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THE ROLE OF COMPUTER SIMULATION MODELS IN THE DESIGN OF PUBLIC POLICIES

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Abstract Cardiovascular diseases are the number one cause of death globally, but their optimal prevention remains a challenge. A high-risk approach can only have a limited effect at a population level, while population-based strategies can improve and extend the coverage of a high-risk approach. However, one main problem for promoting cardiovascular diseases prevention public policies is the difficulty to foresee population health benefits of a single policy. Computer simulation models can assist with this problem, due to their ability to estimate intervention effects over different periods, and by scaling up the evidence to a broader, more diverse population. Their applicability to countries with different social, political and economic contexts can assist in the design of public policies. There are several models that assess health and economics scenarios, but regardless which model is chosen, when adequately used, they can provide reasonable estimations of health policies' impact. There is a growing consensus amongst the public health communities about the powerful role of population-level policies. They are more effective, cost saving and more equitable when compared with individual-level interventions. Policy makers and the public health community need to make further progress in changing the focus of prevention, from individuals to populations.

Kew words: computer simulation model, public health, public policies

Resumen ***EL rol de los modelos de simulación por computadora en el diseño de políticas públicas.*** Las enfermedades cardiovasculares son la principal causa de muerte en el mundo, pero su prevención óptima sigue siendo un desafío. El enfoque prioritario a escala individual en pacientes de alto riesgo solo puede tener un efecto limitado a nivel colectivo, mientras que las estrategias de alcance poblacional pueden mejorar y ampliar la cobertura de estos enfoques de alto riesgo. Sin embargo, uno de los principales problemas para promover políticas públicas de prevención de enfermedades cardiovasculares es la dificultad para prever los beneficios que una política única puede tener en salud. Los modelos de simulación por computadora pueden ayudar con este problema, dada su capacidad para estimar los efectos de una intervención en diferentes períodos, ampliando la evidencia a una población más extensa y diversa. Adicionalmente, su aplicabilidad a países con diferentes contextos sociales, políticos y económicos puede asistir en el diseño de políticas públicas. Existen varios modelos que evalúan escenarios tanto de salud como de economía, pero independientemente de qué modelo se elija, usados adecuadamente pueden proporcionar estimaciones razonables del impacto de las políticas de salud. Existe un consenso creciente en el ámbito de la salud pública sobre el importante rol de las políticas poblacionales. Son más efectivas, económicas, y equitativas en comparación con las intervenciones a nivel individual. En la formulación de políticas públicas en general, y de salud pública en particular, se debe avanzar en cambiar el enfoque de la prevención desde las personas a las comunidades.

Palabras clave: modelos de simulación por computadora, salud pública, políticas públicas

Nearly three out of four deaths worldwide are attributed today to noncommunicable chronic diseases or NCDs (including cancer, diabetes, heart disease and chronic lung disease), killing 39.5 million people a year[1]. Among NCDs, cardiovascular diseases (CVD) are the number one cause of death globally, responsible for almost 18 million deaths each year (31% of all deaths worldwide)[2, 3]; the three leading risk factors for global disease burden in 2010 were hypertension, tobacco smoking, and alcohol use[4]. Therefore, much effort has been put on studying and treating CVD risk factors.

Although most CVD can be prevented by addressing behavioural risk factors using population-wide strategies or by identifying people at high risk[3], their optimal prevention remains a challenge. Health is the result of complex interactions among multifaceted elements, and primarily determined by the interactions of inherited characteristics with social, economic, and physical environments, which together affect exposures and behaviours[5]. While many risks to health are widely distributed in the population,

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individuals differ in the extent of their risk rather than whether they are at risk or not. Therefore, while a high-risk approach may appear more appropriate to the individuals and their physicians, it can only have a limited effect at a population level. Population-based health policies recognize the importance of these non-individual factors in health outcomes and can improve and extend the coverage of a high-risk approach[6].

However, one of the main problems for promoting NCDs prevention public policies is the difficulty to foresee population health benefits of a single policy; direct evidence of its effectiveness is often unavailable or is incomplete. Natural experiments may provide information regarding the impact of population-level policies, such as Chile's and Ecuador's food labelling systems (in which a stop sign or a traffic light colour code is respectively applied to increase awareness about food components)[7, 8], or UK's salt reduction programme[9]. Nevertheless, these are examples of only rare opportunities.

Computer simulation models can assist with this problem, due to their ability to estimate intervention effects over different periods, and by scaling up the evidence to a broader, more diverse population. In a health care context, computer simulation models can be defined as "a technique that evokes or replicates substantial aspects of the real world, in order to experiment with a simplified imitation of an operations system, for the purpose of better understanding and/ or improving that system"[10]. This means developing a simulated reproduction of the environment and then predicting the likely outcomes produced by changing any input parameter or by modifying the process of the system under study[5]. When taking into consideration that the results of any simulation rely on the quality of the inputs included in the model, modelling allows to design, validate, and implement new ideas without disturbing production processes[5].

One good example of the use of computer models is Mexico's tax on sugar-sweetened beverages. Although it will take years to evaluate the health impacts of this policy, the CVD Policy Model, a state transition computer simulation model, already estimated that a 10% reduction in sugar-sweetened beverages consumption would result in about 189 300 fewer incident type 2 diabetes cases, 20 400 fewer strokes and myocardial infarctions, and 18 900 fewer deaths occurring from 2013 to 2022[11].

Likewise, using the IMPACTncd microsimulation model in the UK to reproduce the life trajectories of individuals, structural policies like the reformulation of salt content in processed food, a levy on sugar-sweetened beverages and stricter tobacco policy will result in about 67 000 fewer CVD cases and 8000 fewer cardiovascular disease deaths by 2030, while a cardiovascular disease prevention programme will deliver a substantially smaller reduction in the burden of CVD, 19 000 fewer cases and 2000 fewer deaths[12].

The PREVENT-HIA DYNAMO model, designed to facilitate quantification in the assessment of the health impacts of policies[13], showed that adopting best practice smoking policies would increase life expectancy by 0.4 years for men and 0.3 years for women after ten years, postponing over half a million deaths in eleven European countries[14].

In the USA, the CVD Policy Model projected that reducing dietary salt by 3 g per day would substantially reduce coronary heart disease (CHD) and stroke burden, and could prevent as many as 92 000 deaths from any cause[15]. Similarly, a 10% sugar-sweetened beverages consumption reduction in California would result in a 1.8% decline in new cases of diabetes, as well as a drop of 0.5% in incident CHD cases and 0.5% in total myocardial infarctions[16].

Argentina's version of the CVD policy model[17] has been used to estimate the health impact of both individual as well as population-based strategies. A more aggressive statin indication approach could potentially prevent 3400 myocardial infarctions and 1400 CHD deaths every year, which translates to a 7% and 6% reduction, respectively. But in order to achieve these benefits, it would be necessary the involvement of almost every primary care physician and cardiologist in the country, as well as adherence to treatment of more than half the patient population[18]. On the other hand, a 5 to 15% salt reduction in processed food would be expected to avert about 19 000 all-cause mortality, 13 000 total myocardial infarctions, and 10 000 total strokes in a decade[19]. Likewise, a tax to reduce sugar sweetened beverages consumption by 10% is projected to avert between 13 300 to 27 700 diabetes cases, 2500 to 5100 myocardial infarctions, and 2700 to 5600 all-cause deaths over a 10-year period[20]. Regarding tobacco use, while in Argentina its prevalence has been falling, the perception of its risk has increased[21]; taking advantage of this phenomenon, the implementation of free smoke environments, pictorial warnings and publicity bans could result in the prevention 7500 CHD deaths, 16900 myocardial infarctions and 4300 strokes in 10 years[22].

Apart from having less potential to reduce the burden of disease, individual-level policies might also reproduce existing health inequalities[23]. In Liverpool, the implementation of population-level policies on obesity, salt and tobacco, while maintaining investment at the current level of primary care-based prevention of CVD, has a 80% probability of being able to reduce both absolute and relative inequalities in less than 5 years; on the other hand, invitation-based screening programs for low income populations will be equitable in 2 decades or more[24]. Since inequalities gradients in CVD burden are driven by differential exposure to disease determinants by social class[25, 26], population-level policies have more potential to modify exposure to disease drivers across the entire population[27].

There is a growing consensus amongst the public health communities about the powerful role of population-level policies. They are more effective, cost saving and more equitable when compared with individual-level interventions[28]. Recently, the World Health Organization Independent High-Level Commission on NCDs has issued a set of recommendations that state that NCDs policy treatment should not be restricted to Health Ministries and instead involve the Head of States, who in turn should prioritize this topic in the public agenda; health systems should be reoriented to ensure health promotion and prevention; regulation and engagement of all actors involved should be guaranteed by government; and governments and the international community should guarantee funding action on NCDs[29]. Therefore, the applicability of computer simulation models to countries with different social, political and economic contexts can assist in the design of public policies. They can be used to compare different subpopulations, or to compare effects among the same group of people when applying different interventions[30]. A fuller picture can be achieved by integrating evidence from a variety of sources into simulation models and allowing the exploration of hard questions on the comparative effectiveness of population and individual level approaches to prevention. Even though it can be expensive to create a model itself, several models that assess health and economics scenarios already exist[5, 31-33]; regardless which model is chosen, when adequately used, they can provide reasonable estimations of health policies' impact.

However, many countries still face difficulties implementing NCDs prevention policies, mainly due to lack of political will or adequate prioritization, adequate planning, market factors, insufficient technical or economic capacity[29]. Argentina exemplifies this problem well. Although in recent years health public programs and laws have been passed to address CVD prevention (such as the National Anti-Smoking Law), much remains to be done: tobacco products taxes are still not regulated by the law, access to hypertension, diabetes or dyslipidemia medication is not guaranteed, there are no programs promoting physical activity, sugar-sweetened beverages taxation policy could not be achieved.

These difficulties are not surprising. Implementing population level policies requires a look at the structural, commercial and socioeconomic determinants of CVD. These interventions are often based on strong regulatory and fiscal measures, hence politically difficult. However substantial progress in the adoption of population level policies has been achieved around the globe. Success stories include global tobacco control efforts[34, 35]; salt reduction strategies in more than 30 countries[36, 37]; sugar taxation in Mexico, the Philippines, the UK, several cities in the USA[16, 38-41]. Policy makers and public health community need to build on this momentum, and make further progress in changing the focus of prevention, from individuals to populations.

Conflict of interest: None to declare

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