Setting the Agenda for a New Discipline: Population Health Science

See also Galea and Vaughan, p. 592.

Imagine a typical interaction between a patient and a doctor 20 or 50 years from now, if a patient is complaining of chest pain. What are the questions that will be asked? On the one hand, we could envision a future in which vast amounts of biological data predict the probability that the patient has a number of clinical conditions. But we could also imagine a future in which the questions that are asked include how her neighbors are doing, what financial stress she is feeling, whether she has anxiety or mood problems, and whether her housing is secure. These lines of inquiry are not mutually exclusive, of course, and together set the stage for the emergence of a discipline of science with roots across social, biological, and medical sciences, yet with a conceptual grounding and set of values that distinguishes it from traditional approaches; this discipline is population health science.

After a century with critical wins for public health, we are increasingly faced with challenging chronic and acute diseases for which no clear answers are apparent. Obesity, addiction, mental health, and new and reemerging infectious diseases continue to contribute to global morbidity. Academic research on how to solve these problems is often hitting a wall. As it has become clear that "risk factor" approaches to the study of populations have limited utility in identifying what matters most,[1] the need for a new discipline that can tackle these emerging challenges has become clearer.

Population health science is the study of the conditions that shape distributions of health within and across populations, and of the mechanisms through which these conditions manifest as the health of individuals.[2] It represents a way of thinking, rather than a particular set of questions or methods and, as such, draws from a number of long-standing disciplines. Population health science is emerging as a broad and inclusive for two central reasons. First, scholars from different disciplines are coming together as population health scientists, bringing with them different perspectives and approaches. Second, the challenges that population health science tackles of necessity require engagement with a breadth of concepts and methods to approach complex, solution-resistant problems.

Despite publication more than two decades ago, Rose's volume *The Strategy of Preventive Medicine*[3] provides a foundation for the emerging field of population health science. Rose eloquently and simply articulated the key foundations for population health science, including that health manifests along continua in the population, that causes of such distributions of health between populations may be distinct from causes of health within populations, and that ubiquitous causes can exert a powerful impact on disease incidence but remain unseen without examining cross-population variation. While the challenges that face population health now are perhaps different than those that perplexed Rose, we find ourselves poised to implement many of the principles suggested by his work. We are now in an era of rapidly developing technology that is allowing us to collect vast amounts of data on populations, from biological samples taken throughout the life course to comprehensive clinical records. As these new developments unfold, population health science stands to play a strong role in this new era to shape questions, provide analytic guidance, and set the parameters for discussion and debate. The era of ever increasing "omics" fields has created large amount of data resources on individual biological profiles. Such vast arrays of data are proving to be successful in targeting cancer therapies based on genotypic variation.[4] Yet the social sciences also have a strong role in ensuring that these new technologies and insights remain grounded in the distributions of causes we know to matter for producing health, cementing the need for a discipline that incorporates multiple perspectives.

A focus on the foundational principles of population health science can guide the questions that are asked of big data warehouses, the direction taken by the science that improves the lives of populations, and the policy implications of work with big data resources. Irrespective of the millions of points of biological data collected on individuals' risk of disease occurrence, the structural forces that drive housing, nutrition, poverty, access to resources, and education are likely to fundamentally shape how health is distributed across populations. It remains likely that many causes of incidence across populations are not the same as the causes of cases within populations, and such causes of incidence are likely unequally distributed across populations. Population health scientists therefore can shape the discourse around uses of big data, ensuring that technology and excitement do not drive the questions asked, but rather improve our ability to answer them.

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For example, the promise of big data revolutionizing science and clinical care is linked to the rise of personalized and precision medicine heralding a new way in which clinical care will be delivered. A common refrain is that such techniques will allow us to accurately predict who will get a particular disease, and will provide us with tools to identify risk factors that can be intervened upon for prevention.[5] Yet the incorporation of precision medicine into a population health framework faces mathematical and conceptual challenges, including that the precision of such prediction is bounded by the factors that interact with those factors in the predictive model, and such factors likely vary across populations.[6] In fact, for most common diseases that affect population health, genomic and other biological predictors within populations are often poor discriminators of which individuals will develop disease.[7] Thus, it is unlikely that precision medicine will be able to strongly and accurately predict disease incidence risk, such risks likely to differ in accuracy across populations.

Furthermore, when we look across the last century to the factors that have dramatically improved the lives of the population, few have been personalized, or precise. We know that vaccines do little good for the majority of individuals who get them, because they never would have gotten the disease. Car crashes remain relatively rare but seatbelts are mandatory for all. These fall into the prevention paradox: that most people will not benefit from prevention efforts, and that large numbers of individuals who will not benefit still need to participate for population health to be maximized. Population health, then, is achieved when we collectively decide that we will change for the good of all not the benefit of any individual. In the wake of technological advances in research and care, we should ensure that our resources are equally balanced in promoting preventive efforts that are not individual, and in fact, may not benefit most individuals.

We consider the example that we began with: that of a typical clinical interaction in the future. Population health science is the field that, we hope, will provide us with the information regarding how to best consider the conditions and causes that shape population health, and how to align 21st century medicine with what we have known for centuries regarding the role of emotions and relationships in human health, with the ultimate goal of successful prevention at a population level. A research program that confronts the structural forces that place individuals at risk, creates distributions of health and disease unequally across socially defined groups, and focuses on embedding biological pathways within social interactions that develop across the life course and across generations, is a call to action for population health. AJPH

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