Precision Public Health: Quantifying the Promises and Perils of Targeting

Scientific context

Precision public health is a controversial concept[1,2]. Inspired by ‘precision medicine’, it utilizes new data, methodologies and technologies to identify high-risk communities with accuracy and target them tailored interventions. Supporters of precision public health believe it can improve effectiveness and equity of public health action. Detractors instead argue that precision public health may contradict the very mission of public health, which is to improve the welfare of the population as a whole, and may shift the focus and funding from traditional, time-proven approaches, in favor of costly approaches with dubious efficacy[3]. In this project we will help quantitatively assess the potential of the main tenet of precision public health: targeting communities at high resolution. We will focus on public health response to epidemics of communicable diseases, and use a mathematical modeling approach. We will build a theoretical framework to determine if, when, under which conditions, and up to which point, public health action becomes more cost-effective when the targeting resolution increases (we will also quantify distributional aspects and impact on equity). We will then apply our findings to HIV prevention. Specifically, we will assess and compare strategies to offer pre-exposure prophylaxis (PrEP), determining if, at which resolution, targeting individuals at high risk of HIV is optimal. This PhD project fits with the Health Economics Initiative in its scientific goals - assessing the cost-effectiveness of public health action against infectious diseases as the scale resolution of the intervention changes – and methodologies - cost-effectiveness analyses, behavioral economics.

Scientific aims

Aim A: Development of the theoretical framework

We will build a theoretical framework to estimate how the cost-effectiveness of an intervention scales with the resolution of its targeting. We will start from dynamical models of epidemic risk (continuously developed within our team[4–6]) and use tools from statistical physics, computer science and health economics to determine how the observation scales influences the accuracy of risk estimates, the design of the intervention strategy and the cost associated to that strategy. Our model will need to include three crucial aspects. 1) Increasing the resolution may lead to a more accurate description and understanding of the epidemic process, as currently ongoing research in the host team is suggesting. Specifically, surveillance-based estimates may be biased in highly structured populations, and increasing the resolution may increase the reliability risk and vulnerability estimates. 2) Targeting at higher resolution may or may not increase the effectiveness of the public health campaign, as well as its impact on equity[7]. 3) Targeting at higher resolution may entail additional costs and delay deployment. That decreases the effectiveness of the intervention directly (lower cost-effectiveness) and indirectly: delaying implementation may increase the opportunity cost of high-resolution targeting (where the alternative is not increasing the resolution. This happens as an early decrease in epidemic risk will propagate exponentially into the future, effectively reducing the Net Present Value of late interventions.

Aim B: Application to the distribution of pre-exposure prophylaxis (PrEP) of HIV

Pre-exposure prophylaxis (PrEP) is the use of antiretroviral medication to prevent HIV acquisition in uninfected individuals. Despite being a component of the HIV prevention cascade, PrEP uptake is often inadequate. Identifying potential candidates, supplying medication, and ensuring consistent use present challenges to PrEP scale-up. Common guidelines recommend offering PrEP to those at high risk of acquiring HIV. But their identification and targeting are hard, especially among marginalized communities like men-having-sex-with-men and female sex workers, both groups disproportionately vulnerable to HIV. Plus, targeting may reinforce stigma. A previous modeling study showed started challenging risk targeting[7]. Here, we will employ the findings of Aim A to estimate the cost-effective targeting resolution (behavioral, spatial) of PrEP distribution. We will achieve this through ongoing collaborations with research institutions (University of California Los Angeles, USA and University of Lisbon, Portugal), activists (GAT Portugal). We will also work with behavioral economists at Carlos III University (Madrid, Spain) to evaluate the estimated cost of increasing targeting resolution against behavioral experiments (e.g., Willingness To Pay, Discrete Choice).

Project development

The PhD project will lead to at least 2 scientific publications. The former will be mostly methodological. The latter will focus on the application. Timeline:

Year 1	M1-6	Work on aim A
	M7-12	Work on aim A, preparation and submission of 1st study. Start work on aim B
Year 2	M1-6	Work on aim B; revision & resubmission of 1st study
	M7-12	Work on aim B; writing of 2nd study
Year 3	M1-6	Submission of 2nd study; writing of the thesis; Revision of 2nd study
	M7-12	Resubmission of 2nd study; revision of the thesis; jury set up; evaluation by rapporteurs; defense preparation; PhD defense

The PhD student will work in a stimulating scientific environment. They will carry out their research with the continuous possibility of scientific interactions with peers and with other researchers at IPLESP. Also, they will learn new methodologies by interacting with the scientific collaborators in behavioral economics and computer science. They will have the possibility to visit collaborators in the field.

Profile of the candidate

The candidate should have strong interest in applying quantitative methods from mathematics, physics, statistics and computer science to public health. The candidate should have a background in public health, specifically the cost/benefit and cost/effectiveness evaluation of policies. The candidate should have training, formal or informal, in the aforementioned quantitative sciences.

References

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4. Valdano, E., Ferreri, L., Poletto, C. & Colizza, V. Analytical Computation of the Epidemic Threshold on Temporal Networks. *Phys. Rev. X* **5**, 021005 (2015).
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7. Steinegger, B. *et al.* Non-selective distribution of infectious disease prevention may outperform risk-based targeting. *Nat. Commun.* **13**, 3028 (2022).