

A framework for developing open source economic models of mental health systems

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Abstract

Summary: There is strong in principle support for open source health economic models, but practical barriers limit their availability. We propose a set of principles and standards for the implementation of open source health economic models that are TIMELY - Transparent, Iterative, Modular, Epitomised and Yielding. We then describe a software framework that we have developed for developing TIMELY models in youth mental health and illustrate this framework with an open source utility mapping project.

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1 Introduction

Mental disorders impose high health, social and economic burdens worldwide [[1]][2]. Much of this burden is potentially avertable [3], but poorly financed and organised mental health systems are ill-equipped for this challenge[[4]][5]. The large and widespread additional mental health burdens recently observed during the COVID pandemic[6] and predicted as a potential future consequence of global heating [7], highlight the need to improve the resilience and adaptability of these systems. To help stem growing demand for mental health services, policymakers have also been encouraged to place greater emphasis on tackling the social determinants of mental disorder[8].

Realising significant improvements in population mental health may in part depend on gaining better understanding of the systems in which mental disorder emerges and is treated [9]. Currently, the theoretical basis for understanding these systems is weak [10]. Strikingly, it remains unclear why increased investments in mental health care have yet to discernably reduce the prevalence and burden of mental disorders[11]. The literature about how the requirements, characteristics and performance of mental health services are shaped by spatiotemporal context is underdeveloped [12]. There is insufficient evidence to identify the social determinants of mental disorders most amenable to preventative interventions, and for which population sub-groups such interventions would be most effective [13].

Mental health simulation studies rarely explore the features and behaviours of complex systems [14], with mental health economic models predominantly addressing issues relating to the affordability and value for money of individual programs [15]. Single purpose models that assume static systems, even when sufficiently robust to be formally incorporated into Government resource planning processes, may be inadequate for the decision support needs of policymakers and service planners seeking to successfully identify, prioritise, sequence and target multiple elements of complex reform programs [16].

Multi-application, dynamic systems modelling approaches can provide insights about inter-dependencies between candidate policy settings that static models of isolated scenarios cannot [17]. However, greater use of these types of models may require adaptation on the part of funders, modellers and decision-makers. The complexity of multi-application systems models may make them particularly prone to errors [18], thus requiring greater investments in model transparency and validation [19]. These types of models can be highly resource intensive to develop and may also never be truly “finished”, instead requiring ongoing updates to remain relevant to evolving decision contexts [20] and to meet additional feature requests from end-users. The development, validation and maintenance of these types of models may be simply too onerous and long term a burden to remain the responsibility of a single modelling team and might benefit from collaborations across multiple modelling teams, and perhaps the general mental health modelling field. Similarly, more attention to developing partnerships between modellers and decision-makers across the life-cycle of a modelling project can help ensure multi-purpose models can address priority decision topics and have user-interfaces that meet the needs of non-technical users.

Open source frameworks, which have been recommended for the development of mental health modelling field (Long, 2018), have the potential to help address a number of these challenges. Open source approaches can promote common standards and interoperability, improve model transparency and facilitate routine updates to rectify errors, update data and add features. They may also have educational value in developing the health systems modelling field (Dunlop, 2017).

However, open source computational models also present a range of conceptual, technical, legal and resourcing issues compared to more traditional approaches to model development.

However, of the three components that comprise a mental health computer simulation model - the conceptual model, the mathematical model and the computational model - only the first two are typically developed and reported in a manner that facilitates reuse, refinement and extension by others. This is problematic as the code implementation is where the theory represented by a simulation model is most fully elaborated. In the limited cases where code is made publicly available it is typically in the form of programs (an algorithm that performs one task) rather than code libraries (where the primary algorithm is decomposed into multiple component algorithms, that can be re-used for a potentially large number of other purposes).

In this article, we aim to:

- i. Describe a suggested framework for implementing open source mental health systems models comprised of a foundation set of modelling principles and standards and a software development toolkit.
- ii. Provide a worked example of applying the framework to developing open source models for mapping psychological measures to health utility in young people.

2 Methods

2.1 Sample and setting

2.2 Measures

2.2.1 Population characteristics

2.3 Procedures

2.4 Statistical analysis

2.4.1 Replicability

3 Results

4 Discussion

Availability of data and materials

Ethics approval

Details on ethics approvals go here.

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Conflict of Interest

None declared.

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A Appendix