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## Will Precision Medicine Improve Population Health?

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**Announcement** of the precision medicine initiative has led to a variety of responses, ranging from enthusiastic expectations<sup>1</sup> to explicit skepticism,<sup>2</sup> about potential health benefits, limitations, and return on investment. This Viewpoint discusses whether precision medicine is unlikely or likely to improve population health, aiming to forge a consensus that bridges disparate perspectives on the issue. The potential of precision medicine to improve the health of individuals or small groups of individuals is not addressed here because it involves a different question with different metrics.

## Precision Medicine Is Unlikely to Improve Population Health

There are 3 fundamental reasons why precision medicine might not improve the health of populations. First, disease pathogenesis, especially for common non-communicable diseases, is extraordinarily complex. Abundant evidence has demonstrated this for the association between the multiplicity of specific genes and conditions, including obesity, hypertension, or certain cancers. Additionally, it is known that genetic associations have, in most instances, small effect sizes in contrast with more robust contributions of behavioral and social factors.

Second, a central promise of precision medicine is the identification of predictors of disease that can help guide interventions. This may prove to be the case for some diseases, especially cancer, but is unlikely to be the case for most other complex diseases. The challenge arises from the mathematical foundations of genetic epidemiology. Although large population studies can identify associations between genotypes and phenotypes, resulting associations have limited capacity to predict phenotype in individuals, which is the ultimate goal of precision medicine. It would take substantially stronger associations—several orders of magnitude greater than have been identified so far—to provide sufficient evidence to improve disease prediction in individuals.

Third, an assumed potential benefit of precision medicine (predicated on accurate and meaningful risk prediction) is that disease in the population can be avoided or forestalled by

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