Understanding the Role of Inequality in Creating and Sustaining the Alcohol Harm Paradox using Agent-Based Modelling

Doctoral Consortium

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ABSTRACT

This PhD applies a different perspective and novel methods to attempt to understand a complex health phenomenon, the Alcohol Harm Paradox (AHP). This is the consistent finding that poorer people experience greater risk of alcohol harm despite drinking the same or less as richer people. Thus far a variable-centric approach focused on testing the relationships between health behaviours and harm has dominated research on the AHP. This thesis shifts to a mechanism-based approach rooted in the theories of health inequality to understand how the determinants of health inequality; from the actions and interactions of individuals to the impact of society, contribute to the AHP. Simulation methods, specifically agent-based models, are implemented to test the explanatory value of health inequality theory in creating and sustaining the AHP.

KEYWORDS

Modelling and Simulation of Societies; Social Simulation; Health Inequality Theory

1 BACKGROUND

As a contribution to scholarship in public health, economics and decision science, this dissertation offers a new perspective and application of novel methods to understand the causes of inequalities in alcohol harm. The Alcohol Harm Paradox (AHP) is a consistent finding in the field of alcohol epidemiology, that lower socioeconomic groups experience greater rates of alcohol related harm despite consuming the same or often less alcohol than higher socioeconomic groups. Despite increasing awareness of the existence of this phenomenon the underlying causes remain

unclear. A lack of clarity on the causes of the paradox has made it difficult to design effective policies to reduce inequalities in alcohol-related outcomes. To do so requires a depth of causal understanding, specifically the ability to identify the key mechanisms which must be tackled to mitigate the effects of the paradox.

Generally, this PhD will take a mechanism-based approach to understanding the paradox and will draw on a wider health inequalities perspective. There is some evidence to suggest that experts studying the AHP have considered that the broader factors associated with inequality play a role, however this work fails to explicate theory and has lacked empirical investigation. This PhD aims to bring together what we know about the AHP from the existing literature and attempt to enhance this understanding using health inequality theory. This will then be used to create a computer simulation, specifically an agent-based model, based on the identified mechanisms to try to reproduce the trends associated with the paradox. If the model can successfully reproduce the AHP, it then has the capability to test potential interventions and policies.

1.1 Research Aim and Questions

The overarching aim of this PhD thesis is to advance the understanding of the causal mechanisms behind the AHP by undertaking literature-based and secondary research to develop and validate a theory driven computer simulation model. This model will attempt to reproduce the trend associated with the AHP using mechanisms derived from health inequality theory.

This thesis aims to answer four specific research questions:

1. What are the proposed explanations of the AHP in the existing literature, do these explanations belong to wider domains and what is the existing evidence base for them?
2. Can existing theoretical explanations of health inequalities enhance the explanations already provided for the AHP from the existing literature?
3. Can a quantitative simulation model, derived from theory, provide a candidate explanation for AHP? Can competing explanations be identified, and are there any consistent determinants of health inequalities implicated across those explanations?

4. Using the identified simulation model(s), which policies would be most effective in reducing harm associated with the AHP?

2 WHAT ARE THE PROPOSED EXPLANATIONS FOR THE AHP?

The first part of this thesis employs systematic review methods to identify the proposed explanations for the AHP. The results of this review indicate that those studying the AHP hypothesise several complicated causes at multiple levels from individual behaviour to the impact of changes in affordability of alcohol and economic recession. Yet the empirical evidence was firmly concerned with only individual health behaviours, (e.g., low socioeconomic groups binge drink, smoke and engage in an unhealthy diet). Additionally, it was clear that there has been a distinct lack of theory applied to understand the AHP and hence explanations often lack structure or detailed mechanisms.

3 CAN HEALTH INEQUALITY ENHANCE OUR UNDERSTANDING OF THE PARADOX?

Given that to date alcohol researchers have predominantly taken an individualized approach, the second section of the thesis then explores the utility of applying existing theories of health inequality to understand the causes of the AHP. Theories of health inequality, including the social determinants of health model, fundamental cause theory, the political economy of health, and the eco-social model, all take a multi-level approach to differences in health outcome between socioeconomic groups. These theories consist of several interwoven causal mechanisms including genetic inheritance, the role of social networks, the unequal availability of wealth and other resources, the psychosocial experience of lower socioeconomic status, and the accumulation of these experiences over time. Applying these theoretical approaches to alcohol research requires a shift in focus from individual-level behaviours to instead understanding that alcohol-related harm occurs within a wider context and is the result of a complex landscape of interacting mechanisms. I argue that theories of health inequality provide a framework for structuring and identifying the causal mechanisms underlying alcohol-related harm. Making greater use of these existing frameworks in alcohol epidemiology would offer potential novel insights into the causal mechanisms of the AHP and generate knowledge of where to intervene to mitigate inequalities in alcohol-related harm.

4 DEVELOPMENT OF A THEORY DRIVEN ABM OF THE AHP

Given the complexity associated with theories of health inequality, specifically the presence of feedback loops, interacting mechanisms and individual agency, the third section of the thesis implements a system dynamic agent-based model. Simulation methods allow us to move from a variable-centred approach; testing the associations between variables, to a mechanisms-centred approach; specifies the properties and activities of entities which bring about an outcome. Fundamental Cause Theory (FCT) has been selected as a candidate explanation for the AHP. This PhD will primarily follow the Mechanism-Based Social System Modelling (MBSSM) software architecture [1]. Glasgow, Scotland is the setting for this model due to availability of secondary data and micro-synthetic population. The first step of abductive reasoning, redescription, has been applied to identify interacting entities and mechanisms from FCT. FCT is primarily concerned with the distribution of fundamental resources: Power, Money, Prestige, Knowledge and Social Connections, and how they allow individuals to obtain health outcomes and employ these resources to adapt successfully to external events. Following the MBSSM architecture an initial conceptual model has been developed. The remainder of the thesis will document the unified modelling language development of the model, implementation in C++ using Repast HPC libraries, initialization and parameterization using existing secondary sources of data, adaption of the existing microsimulation and the calibration and validation of the model. Depending on whether the model can reproduce the trends associated with the AHP scenario analysis will be conducted to test potential interventions and policies. Potential interventions and policies will be identified following model development.

REFERENCE

[1] Tuong M. Vu., Charlotte Probst, Alexandra Nielsen, Hao Bai, Charlotte Buckley, Petra. S. Meier, Mark Strong, Alan Brennan, and Robin. C. Purshouse. 2020. A software architecture for mechanism- based social systems modelling in agent-based simulation models. JASS 23, 3.