networks as a predictor of mortality. Such studies indicate either a causal relationship or some unknown confounder that is the true cause. It is clear that the association persists after adjusting for obvious confounders, such as baseline health status and health habits, but we can never

fully rule out some unknown third factor by using a prospective methodology.

Nevertheless, prospective studies can help us to refine the possible causal factors. If social networks are protective, what components contribute to the effect? A study by Giles *et al* in this issue reports that networks of friends and confidants (which includes spouse confidants) predict mortality in older people, but networks of children and other relatives do not.² The authors suggest that networks of friends might have a protective effect by influencing health behaviours and help seeking, as well as the psychological benefits they confer for depression, self efficacy, self esteem, coping, and morale. These findings suggest what sort of interventions might be useful in improving the health of older people.

Despite the many studies on this topic, this line of research has yet to be translated into health benefits for older people. The only sure way to find out if intervention has a health benefit, and whether the association is causal, is to carry out a randomised controlled trial.

Fortunately, friendship networks are likely to be more modifiable than family relationships. We are now arguably at the point where a large scale trial is warranted. Befriending schemes have been developed and trialled for people suffering from depression and could provide a model for a potential intervention.³ The assumption of a befriending intervention is that the resulting friendships are qualitatively similar enough to serve the same function as lengthier, naturally occurring friendships. The challenge would be to carry out a trial on a sufficiently large sample, and over a sufficiently long enough time, to see an impact on mortality. Such a trial should examine effects on other health indicators besides mortality, such as disability, and a combined indicator like disability adjusted life years would be warranted. Factors that might mediate the association, such as health habits, help seeking, psychological state, and specific disease processes, should also be measured. If such a trial successfully showed that social networks could be modified with benefits to health, this would provide the basis

for more widespread health promotion action, with the aim of increasing friendship networks in the whole population. Only then would we be ready for a US surgeon general's report on social relationships and health.

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Social networks

Why do friendships matter for survival?

Carlos F Mendes de Leon

Presently, the exact mechanisms by which friendship and social relationships affect health are poorly defined. Perhaps one day the physiological pathway between positive social experiences and health will be able to be defined.

The idea that social relationships affect health and longevity has enjoyed considerable popularity ever since the seminal paper by Berkman and colleagues showed a protective effect of social networks on survival.¹ Numerous studies have reported that being connected to people seems to confer various forms of health benefit. The paper by Giles and colleagues in this issue of the journal follows this line of research,² showing that social relationships remain an important health resource into very old age. The paper further illustrates that this health benefit may be restricted to social relationships that tend to be more discretionary, such as those with friends and relatives other than children. Similar findings have been reported for other important health outcomes in

older age, both by this group of investigators³ and others.^{4,5} Yet as appealing the idea is that social relationships, and friendships in particular, are good for our health, as elusive remains our understanding of why or how this is so.

The list of answers to this question is potentially long and complex. The usual suspects have been covered previously, and are nicely summarised in the paper by Giles *et al*.² There is little doubt that declining health affects the ability to maintain an extensive and active network of social contacts. This source of confounding is a vexing problem in observational research, given the imprecise variables of social function and health we typically are able to collect in large scale studies. But residual confounding attributable to poor measurement can hardly be a satisfactory

explanation for a finding that has been validated in so many different settings. Two sets of theoretical perspectives have been offered to interpret the association between social relationships and health. The first perspective emphasises the health implications of the broader social-structural conditions in which we live. This perspective has been popularised by the notion of social capital, which is usually defined as the sum total of a person's social connections, including the norms, values, and trust that build and sustain these connections.⁶ By and large, social capital is thought to promote health through the resources that flow between inter-connected members of social networks, social support often being thought of as one of the primary resources.⁷

The second perspective has put greater emphasis on the psychological mechanisms that form the putative link between social relationships and health. Insights from theoretical frameworks such as social cognitive theory⁸ and self determination theory⁹ have underscored the importance of social determinants in promoting feelings of competence and perceived control that regulate behaviour, including health improving behaviour. In other words, social contexts and social interactions shape patterns of behaviour that may be of direct consequence to physical and mental health. For example, in a study of older adults

McAuley and colleagues have shown that social support had a significant positive effect on exercise self efficacy, which in turn predicted higher physical activity levels and greater maintenance of activity levels over time.¹⁰ It is of note that a recently proposed conceptual framework is an attempt to assimilate these two somewhat distinct perspectives into one model that incorporates the entire sequence of causal events, ranging from the broader structural "up-stream" conditions that shape individual behaviour to the intra-individual "down-stream" psychological and physiological mechanisms that link social relationships with concrete disease processes.¹¹

So why do friends seem to matter more than children? Giles *et al* suggest that discretionary ties, such as those with friends, provide a greater survival benefit than the less discretionary ties with children. As they indicate in their paper, socioemotional selectivity theory may offer an explanation by predicting that older adults become increasingly selective as they age in the type and number of social relationships in which they invest emotional attachment.¹² Thus, perhaps because of filial obligation and responsibility, older adults tend to turn to members of the nuclear family for emotional and instrumental support, especially when they experience or anticipate increasing dependence because of declining health.⁵ Another explanation may be that relationships with friends, more so than those with children, is marker of a person's ability to develop and maintain the sort of connections with other people and groups that form the basis of social capital. The specific social capital resources that produce tangible health benefit can be thought of as the supports available in one's social network or broader social environment that are conducive to healthy lifestyles—better access to healthy food, better dietary habits, more physical activity—and minimises exposure to stressful personal, work related, or neighbourhood related circumstances. Social capital may also include the resources

available in networks of people that facilitate access to (health related) information and services, and even facilitate forms of political organisation that may be used to improve access to and quality of care.⁷ But friendships could be salubrious for other reasons. One could argue that friendship often is an end onto itself, valued for its own sake, offering intrinsic rewards that fulfil basic psychological needs of competence, autonomy, and relatedness.⁹ In other words, friendship, feeling connected to other human beings who are valued, trusted, and loved, may provide meaning and purpose that is essential to our human condition, and perhaps to longevity as well.

So far, the exact mechanisms by which friendship and related positively valued social relationships and conditions affect health remain poorly specified. Perhaps they act through a psychological equivalent of the notion of physiological reserve, a source of surplus psychic energy or capacity that generates a physiological benefit, which the organism applies to slow down chronic disease processes that typically lead to disability and death as we age. All we need to do is to identify the biological substrate of this surplus capacity, measure it in human beings, show that it is related to friendship networks and other positive social interactions, and test the degree to which it slows down disease, disability, and death. Although this may sound like a daunting task, a precedent exists in the form of the concept of stress, which portends to summarise and unify the negative experiences we encounter in our interactions with others and the world around us. There are also emerging ideas about a common physiological pathway such as embodied by the concept of allostatic load that links stress with the development of degenerative diseases.¹³ Perhaps we will find one day a similar unifying concept and common physiological pathway for the totality of our positive social experiences, a concept that hopefully will be defined on the basis of more than merely the absence of stress.

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