

SOCIAL NETWORK ANALYSIS AS A TOOL TO COMPLEMENT EVALUATIONS OF PARTICIPATORY SYSTEMS MODELLING.

Can participatory processes lead to changes in the configuration of local mental health networks? A social network analysis in Bogota, Colombia.

Authors **Salvador Camacho** ^{1,2*}, **Adriane Martin Hilber** ^{1,2}, **Laura Ospina-Pinillos** ³, **Mónica Sánchez-Nítola** ³, **Débora L. Shambo-Rodríguez** ³, **Grace Yeeun Lee** ⁴ , **Jo-An Occhipinti**

Affiliations ¹ Swiss Centre for International Health, Swiss Tropical and Public Health Institute, Basel, Switzerland; ² University of Basel, Basel, Switzerland; ³ Department of Psychiatry and Mental Health, School of Medicine, Pontificia Universidad Javeriana, Bogota, Colombia. ⁴ Brain and Mind Centre, The University of Sydney, Sydney, NSW, Australia, ⁵ Computer Simulation & Advanced Research Technologies (CSART), Sydney, NSW, Australia

Introduction

This study focuses on the use of a Social Network Analysis (SNA) as a tool in the evaluation od participatory approaches to enhance youth mental health networks in a systems model project in Bogota, Colombia. Systems models, powerful tools for deciphering complex causal relationships driving mental health outcomes, are employed to simulate policies and initiatives for optimizing youth mental health investments. Through participatory systems modelling (PSM), a diverse group of stakeholders collaboratively maps the intricate causal mechanisms within the mental health system, including care providers, recipients, and individuals with lived mental health experiences. Particularly relevant in low-and middle-income countries (LMICs), this participatory process aims to bridge gaps in evidence-based decision-making tools. In Colombia's intricate health system, where various actors influence policy, this research investigates whether participatory processes can potentially modify connections within the network, enhancing dialogue, knowledge exchange, and overall system coherence.

Objectives

To use a SNA to gain insights otherwise missed by a traditional evaluation approach in a participatory process. The SNA was used to assess the impact of participatory processes on network connections, coordination, and communication. Moreover, SNA identifies influential stakeholders and their roles, contributing to a comprehensive understanding of the youth mental health network in Bogota.

Methods

The participatory process involved multidisciplinary stakeholders through three workshops, purposefully selected from Bogota's youth mental health system. These stakeholders encompassed policymakers, providers, community representatives, and young individuals with mental health experiences. Social Network Analysis (SNA) was incorporated into a broader evaluation approach. It examined stakeholders' perspectives and collaborations within the network before, during, and after workshops. Using online surveys and virtual interviews, the study aimed to comprehend stakeholder linkages, relationships, and changes in perceptions of partnerships. The SNA module in the survey explored interconnections, relationship types, and interaction frequencies between organizations. Basic SNA techniques were applied to map the network structure, assess influence, and analyze changes resulting from the participatory process. The metrics measured are shown in Table 1. The research adhered to ethical standards and received institutional approval. Participants engaged in several smaller workshops due to pandemic restrictions, and purposive sampling ensured diverse stakeholder representation.

Table 1. Basic metrics of the SNA

Metric	Description
Degree	Counts connections; high degree suggests local connectors, not necessarily best connected to wider network.
Closeness	Measures distance from all elements; high closeness spreads info easily and provides good overview of network.
Betweenness	Counts shortest path appearances; high betweenness controls info flow, acts as key bridges, potential single points of failure.
Size	Measures neighbors (including self); similar to degree, counts elements instead of connections.
Indegree	Counts incoming connections; high indegree means leadership and as source of advice, expertise, info.
Outdegree	Counts outgoing connections; high outdegree spreads info, sparks flow across network, not always most efficient.
Eigenvector	Measures well-connectedness to other highly connected nodes, considering node's connections' quality. High eigenvector centrality indicates network leaders with influence.
Reach (2-step)	Measures network portion within two steps of an element; high reach spreads info through close friend-of-a-friend contacts.
Reach Efficiency	Normalizes reach by dividing it by size (number of neighbors); high reach efficiency gains exposure through direct relationships.
MICMAC	Analyzes element exposure (how affected by others) and influence (how affecting others); plotted scores identify leverage points.
Density	Compares existing links to possible links between nodes.
Reciprocity	Likelihood of mutual links between nodes.
Diameter	Length of longest path between two nodes.
Avg. Degree	Average links per node in network.
Avg. Path Length	Average steps along shortest paths for all possible node pairs

Results

A total of 78 stakeholders were involved in three participatory workshops, but analysis focused on the 24 participants who attended all sessions and completed pre and post surveys. Representing 11 stakeholder categories, 32 nodes were identified due to some participants representing multiple institutions. Social Network Analysis (SNA) metrics were used to describe the network's characteristics before and after workshops. While network size and diameter remained constant, significant changes occurred in connection numbers and average degree. Key actors identified by degree centrality were the Bogota's Health District Department (HDD) and the Ministry of Health and Social Protection (MoH), with unchanged centrality values. Both maintained high visibility and control over information flow via closeness and betweenness centrality. Outdegree and indegree connections also ranked high for MoH and HDD, confirming their network leadership. Eigenvector centrality underscored their influence. Reach efficiency indicated shifts in lesser-connected nodes gaining exposure through direct relationships. Substantial changes in dominant actors were detected through MICMAC Cross Impact Analysis in exposure and influence.

Figure 1-A. Baseline Social Network structure for Mental Health in Bogota, Colombia. The circles represent stakeholders (nodes) and the links are the lines connecting two stakeholders. The node size is proportional to the node's degree and the node color was coded according to the type of group they belong to. SNA measures: 32 elements, 321 connections, 0.64 density, 0.97 reciprocity, 3 diameter, 19.91 avg. degree, and 1.45 avg. path length

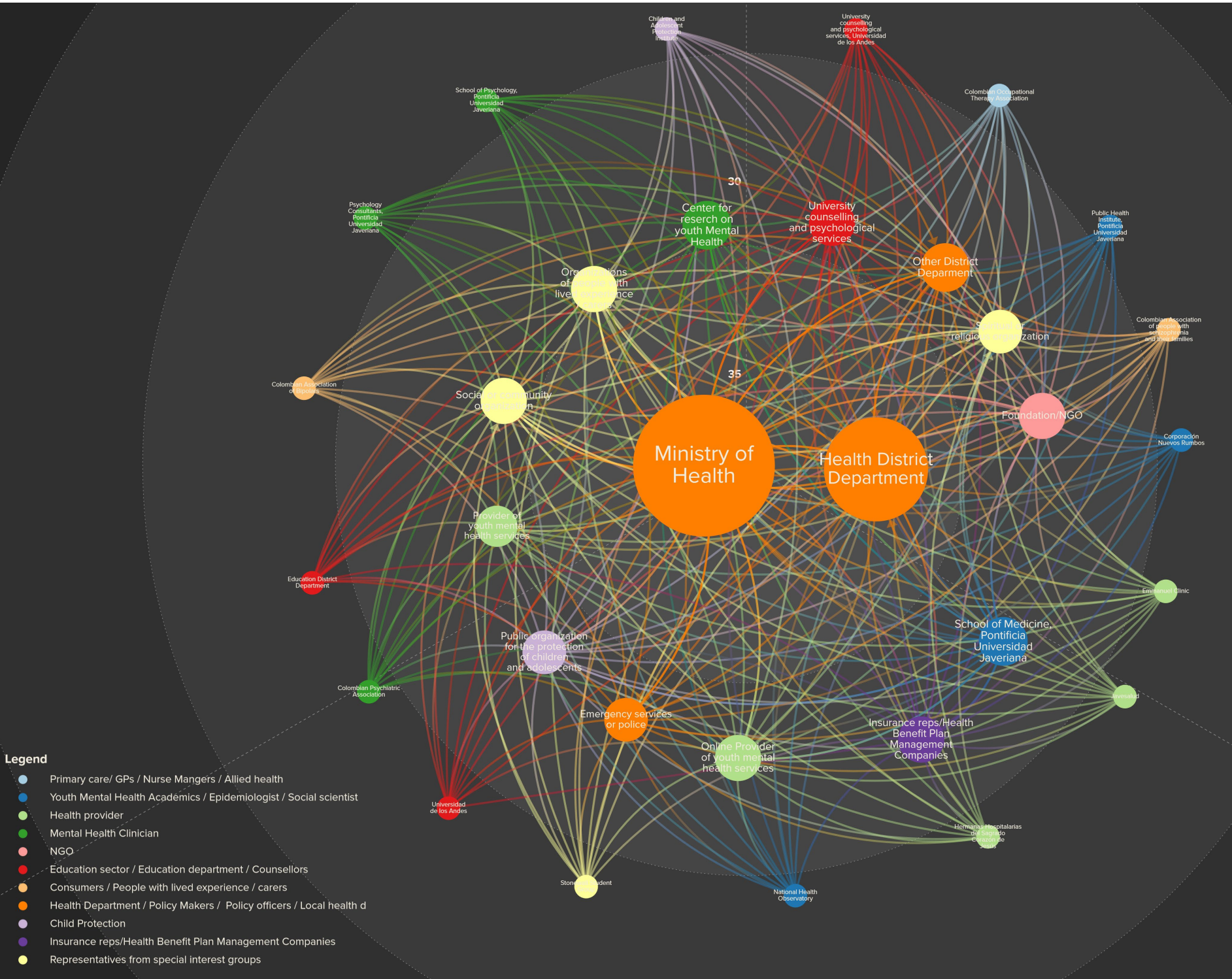
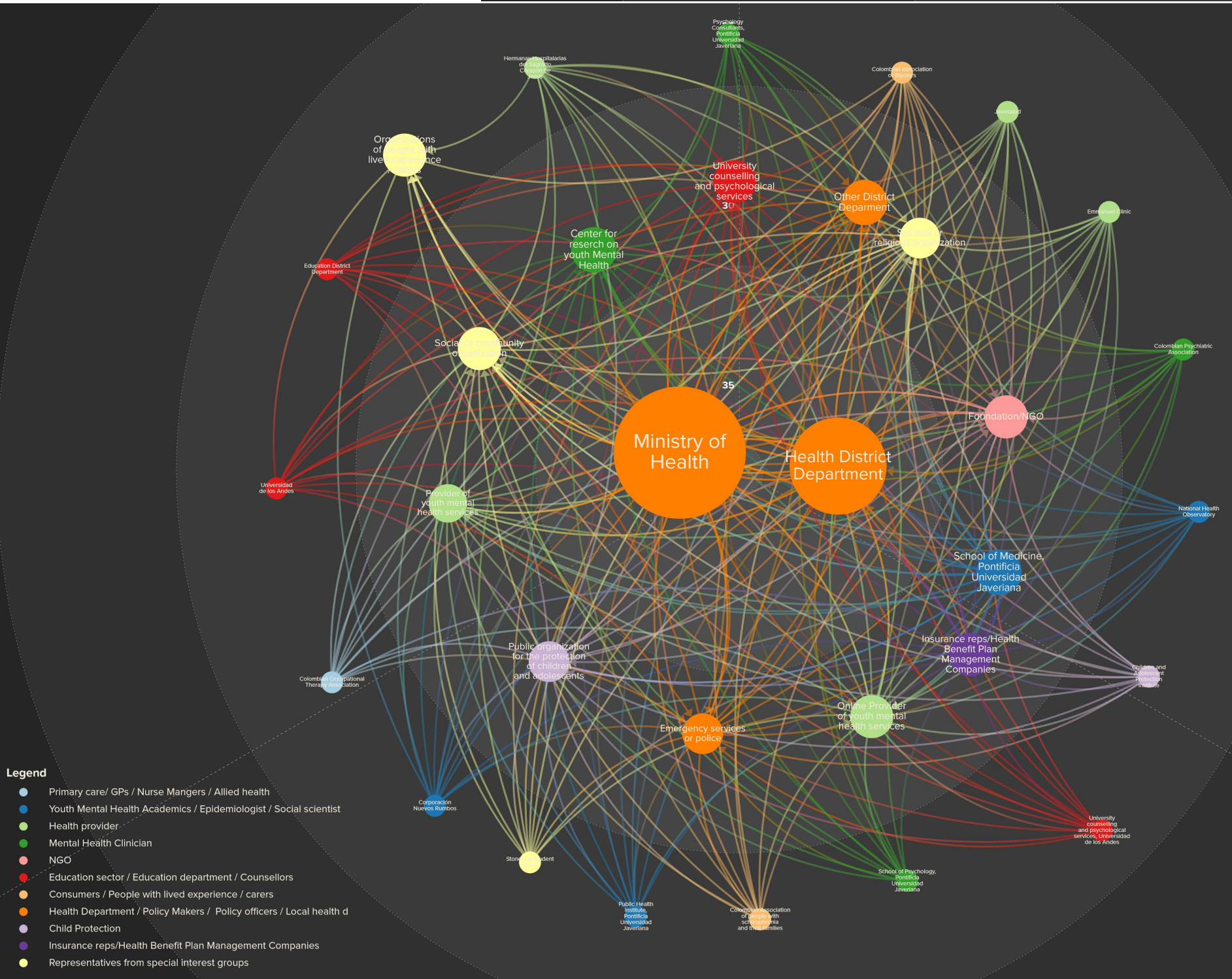


Figure 1-B. End line Social Network structure for Mental Health in Bogota, Colombia. The circles represent stakeholders (nodes) and the links are the lines connecting two stakeholders. The node size is proportional to the node's degree and the node color was coded according to the type of group they belong to. SNA measures: 32 elements, 308 connections, 0.57 density, 0.82 reciprocity, 3 diameter, 19.13 avg. degree, and 1.52 avg. path length

Conclusions

Insights provided by this SNA suggest that the participatory approach to systems modelling can impact the relationships between stakeholders and organizations that provide mental health services to young people. The insights from an SNA can assist with identifying the ideal actors within the network, e.g., most influential ones, to distribute information, support initiatives, and foster collective action to improve the mental health system, which in turn can assist decision makers and program designers to form more efficient partnerships in the aftermath of a PSM. The information provided by an SNA can be combined with other insights in available from more traditional evaluation tools applied to participatory processes, e.g. qualitative insights, such as stakeholder interviews and observational notes, to provide additional context for network structures and relationships supporting the co-generation of local and scientific knowledge and cooperation between scientists and decision-makers

References

Occhipinti J-A, Skinner A, Freebairn L, Song YJC, Ho N, Lawson K, et al. Which Social, Economic, and Health Sector Strategies Will Deliver the Greatest Impacts for Youth Mental Health and Suicide Prevention? Protocol for an Advanced, Systems Modelling Approach. *Frontiers in Psychiatry*. 2021;12. Freebairn L, Occhipinti JA, Song YJC, Skinner A, Lawson K, Lee GY, et al. Participatory Methods for Systems Modeling of Youth Mental Health: Implementation Protocol. *JMIR Res Protoc*. 2022;11(2):e32988. Koon AD, Rao KD, Tran NT, Ghaffar A. Embedding health policy and systems research into decision-making processes in low- and middle-income countries. *Health Research Policy and Systems*. 2013;11(1):30. Atkinson J-A, Wells R, Page A, Dominello A, Haines M, Wilson A. Applications of system dynamics modelling to support health policy. *Public Health Res Pract*. 2015;25(3):e2531531. Freebairn L, Rychetnik L, Atkinson J-A, Kelly P, McDonnell G, Roberts N, et al. Knowledge mobilisation for policy development: implementing systems approaches through participatory dynamic simulation modelling. *Health Research Policy and Systems*. 2017;15(1):83. Freebairn L, Atkinson J-A, Osgood ND, Kelly PM, McDonnell G, Rychetnik L. Turning conceptual systems maps into dynamic simulation models: An Australian case study for diabetes in pregnancy. *PLOS ONE*. 2019;14(6):e0218875. Freebairn L, Atkinson J, Kelly P, McDonnell G, Rychetnik L. Simulation modelling as a tool for knowledge mobilisation in health policy settings: a case study protocol. *Health Research Policy and Systems*. 2016;14(1):71. Krupa M, Cenek M, Powell J, Trammell EJ. Mapping the Stakeholders: Using Social Network Analysis to Increase the Legitimacy and Transparency of Participatory Scenario Planning. *Society & Natural Resources*. 2018;31(1):136-41.

Comments / Abbreviations / Statements

The authors would like to thank to Fondation Botnar, all the persons that participated in the modelling workshops, the organizations that they represented, and the staff of the Pontificia Universidad Javeriana. Special thanks to the community workers and young people with lived experience of mental illness that enriched the methodology with their participation. This research was carried in its totality thanks to a grant from Fondation Botnar (REG-19-026)

