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**Evaluating local-level interventions to address alcohol-related harms in England: the development and application of a complex systems perspective to process evaluations**

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**Thesis submitted in accordance with the requirements for the degree of**

**Doctor of Philosophy  
of the  
University of London**

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**Department of Public Health, Environments and Society**

**Faculty of Public Health**

**LONDON SCHOOL OF HYGIENE & TROPICAL MEDICINE**

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This research was supported by the NIHR SPHR. The views expressed are those of the author, and not necessarily those of the NIHR or the Department of Health and Social Care.

## Declaration

I, Elizabeth Tyner McGill, confirm the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

## Abstract

**Background:** Alcohol misuse is a wicked problem that may be best addressed by applying a complex systems perspective to the development and evaluation of alcohol interventions. Public health researchers have increasingly advocated this perspective, but the methods for complex systems process evaluations are under-developed. This thesis aims to develop and apply a framework for the application of a complex systems perspective to process evaluations of interventions to reduce alcohol-associated harms.

**Methods:** The research involved 4 elements: i) a qualitative study involving interviews (n=30) and a focus group to evaluate the mechanisms by which the intervention 'Reducing the Strength' (RtS) may generate multi-level changes; ii) a scoping review of 87 primary studies and 3 systematic reviews to describe the scope of complex systems alcohol research; iii) a systematic review of 21 complex systems process evaluations and the development of a framework for qualitative process evaluation from a complex systems perspective; and iv) the application of this framework to evaluate the 'Late Night Levy' (LNL) using documentary analysis, interviews (n=21) and observations (35.5 hours).

**Findings:** Alcohol interventions may generate multiple changes within and beyond the systems into which they are implemented. Alcohol research taking a complex systems perspective focuses on individual and local systems, with far less analysis of regional, national and international systems. Process evaluations from a complex systems perspective describe systems at a single timepoint, but utilise few complexity concepts to analyse system change. A two-phase process evaluation framework illustrates how to assess mechanisms of system change following intervention implementation. Applying the framework to evaluate the LNL demonstrated how the levy generated system changes which were both anticipated and unanticipated by system actors.

**Conclusion:** The process evaluation framework can produce holistic appraisals of how interventions generate system changes across system levels; evaluators should further apply and refine the framework.

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## Abbreviations

ABM	Agent-based model or agent-based model
ABV	Alcohol by volume
ASB	Anti-social behaviour
BID	Business Improvement District
CAP	Community Alcohol Partnership
CECAN	The Centre for the Evaluation of Complexity Across the Nexus
CIP	Cumulative Impact Policy
CIZ	Cumulative Impact Zone
DALYs	Disability-adjusted life years
IAS	Institute for Alcohol Studies
LA	Local Authority
LGA	Local Government Association
LNL	Late Night Levy
LSHTM	London School of Hygiene & Tropical Medicine
MRC	Medical Research Council
MUP	Minimum unit price or minimum unit pricing
NHS	National Health Service
NIHR	National Institute for Health Research
NTE	Night time economy
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RtS	Reducing the Strength
SD	System dynamics
SES	Socioeconomic status
SPHR	School for Public Health Research
The Act	The Licensing Act (2003)
ToC	Theory of change
UK	United Kingdom
VUE	Visual Understanding Environment

## Chapter 1: Introduction

### 1.1 Introduction

Alcohol misuse can lead to a variety of individual and societal harms, ranging from alcohol-related morbidity and mortality to a burden on health and social services, violence and productivity losses (1-6). There are numerous risk factors for harmful alcohol consumption including individual (7), community and family (8,9) and area-level characteristics (2,10,11). The latter often focus on availability of alcohol with a particular emphasis on the local retail environment.

Since the 1970s, public health academics and practitioners have argued that alcohol-related harms should be considered at a population level (12). This has translated into calls for strategies to reduce population-wide alcohol consumption that seek to modify the upstream determinants of alcohol consumption (13,14), in addition to focused prevention and treatment efforts for those who suffer disproportionately high levels of alcohol-related harms (15). In particular, a growing public health evidence base has suggested that alcohol consumption and related harms may be reduced through restricting the physical, economic and temporal availability of alcohol (10,11,16-23). Interventions to address these facets of availability might include, for example, a reduction in alcohol outlet density, increases in the price of alcoholic beverages and reductions in the days and hours in which premises are permitted to sell alcohol.

Over the past two decades, the public health voice and evidence base has increasingly advocated regulatory, as opposed to voluntary, measures in order to address the availability and affordability of alcohol, which reflects the large evidence base for the effectiveness of regulatory approaches (2,11). In England, many of these calls have emphasised approaches to be taken at a national level, with an argument that compulsory, wide-reaching interventions will best address population-level consumption and harms. An example of a national intervention that has been advocated by the public health community, on the basis of evidence for its effectiveness, is minimum unit pricing (MUP), an intervention that seeks to address the affordability of alcohol by legislating a minimum price for beverages based on their alcoholic content (24). To date, MUP has not been adopted in England, but it was adopted in Scotland in May 2018 and in Wales in March 2020 (25-27).

The UK government has also increasingly emphasised a localism agenda which has aimed to reduce the concentration of power held by the central government by transferring some powers to local governments and communities (28). In addition, public health moved out of the National Health Service (NHS) and back into local government in 2013 (29). Local governments control many aspects of alcohol availability through licensing, planning and trading standards (30). While national-level attempts to restrict and regulate alcohol availability through interventions like MUP have at times

faced political and legal challenges, local government functions have been seen as possible tools to modify alcohol availability and address alcohol-related harms (30). Fuelled by the localism agenda, inaction on alcohol harm prevention at the national level, the move of public health into local government and a view amongst public health researchers that licensing processes offer a way to shape alcohol environments, researchers have begun conducting more research on local-level alcohol policymaking and interventions (31,32).

Research on alcohol has been critiqued for sometimes taking a narrow lens, with many studies evaluating the effect of interventions on a limited number of pre-defined outcomes or failing to situate alcohol consumption and harms within the broader environments in which they occur (33-35). Such research has been criticised for potentially producing misleading findings by failing to analyse broader system-level effects of interventions (33). However, while increasingly researchers have called for system-level appraisals of public health interventions (36), little exists in the way of frameworks or guidance on how to apply systems-level thinking to understand the mechanisms by which such interventions may lead to impacts within and beyond the systems in which they are implemented (33,37,38). Therefore, this thesis aims to draw these threads together in order to fill a methodological and empirical gap by applying a complex systems perspective to conduct process evaluations of alcohol licensing interventions introduced in two English local authorities (LAs).

## 1.2 Aim and objectives

The overarching aim of this thesis is to develop and apply a methodological framework for the application of a complex systems perspective to public health process evaluations of interventions to reduce alcohol-associated harms.

This aim is underpinned by six objectives:

- 1) To understand how complex systems are defined and conceptualised in public health.
- 2) To describe the scale and scope of research on alcohol consumption and associated harms from a complex systems perspective and to identify evidentiary gaps in this literature base.
- 3) To identify and appraise process evaluations of public health interventions that utilise qualitative methods and apply a complex systems perspective.
- 4) To develop a methodological framework for process evaluation from a complex systems perspective.

- 5) To theorise and analyse how local alcohol interventions affect the systems within which they occur by exploring intervention pathways to impact with reference to key complex systems concepts.
- 6) To identify implications of this research for further development of evaluative methods from a complex systems perspective.

### 1.3 Overview of the thesis

This thesis is comprised of seven chapters and is presented in the order in which I conducted the analyses for each study. Following the London School of Hygiene and Tropical Medicine's (LSHTM) guidance for a 'research paper style thesis,' the results chapters are presented as published articles (Chapters 3, 4, and 5) or as a submitted manuscript (Chapter 6). Due to the nature of a 'research paper style thesis' there is inevitably some repetition between chapters, particularly when introducing and describing complex systems and their application within public health. A reference list is provided within each chapter.

The first two chapters provide an introduction and background to the thesis. Chapter 2 provides important context within which to situate this research. It overviews the association between alcohol and a range of individual and societal harms before describing the recent history of alcohol policy in England, with a specific emphasis on the local nature of policy responses to alcohol harms. It highlights the complexity of the alcohol policymaking environment in England and a number of tensions evident within this multi-level system which suggest the need to approach alcohol consumption and harms from a complex systems perspective. The chapter then introduces systems thinking and complexity science, considering its application to public health evaluation. Chapter 3 is the first research paper included in this thesis and illustrates an early application of complex systems thinking to public health evaluation: a process evaluation of a voluntary alcohol intervention called Reducing the Strength (RtS). The research paper was published in *BMJ Open* (39). Following the publication of the *BMJ Open* paper, I designed and collected data for the process evaluation of a discretionary, regulatory intervention called the Late Night Levy (LNL) using a complex systems perspective (which is described in Chapter 6). There was then an interruption of studies due to competing work priorities and maternity leave. Following this interruption, I proceeded to conduct two literature reviews to inform my analytical approach for the LNL evaluation. The first review was on the use of a complex systems perspective in alcohol research. The second review was on the application of complex systems perspectives to public health process evaluations. Chapter 4, therefore, describes a scoping review which was designed to identify and describe the nature of research on alcohol consumption and associated harms that takes a complex systems perspective.

This research paper was published in *Addiction* (40). Simultaneously, I designed and conducted a systematic review that identified process evaluations that utilise qualitative methods to evaluate public health interventions. After critically appraising these studies, and drawing on complex systems literature, I developed a two-phase framework for qualitative process evaluation from a complex systems perspective. The systematic review and process evaluation framework are presented in Chapter 5; this research paper was published in *PLoS Medicine* (41). I then applied the process evaluation framework to the data I collected on the LNL, supplemented by further documentary data. The findings from this process evaluation are presented in Chapter 6 and, at the time this thesis was submitted, the manuscript had been submitted to *BMJ Open*. Chapter 7 draws together the findings from across this body of research and considers the implications for public health methodological development.

The presentation of the papers in the order I conducted the analyses is designed to show the ways in which this programme of research progressed and evolved over time. The first paper (Chapter 3) represents my initial attempt to conduct an evaluation from a systems perspective. Following this initial study, I conducted two reviews to support the methodological development of complex systems evaluation (Chapters 4 and 5). The final research paper then illustrates the application of this methodological development (Chapter 6).

To provide an overview of thesis and how it fits together, Table 1 describes which objectives have been addressed in which chapters.

**Table 1: Thesis objectives and chapters**

<b>Objective</b>	<b>Addressed in chapters</b>
1. To understand how complex systems are defined and conceptualised in public health.	2, 4, 7
2. To describe the scale and scope of research on alcohol consumption and associated harms from a complex systems perspective and to identify evidentiary gaps in this literature base.	4, 7
3. To identify and appraise process evaluations of public health interventions that utilise qualitative methods and apply a complex systems perspective.	5, 7
4. To develop a methodological framework for process evaluation from a complex systems perspective.	5, 7
5. To theorise and analyse how local alcohol interventions affect the systems within which they occur by exploring intervention pathways to impact with reference to key complex systems concepts.	3, 6, 7
6. To identify implications of this research for further development of evaluative methods from a complex systems perspective.	7

## 1.4 Context of the thesis

This PhD was undertaken while I was employed at LSHTM working within the NIHR School for Public Health Research (SPHR). SPHR is a national research school that was established in 2012 in order to improve the evidence base for local-level public health practice by conducting applied research, supporting policymaker and practitioner engagement in research and building research capacity (42). The school and its constituent members have developed strong links with individual LAs as well as regional and national organisations, such as the Greater London Authority and the Local Government Association to support these aims. SPHR has encouraged the co-production of evidence in order to better meet the evidentiary needs of those working in public health policymaking and practitioner roles. I have been involved in SPHR-funded research on local decision-making (43,44), alcohol harm prevention (11,45) and complex systems thinking in public health evaluation (46-48). Work conducted for the thesis is supported by SPHR as it builds upon, but is distinct from, work planned and conducted as part of these SPHR collaborative projects. The thesis is registered as a staff PhD thesis at LSHTM.

## 1.5 Role of the candidate

My thesis contains four research papers, each of which has a number of co-authors. The research described in each stemmed from, but was independent from, research planned and conducted within the SPHR. For each component of the research described in my thesis, I led on the conceptualisation, ethics, data generation, data analysis and interpretation, writing, manuscript submission and manuscript revisions. My co-authors provided supervision, validation (e.g. independent screening of studies, critical appraisal, data extraction), input into the interpretation of findings and critical comments on drafts. Each research paper in the thesis is accompanied by a research paper cover sheet which details my role in the research and the preparation of the paper.

## 1.6 Ethical approvals

The research described within this thesis obtained ethical approval from the LSHTM Research Ethics Committee. The approval letters can be found in Appendix A.

The first primary study (Chapter 3) was an off-shoot of an SPHR project entitled “How is local government alcohol policy implemented and evaluated?” which aimed to identify and contrast alcohol policies implemented in English LAs and explore influences on implementation and outcomes. The original ethics approval (Ref: 6452) covered data generated through formal and informal interviews with LA practitioners and documentary review. When I designed the RtS study, I

submitted an amendment to interview homeless, street drinkers and service providers working with this population, in addition to interviewing LA practitioners. Ethical approval for this amendment was granted (Ref: 6452-02) in August 2014. The ethics application paid particular attention to interviewing homeless people in hostel settings.

I also applied for and obtained ethical approval for the fourth study (Chapter 6; research paper 4) (Ref: 10129), which is a process evaluation of the LNL. The protocol was designed to explicitly take a systems perspective, which informed the sampling strategy (e.g. sampling from a wide range of participants within the local system) using a range of data generation methods (e.g. interviews, informal conversations, observations and documentary review) in a number of settings (e.g. in alcohol-retailing venues, on community-safety patrols and in LA offices). The ethics application paid particular attention to conducting research in settings where alcohol is consumed, with consideration to obtaining informed consent from those consuming alcohol and ensuring fieldworker safety.

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## Chapter 2: Background

### 2.1 Alcohol consumption and related harms

On an individual level, the consumption of alcohol is linked with a wide range of physical and mental health conditions, including a diagnosable ‘alcohol use disorder,’ as well as a range of illnesses associated with different levels and patterns of alcohol consumption (1). The International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10) lists 230 disease and injury codes in which alcohol is a component (1,2). Of these codes, over 30 are conditions that cannot manifest themselves without the individual having consumed alcohol (3,4).

Alcohol consumption is causally associated with many types of disease and injury, including, for example, some neuropsychiatric conditions (particularly alcohol use disorders), gastrointestinal diseases (liver cirrhosis, pancreatitis), most cancers, intentional and unintentional injuries, cardiovascular diseases, foetal alcohol syndrome, diabetes mellitus and infectious diseases (tuberculosis, pneumonia) (1,5). Some research evidence shows that there is a complex relationship between alcohol consumption and cardiovascular disease whereby light drinking may provide some protective effect against cardiovascular disease risk (2,6). However, modelling studies from the United Kingdom (UK) have shown that this benefit, if it exists, is confined to women over the age of 55 who drink at levels of approximately five units<sup>1</sup> per week (7) and does not extend to other conditions, including major cancers (8,9).

Both single episodes of alcohol consumption and patterns of alcohol consumption have effects on the physical and mental health of individuals. For example, most intentional and unintentional injuries attributable to alcohol are caused by a single episode of acute alcohol consumption, and the risks are higher in men compared to women (7,8). However, repeated episodes of acute alcohol consumption also increase an individual’s cumulative risk of injury over the duration of their life (10). Globally, alcohol accounted for 3 million or 5.3% of all deaths and 132.6 million disability-adjusted life years (DALYs) or 5.1% of all DALYs in 2016 (2). In England in 2018 there were 5,698 alcohol-specific deaths (i.e. deaths where the cause of death is fully attributable to alcohol) and in 2018/2019 there were just under 1.3 million recorded hospital admissions which were either wholly or partially attributed to alcohol consumption (11). Alcohol-related harms are not distributed equally across socioeconomic groups; both UK and international evidence has consistently demonstrated that individuals of a higher socioeconomic status (SES) report higher levels of alcohol consumption,

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<sup>1</sup> 1 unit = 10mL or 8g pure alcohol

while individuals in lower SES groups experience greater levels of alcohol associated harms (12). This phenomenon has been referred to as the ‘alcohol harm paradox’.

In addition to individual physical and mental health harms associated with alcohol, alcohol consumption can lead to physical and psychological harms to others, including individuals both known and unknown to the drinker and broader society (13-15). Harm to others may include injuries or death, for example through road traffic accidents, violence or crime (2,16). Alcohol consumption also results in broader social and economic costs, including direct costs to the health, police and criminal justice and welfare systems and indirect costs as a result of lost productivity (2). There have been relatively few assessments of the cost of alcohol consumption and harms in England, but in 2009 the Department of Health estimated that alcohol-related harms cost the National Health Service (NHS) £3.5 billion per annum, cost society £7.3 billion due to lost productivity and alcohol-related crime is estimated to cost £11 billion per year (15).

## 2.2 Reducing alcohol consumption and preventing alcohol-related harms in England

### 2.2.1 A public health perspective

A public health framing of alcohol emphasises population-level consumption and associated harms (17). By conceptualising alcohol-related harms as a population-wide problem, public health academics and practitioners have called for strategies, policies and interventions that strive to reduce population-wide alcohol consumption and that address the upstream influences on behaviour and health outcomes (18,19), as well as seek to reduce harms in drinkers who suffer disproportionately high levels of alcohol-associated harms (20). This large public health evidence base suggests that alcohol consumption and related harms may be effectively reduced by using regulatory measures to restrict alcohol availability (2,21,22). Alcohol availability has three broad dimensions: economic (affordability), temporal and physical (spatial).

Economic availability refers to the cost of alcohol in relation to disposal income (23). A recent review of the effectiveness and cost-effectiveness of a range of different types of alcohol control policies concluded that “policies that reduce the affordability of alcohol are the most effective, and cost effective, approaches to prevention and health improvement.” (24 p.7). Minimum unit pricing (MUP) is a regulatory intervention which has been supported by public health advocates as an effective measure to reduce alcohol consumption and harms. MUP establishes a minimum price per unit of alcohol (25), ensuring the minimum price is paid by the consumer (rather than absorbed by alcohol producers or retailers) and is the same across all types of alcoholic products (rather than varying the price by beverage type) (24,26). The Sheffield Alcohol Policy Model estimated that a MUP of £0.45 in

England would reduce alcohol consumption across the population, with the greatest decreases in consumption occurring amongst harmful drinkers (25). Their modelling also suggested MUP would have the largest reduction in mortality in harmful drinkers and those in lower socioeconomic groups (25). Evidence from British Columbia, Canada, where the minimum price of alcohol has been increased over time, found the price increases reduced consumption and both acute and chronic-alcohol attributable hospital admissions (27,28). In Scotland, a recently published evaluation of off-trade sales following the introduction of MUP in May 2018 found an increase in the average price of alcohol and a reduction in the volume of per alcohol sold per unit, compared to England and Wales (29). MUP, at the time of writing this thesis, has been ruled out in England (30).

Temporal availability refers to the days and hours in which alcohol is available for purchase (31). A recent review exploring the impact of temporal availability on alcohol-associated harms concluded there is strong evidence that reducing the hours of sale can reduce alcohol-related harms, particularly within the night-time economy (NTE) and that policies to reduce the days and hours of sale can lead to reductions in alcohol-attributable injuries, hospitalisations, homicides and crime. (24). This is corroborated with other review-level evidence on the effects of restricting the days and hours of sale (32).

The final dimension of availability is the physical or spatial availability of alcohol, which describes the degree to which individuals encounter alcohol in their environments and is typically measured in terms of alcohol outlet density (23,33). Reductions in alcohol outlet density have been demonstrated to be associated with alcohol consumption and associated harms (2,32,33), although the causal relationships are less clear than for economic and temporal availability due to methodological limitations of the current evidence base (34).

The public health perspective can be contrasted with the perspective prevalent in alcohol industry discourses. Commercial actors have tended to frame problematic alcohol consumption as being confined to a small minority of the population, and by implication, unproblematic for the general population (35,36). The concept of a problematic minority of drinkers emphasises the behaviour of certain types of individual consumers, and so arguably focuses attention away from overall consumption and industry retail and marketing practices (37). These framings could serve corporate interests by, for example, justifying continued alcohol sales to a supposed majority of 'unproblematic' drinkers, and supporting the case for individual-level interventions rather than population-level approaches that include greater corporate regulation and alcohol availability restrictions (38). This framing is evident in the types of interventions that the alcohol industry has tended to support, including local-level interventions and/or those focussed on specific groups, such

as binge or underage drinkers (37,39). As described in the following section, these framings promoted by the industry have also been reflected in national-level alcohol policy and strategy in England.

### 2.2.2 Alcohol strategies and legislation

In England, national alcohol strategies have been utilised to determine priorities and outline policies aimed at reducing what the Government considers to be the important alcohol-related harms; as such, they provide insights into how policies are framed and justified. In addition, the Government passes alcohol-related legislation that creates powers to address alcohol-related harms and defines what is legally permissible action at the local-level. The following section will briefly introduce the English policy context by describing some of the key themes that have emerged from the most recent national alcohol strategies and legislation.

In the past two decades, the English Government has produced two alcohol strategies, and two ‘next steps’ documents. The first two documents, *Alcohol Harm Reduction Strategy for England* (2004) (40) and *Safe, Sensible, Social: The next steps in the National Alcohol Strategy* (2007) (41) were published under a New Labour Government. The third and fourth documents, entitled *The Government’s Alcohol Strategy* (2012) (42) and the *Next steps following the consultation on delivering the Government’s alcohol strategy* (2013) (43) were published under the Conservative and Liberal Democrats Coalition Government that came to power in 2010. In 2018 the Conservative Government announced they would develop a new alcohol strategy, but in 2020 announced they were no longer proceeding with plans for a “stand-alone strategy” (44 p.6). A summary of the key themes from these strategy documents is provided in Table 1.

**Table 1: Overview of key themes in national alcohol strategies since 2004**

	<b>Alcohol Harm Reduction Strategy for England (2004)</b>	<b>Safe, Sensible, Social: The next steps in the National Alcohol Strategy (2007)</b>	<b>The Government's Alcohol Strategy (2012)</b>	<b>Next steps following the consultation on delivering the Government's alcohol strategy (2013)</b>
<b>Emphasis</b>	Individual responsibility Problematic minority of drinkers Crime and disorder	Individual responsibility Problematic minority of drinkers Crime and disorder	Problematic minority of drinkers and businesses Crime and disorder Some environmental influences on drinking	Individual responsibility Problematic minority of drinkers and businesses
<b>Sources of alcohol problems</b>	Binge drinkers Chronic drinkers	Under-age drinkers Binge drinkers 'Harmful' drinkers	Binge drinkers and pre-loaders 'Irresponsible' businesses	'Irresponsible' drinkers 'Irresponsible' promotions
<b>Proposed strategies to address alcohol harms</b>	Education Improved health and treatment services Targeted action against binge drinkers, and under-age drinkers committing crime and disorder Alcohol-industry engagement and voluntary social responsibility schemes	Education Expanded treatment services Measures to address alcohol-related offending Alcohol-industry social responsibility schemes Evidence review on association between alcohol price / promotions and harm	Criminal justice measures Minimum unit pricing and multi-buy promotion ban Industry-led initiatives Greater control to local areas	Ban of alcohol sold below duty + VAT Local-level action Industry-led initiatives

All four strategies emphasised the position that alcohol problems are largely concentrated within a minority of drinkers (45). Collectively, the strategies have suggested that while the majority of individuals consume alcohol in such a manner that does not cause harm to themselves or others, certain group of individuals do not, thus necessitating targeted efforts directed at specific groups (46-48). Starting in the 2007 next steps document, and with more emphasis in the 2012 strategy, the Government also began to characterise certain types of alcohol-retailing premises as problematic if they allowed, or were viewed as encouraging, drunken individuals and drunken behaviour (49). The 2012 strategy also placed a particular emphasis on the cost of alcohol and made linkages between readily available inexpensive alcoholic drinks and alcohol-related disorder and anti-social behaviour (48).

Evident throughout these strategies is a framing of alcohol problems that emphasises public drunkenness and associated behaviours. While physical and mental health harms to individual

drinkers, their families and their communities are described, the strategies place more emphasis on social harms such as crime, disorder and anti-social behaviour (47,49,50). As a result, many of the proposed actions or strategies to address alcohol harms have focused on addressing the visible effects of drinking.

Based on their conceptualisations of alcohol problems, the 2004 and 2007 documents proposed similar strategies to address alcohol-related harms. These included the use of educational campaigns to promote 'responsible drinking', expansion of treatment services, measures to address alcohol-related offending and industry-led social responsibility schemes (46,50,51). Both strategies placed a particular emphasis on combatting alcohol-related crime and disorder targeted at binge and youth under-age drinkers (47,49). While some references were made to the local environment, particularly in the 2007 next steps document (49), the perceived need to strengthen and utilise existing legislation and penalties against individuals engaged in alcohol-related disorder or underage drinking was emphasised. The 2012 strategy represented in some ways a shift away from the two previous alcohol strategies (48). While much of the rhetoric remained focussed on punitive actions that should be taken against drunk and disorderly individuals, the 2012 strategy placed a greater emphasis on the social context and the multiple factors that influence the creation of environments where drunken behaviours are exhibited. The strategy acknowledged the role of different actors, including the government and the alcohol industry, in shaping these environments, and therefore for being partially responsible for changing these environments. As a result, the strategy recommended the use of supply-side controls and tighter licensing regulations. Specifically, the 2012 strategy proposed the national introduction of a MUP for alcohol in England and introduced a consultation on a multi-buy promotion ban within the off-trade (42). While the impetus for these price and availability policies, according to the strategy, was the need to tackle binge drinking, the means to do so included the possibility of impacting population-level alcohol consumption and harms. The 2012 strategy also proposed actions to be taken at the local level. The strategy emphasised the need for local areas to take more control over alcohol availability through the use of local licensing tools and the funding of additional policing services (48).

However, following a consultation on the 2012 strategy, the Government postponed MUP and called for more evidence on its effects and effectiveness (43,52). The post-consultation document argued that interventions such as MUP may unfairly affect those who consume alcohol responsibly and that more targeted action was required to address the minority of individuals who consume alcohol at harmful levels and irresponsible premises: "Rather than use the sledgehammer of national legislation, which often misses its target, our immediate priority is to engage the industry – and of course, its customers – to follow practices that help everyone who likes a drink to consume alcohol

responsibly” (43 p.3). In order to address ‘irresponsible’ retail and consumer practices, the Government advocated industry-led social responsibility actions or public-private partnerships, such as the Public Health Responsibility Deal which launched in 2011 and consisted of companies, including alcohol producers, voluntarily committing to a series of public health pledges (45,53). In addition, the Government announced a ban on alcohol sold below duty plus value added tax, a measure likely to be ineffective due to the very small market share held by these products. Brennan and colleagues (2014) estimated that only 0.7% of all units of alcohol are sold below this level (54). Later in 2013, the Government announced that it would not be proceeding with MUP in England (45). The Government’s ‘U-turn’ on MUP in 2013 was criticised by the public health community with arguments that the Government was abandoning alcohol availability controls that have an evidence base for effectiveness because of industry lobbying and influence (52,55). Industry representatives have lobbied against MUP and challenged it in the courts, arguing that it unfairly penalises ‘responsible drinkers’, instead of targeting those ‘problem drinkers’ (56). However, as described above, modelling studies have shown that the policy would lead to the greatest decreases in consumption and mortality amongst harmful drinkers (25). An alcohol strategy has not been published since 2012, although the 2016 *Modern Crime Prevention Strategy* contained a large section on alcohol and advocated the continued use of local-level approaches to alcohol-related harms through new police powers, local intelligence and partnerships (57).

In addition to the alcohol strategies published since the turn of the century, two major pieces of legislation have been passed and enacted that affect licensing of alcohol-retailing establishment and policing in the night-time economy: the Licensing Act (2003) (58) and the Police Reform and Social Responsibility Act (2011) (59).

The Licensing Act (2003), which was enacted in November 2005, was designed to change the licensing regulatory framework within England and Wales. The Act transferred licensing powers from magistrate courts to local authorities (LAs), with the aim of ensuring that local bodies could participate in decision-making about licensing (58,60). Alongside this, the Act created four ‘licensing objectives’ which guide all licensing decisions (see Box 1). In addition, the Act removed fixed closing times for alcohol-retailing establishments (61-63). In 2000, a Home Office White Paper, *Time For Reform*, drawing extensively on an industry-funded study (63), argued that the set closing times were themselves problematic because they pushed intoxicated consumers onto the streets and transportation at the same time, resulting in disorder, public nuisance and anti-social behaviour (61-63). The Act enacted the deregulation of closing times, allowing for an increase in the temporal availability of alcohol, a move which has been characterised as the “largest liberalisation of alcohol regulations in England and Wales since the beginning of the 19th century” (61 p.42).

**Box 1: Licensing objectives in England and Wales**

- a) the prevention of crime and disorder;
- b) public safety;
- c) the prevention of public nuisance; and
- d) the protection of children from harm

Source: Licensing Act (2003) (58)

Whilst the 2003 Act liberalised licensing regulations, it also offered LAs stronger powers to control alcohol outlet density. Specifically, the Act introduced the ability for LAs to implement a Cumulative Impact Policy (CIP), a policy tool to limit the growth of alcohol outlet density in areas where the sale and consumption of alcohol is leading to adverse social consequences (64,65). Therefore, in the same Act, licensing regulations were both liberalised, in an attempt to address night-time disorder and nuisance, while at the same time providing LAs additional powers to tighten licensing restrictions as a response to alcohol-related harms.

In 2011, the Police Reform and Social Responsibility Act (2011) was enacted. A key feature of the 2011 Act was the introduction of the 'Late Night Levy' (LNL) whereby LAs may require that local alcohol retailers pay a fee for having a license to sell alcohol between midnight and 6 am. This fee is split between the police and the LA in order to help police and manage the night-time economy. (66)

Considering this policy landscape holistically, within the past decade there has been a liberalisation of licensing legislation, through the deregulation of opening hours, and somewhat paradoxically, a simultaneous tightening of licensing controls through the introduction of CIPs. With the introduction of the LNL and the latest crime strategy, there has been another move towards greater licensing controls and the provision of additional powers to address local-level alcohol harms within local government. Furthermore, the recent English national alcohol strategies and legislation have emphasised the need for local responses to alcohol consumption and related health and social harms. This position has been advocated within the context of a broader political agenda around 'localism' with an emphasis on power being transferred to local communities. This localism agenda has, in part, contributed to a rapid growth in local-level alcohol research (67).

### 2.2.3 A trend towards local action and research on alcohol

The research presented in this thesis can be situated within a growing body of literature exploring local alcohol policymaking processes and evaluating local-level alcohol interventions (67). The impetus for the growth stems from a number of factors, including an overarching trend of localism in England, the relative failure of action on alcohol harm prevention at the national level, the move of public health into local government in 2013 and some evidence that licensing powers can play a role in preventing alcohol harms (65,68-73).

Since the start of the 21<sup>st</sup> century, successive governments have shown an interest in the devolution of power from the central government to LAs, communities and individuals. Localism, defined either as giving local bodies more power or as a description of local government institutional structures, is hardly new in the UK (74-76), but has gained momentum since the New Labour government began promoting *new localism* as part of its 'third way' ideology in the early 2000s (74,76). The subsequent Conservative – Liberal Democrat coalition government passed the 2011 Localism Act which introduced a range of new powers and responsibilities for LAs and communities, arguing: "local authorities can do their best job when they have genuine freedom to respond to what local people want, not what they are told by central government" (77 p.4). The Conservative government, elected in 2015, continued this approach and has emphasised localism as a means to continue to move decision-making closer to local communities in an effort to generate efficiency, fairness and greater democracy (75,78). While both the Coalition and Conservative governments have pushed the localism agenda, this agenda has been implemented alongside an austerity budget that reduced central government funding of local services and led to net reductions in local authority budgets (75,79,80).

Localist policies and rhetoric have also faced a number of criticisms. For example, while there are arguments in favour of locally-tailored interventions to suit local community needs, achieve meaningful impact and help maximise sustainability, this form of localism may also result in inequalities due to uneven investment and delivery of local interventions (65). Others have criticised the way in which localism has been approached in the UK, arguing that it has placed too much responsibility on local populations for improving their health and social conditions while simultaneously removing the funding in order to effectively do so (75). Furthermore, budget cuts have disproportionately impacted already disadvantaged local authorities (80). In the case of alcohol, others have argued localism has been used as a strategy to avoid implementing national-level regulatory measures (81).

Indeed, concurrent to the localism agenda, there has been relatively little action on reducing alcohol consumption and preventing alcohol-associated harms at a national level (82), with government policies and strategies illustrating little commitment to reducing alcohol consumption and preventing alcohol-associated harms across the population. Little action has been taken to enact national, population-wide measures to tackle alcohol-associated harms. A clear example of this inaction, as illustrated in the previous section, has been the failure of successive governments to introduce MUP in England (45). As a result of this inaction and the provision of more powers to local government to address alcohol harms in local communities, there has been increase in the

implementation of range of alcohol policies and interventions at the local level across England over the past decade (83).

Over the same time period, in 2013, the public health function moved back into local government after 40 years in the NHS, in part to better integrate action to address the social determinants of health into public health practice (84,85). As Phillips and Green describe, alcohol was a specific policy area where proponents of the move argued that benefits of this move might be particularly clear (86). Specifically, the co-location of public health with statutory functions such as licensing and planning was seen as an opportunity to embed public health within the planning and management of local environments (86). Licensing processes, in particular, have been increasingly highlighted as mechanisms to reduce population-level alcohol consumption and harms and provide a possible avenue for public health practitioners to shape alcohol environments (68).

As a result of the convergence of these factors, in England there has been what Toner et al. have characterised as “an explosion of new epidemiological information and other forms of research information designed to support the development and implementation of evidence-based alcohol policy at local levels” (67 p.96).

#### 2.2.4 The need for a complex systems perspective for alcohol harm prevention efforts

This description of alcohol policymaking in England has illustrated that such efforts operate within a complex system, comprised of multiple levels of actors, operating from the national to regional and local levels (83). Actions at one systemic level influence and are influenced by actions at the other, as well as the international systems in which multi-national alcohol industry actors operate. The previous discussion has also highlighted a number of tensions in this field: tensions between public health and alcohol industry framings of alcohol harms, population and individual framings of prevention, regulatory and voluntary initiatives and national and local action. Together, these multiple levels and competing frames suggest the need for a holistic approach to alcohol research. Some researchers have therefore argued that alcohol researchers should explicitly adopt a complex systems perspective to analysing alcohol policymaking processes and evaluating alcohol interventions (82,87).

### 2.3 A complex systems perspective

Over the past two decades, public health researchers and practitioners have increasingly embraced what is variously referred to as a ‘complex systems perspective’ or ‘complex systems lens’ or ‘complex systems thinking’ in response to “the lack of progress in addressing wicked problems such

as obesity, chronic disease and the social determinants of health” (88 p.2). Alcohol misuse can also be considered as a wicked problem (89). Proponents of a complex systems perspective argue that public health research has been rooted in linear models of cause and effect which are overly reductionist and fail to situate health behaviours, outcomes and inequalities within the systems in which they created (88,90). Applying a complex systems lens is intended to situate these emergent properties within the complex systems which give rise to them, making explicit and analysing the multiple interdependent variables that affect and influence each other (90,91). While this perspective is increasingly advocated, there is some divergence in the ways concepts and terminology is used, which, in part, stems from the multiple disciplines that have embraced and utilised systems and complexity theory. Indeed, a recent review on definitions used in complex systems thinking concluded: “the overall landscape is best characterised as a conceptual muddle, with the same concept terms being used differently and different concept terms being applied with similar meanings within and between communities. More often than not, the definitions are vague and lack an operational orientation [...]” (92 p.167). The remainder of this chapter aims to bring some clarity to this ‘conceptual muddle’ by introducing two distinct but intersecting traditions: systems thinking and complexity science (93), before turning to how these two traditions have been brought together in public health. In doing so, the key concepts and how they are operationalised in this programme of research will be defined.

### 2.3.1 Systems thinking

While public health researchers have only recently embraced systems thinking, it has roots in ancient philosophy (94) and, in more modern times, has a strong tradition within the natural sciences (95). Over the past century, systems thinking has been adopted and further developed in numerous disciplines, ranging from engineering to ecology (96-98). More recently, systems thinking has been applied within health services research with an aim of developing stronger health systems (98) and within public health to tackle the spread of infectious diseases, prevent and reduce obesity, control tobacco and prevent and reduce alcohol-associated harms (87,98-100).

A system is “a set of things – people, cells, molecules or whatever – interconnected in such a way that they produce their own pattern of behaviour overtime” (101 p.2). However, while that is a fairly straight-forward definition, the term ‘systems thinking’ encompasses a “a sizeable and amorphous body of theories, methods and tools” (102 p.1). In this thesis, ‘systems thinking’ or a ‘systems approach’ will be considered a conceptual orientation that is utilised to think systemically and holistically (94,96,103,104). This draws on arguments made by Cabrera and colleagues who have characterised systems thinking as “a formal, abstract, and structured cognitive endeavour” (103

p.301) in which researchers consider relationships, varying perspectives and boundaries as they fit within a broader whole. These concepts therefore are not utilised to denote any specific methodologies or methods that can be used to describe, analyse and understand systems and their dynamics, but rather refer to the adoption of a specific perspective. Systems thinking focuses attention on three main system attributes: i) interdependent elements; ii) multiple perspectives; and iii) boundaries (93,105,106). Specifically, systems thinking forefronts the relationships between elements and considers how these relationships give rise to the system structure and systemic patterns of behaviour (101,105). Thinking systemically also involves accounting for the multiple perspectives within any given system since a system contains a number of actors, each of whom has a different view of the system and their role within it. These views inform how they act within a system and respond to different system inputs (105). Finally, systems thinking involves critically assessing and determining the boundaries of a given system (107,108), a process which is discussed later in this chapter.

### 2.3.2 Complexity science and theory

Complexity theory is often drawn on when describing and analysing systems. As with the systems thinking tradition, complexity theory, which can be located in the field of 'complexity science' has been developed and utilised by a range of different disciplines (109) and is characterised by "conceptual confusion" (110 p.2) and incoherence (107). Byrne, who has written extensively on complexity theory within the social sciences, defines complexity theory as "the interdisciplinary understanding of reality as composed of complex open systems with emergent properties and transformational potential" (111 p.97). The concepts raised within this definition will be further defined and explored in the sections below.

Many authors have argued that applying complexity theory allows researchers to better represent and analyse change within systems, representing a divergence from more linear, reductionist models of research (112). Utilising complexity theory in understanding systems has been seen as a means to simultaneously consider the system as a whole – a 'holism' perspective – while also exploring the relationships within the system, and those external to the system that may impact it (113-115). In addition, complexity theory introduces the consideration of time to the study of systems and their dynamics: by conceptualising systems as evolving entities, as opposed to something static, complexity theory facilitates an exploration of how the system adapts over time and how inputs into the system may have impacts across a range of timescales (116-118). Finally, complexity theory can also be viewed as a conceptual framework that creates an 'ordering logic' to help study complex systems and interventions within them, focusing on how the interdependent nature of system

elements generates change and emergent properties. Authors who view complexity theory as this sort of conceptual framework argue the theory is useful for generating “theoretical explanations” (Castellani and Hafferty quoted in (119 p.7). Complexity theory therefore provides a lens through which the researcher develops theories to explain the nature of the system and its patterns of behaviour (110,112).

Complexity has also been characterised as an attribute of either an intervention and/or of a system (113,120-122). Complex interventions are ones with many interdependent parts, often delivered at multiple organisational levels or to different population groups, that aim to affect multiple outcomes (123,124). In contrast, complexity can also be viewed as the property of the system into which an intervention – either simple or complex – is implemented (121,125,126). The latter perspective has been referred to as a ‘complexity frame of reference’ (107,127), and it is this framing of complexity that informed the research contained in this thesis. Adopting a ‘complexity frame of reference’ to evaluation research means exploring the ways in which an intervention may disrupt system dynamics, with an emphasis on how the system, its elements and the intervention adapt and co-evolve to either dampen or amplify intervention impacts (121,125).

### 2.3.3 Complex systems

Byrne and Callaghan suggest that “when we talk about complexity we are talking about systems” (119 p.3) and the phrase ‘complex systems’ brings a complexity lens to the study of the properties of systems (such as levels of alcohol consumption or associated harms) or the evaluation of interventions within these systems. A complex system is a dynamic system; that is, it changes overtime (128). These changes and the evolution of the system occur due to a complex system’s properties: it is comprised of multiple, intersecting and interacting levels and agents (107,113,116,129,130) and characterised by non-linear dynamics (107,112,114,120-122,129-131), feedback loops (112,114,120,122,128,129), adaptation (107,108,113,117,129,132,133) and emergent properties (95,107,111-113,116,122). A narrative description of these characteristics is provided below and a table defining each of these terms can be found in Chapter 5 (Table 2).

Many researchers in the field of systems research have emphasised the distinction between complicated and complex systems. Complicated systems are ones which are comprised of many different elements; these elements can be studied individually and the relationships between them are assumed to operate in a linear fashion (114,119,133). On the other hand, complex systems are ones in which there are also many components, but they do not operate independently from one another and are characterised by disproportionate relationships which lead to system uncertainty

(114,119,133). What is key from this distinction is that in complex systems, the relationships between agents, structures of the system and the environment are critical (98,101,108,113,128,129,134,135). While a researcher can learn about a complicated system by studying its individual elements, in order to research a complex system, the researcher must analyse the dynamic relationships between the many system elements. It is these relationships and these interactions that create the system and its behaviour.

Hawe, Shiell and others have argued that community interventions can often be considered 'events' in complex systems that may trigger chains of responses and relational changes between individuals or groups (121,122,128). This complex system perspective argues that the most significant aspect of complexity lies not (necessarily) in the intervention itself, but in the system into which the intervention is introduced (122). In this perspective, interventions are viewed as 'critical events' which may change system structures and behaviours (121). Such an approach is valuable because it emphasises how an intervention may (or may not) have wide-reaching impacts within the system in which it is implemented (121).

Complex systems are considered to be 'open' which means they both impact and are impacted by the broader environment, a process referred to as co-evolution (112,115,117). For example, a local system may have geographical and administrative boundaries but it will inevitably be influenced by systems operating at other levels, including, for example, neighbouring local areas and national-level regulatory, economic and political factors. Researchers, however, must draw some boundaries around a system in order to study it and make judgements about what will be the focus of the research and what will be excluded (107,108). Actors within and outside any given system will have their own views as to what constitutes legitimate system boundaries, which may result in competing 'boundary judgements' (136). For example, a public health researcher would consider the advertising efforts of alcohol producers as an important influence on alcohol consumption; public health actors may therefore include alcohol advertising as a system element (137). Alcohol industry actors, on the other hand, who argue there is no evidence for the influence of advertising on consumption, might draw more narrow system boundaries that focus on more individual-level influences on consumption (137). System boundaries are not static, but rather may change as a system adapts in response to an intervention or other internal and external inputs (114). Taken together, a clear challenge for a researcher is to define the boundaries of the system of interest and to justify the drawing of such boundaries on the basis of different actors' perspectives and the observed behaviour of the system as a whole. As such, some scholars have argued that researchers should be cautious in declaring that they have absolutely 'found' or 'defined' a system's boundaries (108).

Complex systems also span multiple levels, which means they are comprised of multiple elements operating at different levels, and that different systems interact with each other (107,114,116,122). While some authors have argued that this aspect of a complex system can be conceptualised as a hierarchy, others have utilised the terms ‘nested’ (98,107,111,114) or ‘negotiated orderings’ to describe this structure (119). These terms are utilised to convey the notion that different elements of a single complex system, and different complex systems, are assumed to interact across different levels (108,111). As Byrne argues, “determination runs in all possible directions, not just top down” (111 p.105) and as a result, any one level of the system, and the actors and their behaviours that exist at that level, may have impact on any of the other levels within the system. Within the context of local-level alcohol interventions, for example, ‘the system’ may contain a number of levels and actors, including a macro regulatory framework, organisations and groups who plan and deliver interventions and the individuals, communities and groups who may influence and be impacted by interventions (130). Additional systems that interact with the local system might include the global networks of alcohol producers, global health alliances, the national legislative system, the alcohol industry who lobby and influence at a national level and national health policymakers. Complexity theory provides a lens to explore how these different agents interact with each other on the same level (referred to as ‘horizontal complexity’) and between different levels within the system (called ‘vertical complexity’) (107).

Complex systems are also characterised by non-linear dynamics, which means that inputs into the system, such as local-level licensing interventions, do not necessarily result in correspondingly-sized effects to the system (107,112,114,116,120-122,128-131). As such, small inputs into a system may result in broad system changes or large impacts on certain aspects of the system, whilst larger inputs may not trigger similarly large changes. Non-linearity occurs due to the diverse interactions of the many system elements with each other, the system’s history and external factors (130). The history of a system is crucial, and actors and the system as a whole will be influenced by the system’s historical trajectory, which will influence their behaviour and future system properties (112-114). Taken together, this means that complex systems may not have predictable patterns of behaviour, the result of which is that it is challenging for evaluators to predict the type, scale and timing of system responses to changes within or external to the system (101,107,114).

Feedback loops are also considered a key aspect of complex systems whereby an ‘event’ or ‘activity’ within the system may affect other aspects of the system, which in turn, affects the original activity (112,114,121,122,128,129). Feedback loops can be positive (reinforcing) or negative (balancing) (114). Positive feedback loops lead to amplification of change within a system; negative feedback loops dampen change or lead to stability within a system (138). Fitzgerald and colleagues use a

licensing example to illustrate a reinforcing feedback loop within a local system (139): as licensing powers are used to reduce the density of alcohol outlets, the visibility and ability to easily procure alcohol decreases. As a result, fewer people may drink or individuals may consume fewer units of alcohol, which in turn reduces the demand for alcohol in the local area. As a result of decreased demand, fewer alcohol outlets may be economically viable, which leads to a further reduction in alcohol outlet density (139). By contrast, if a licensing policy reduces alcohol outlet density, commercial actors may increase lobbying efforts, which may, in turn, lead to policies that stop or even reverse the reduction in outlets; this hypothetical example illustrates a stabilising feedback loop. Feedback can occur at the same level or between levels within the system, or between a system element and a variable external to the system (128). As a result of non-linearity and feedback loops, complex systems are characterised by unanticipated, or unintended, changes and consequences (107,114,116,122).

Another key feature of complex systems is the principle of adaptation. Adaptation refers to the processes whereby individual system elements, and the system as a whole, adapt to changes internal or external to the system (114,122,132,133,140). For example, individual agents, and the system as a whole, change and adapt their behaviours in response to the introduction of interventions into the system (141). In doing so, this may change the nature of the relationships between system components and affect the system's emergent behaviour. Such changes in these interactions are key mechanisms by which interventions may, or may not, lead to changes within the system (108). For example, system actors may change their behaviour to 'work around' an intervention, thereby reducing its impact. Adaptation occurs naturally within systems and is not directed by any single agent or power; this characteristic is called 'self-organisation' within complex systems (138).

Finally, a key feature of a system is the concept of emergent properties. Emergent properties are characteristics of the entire system (111,116,122) that arise from the interactions between the various elements within a system (107,117). A challenge in identifying emergent properties is that they cannot be measured by simply adding up the properties of the individual system components. That is, emergent properties are a feature of the system in its entirety and cannot be understood by combining 'micro-level' analyses (95). For example, alcohol-associated harms are a property that emerges from a system that includes alcohol production, advertising, sales, cultural views towards consumption, as well as policies and interventions to affect patterns of consumption and harms (139).

#### 2.3.4 Complex systems and public health evaluation

Evaluators have increasingly suggested that applying a complex systems lens can produce better evaluative evidence, something Mowles has characterised as “repeated appeals to the complexity sciences to inform evaluative practice [...]” (118 p.160). Advocates of applying a complex systems perspective to evaluative research have suggested that it is one possible means to move away from ‘reductionist’ evaluative approaches that focus on a single or small numbers of outcomes (112,135). Such evaluations may offer few insights into change that occurs within dynamic systems if they fail to account for the influence of, and interaction of the system with, its broader social, economic, political and historical contexts (98,114,115,142). In contrast, a complex systems perspective has been suggested as a way of generating more holistic descriptions of systems which can subsequently inform the analysis of their dynamics as the system and its elements adapt and change in response system inputs (such as a public health intervention) (88,90,121). It is assumed that these more holistic analyses generate a more nuanced understanding of, and richer theories to explain, system dynamics (115,118). However, it is worth noting two important caveats: first, any system description and analysis will inherently be a simplified version of reality and therefore to some extent reductionist (104); second, and related, evaluators adopting a complex systems perspective still need to make decisions about which uncertainties and emergent findings to focus on as it is simply not possible or necessary for a single evaluation to explain or measure all possible changes across all system levels that may stem from the introduction of an intervention (125).

With these caveats in mind, there are a number of additional reasons that evaluators have suggested embracing a complex systems perspective. Such a perspective encourages a broader evaluative lens that moves beyond individual-level analyses and explores multiple and interconnected levels of influence (91,143,144). This argument has particularly resonated with some alcohol researchers who contend that too much alcohol research has focused on high-risk populations and individual-level risk factors at the expense of situating population-level alcohol consumption and associated harms within the environments that create and sustain them (135,145). Evaluations that take a complex systems perspective may well measure impacts on individuals, but they will also consider intervention influences and impacts at other system levels.

In addition, adopting a complex systems lens in evaluative research entails a focus on system dynamics and non-linearity. This orientation allows evaluators to understand and measure planned impacts, as well as those that were unanticipated or unexpected by intervention designers. Such a focus also allows evaluators to explain the mechanisms by which an intervention is either absorbed by a system, thereby dampening down its intended impact, or the ways in which systems dynamics enhance intervention impacts (125). It also captures impacts that are related to other factors not

associated with the intervention and the ways in which interventions may spur additional system activity (146). Some alcohol researchers have argued that applying a relatively narrow lens risks more than simply missing out on some processes or impacts, but can lead to misleading conclusions (137). Petticrew and colleagues, for example, demonstrate how measuring the impact of alcohol advertising on alcohol sales and consumption alone can lead to narrow conclusions and they advocate for a broader systems-level perspective that explores the complex causal relationships between advertising and consumption, including evaluating how alcohol advertising affects social norms around alcohol and regulatory mechanisms (137).

#### *Process evaluation with a complex system lens*

A recent review<sup>2</sup> of complex systems methods applied to public health evaluations developed a framework which mapped systems methods against five evaluation stages: i) theorising; ii) prediction; iii) process evaluation; iv) impact evaluation; and v) further prediction (126). Seventy-four unique evaluations were identified; most of these were modelling studies used in the prediction stages of an evaluation. They used simulations to test potential consequences of different 'what-if' scenarios. However, the review also identified twenty-four process evaluations that explicitly adopted a systems framing to assess how an intervention has system impacts, through either qualitative or mixed qualitative and quantitative methods. The studies varied considerably in their focus, as well as in the extent and the ways to which they applied complex systems thinking to the evaluation (126).

Process evaluations may be conducted alongside or in isolation from an outcome evaluation, which in public health practice have tended to quantify the impact of the intervention on a single or relatively small number of pre-defined outcomes (123,141). By contrast, process evaluations can be used to assess intervention implementation (fidelity and quality) to make sense of the causal mechanisms that generate outcomes and to explore the contextual factors that explain why impacts may be unevenly distributed between settings or amongst different population groups (124). Process evaluations may be conducted in a manner that is compatible with a complex systems perspective without utilising the language of systems and complexity. For example, they may emphasise how context shapes both the intervention and implementation processes or analyse how dynamic responses to an intervention may lead to both anticipated and negative consequences

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<sup>2</sup> I co-led on this review and it was completed after the systematic review published in *PLoS Medicine* (Chapter 5). The review includes the studies I identified for the *PLoS Medicine* review, along with a number of other studies, given its broader inclusion criteria.

(125). However, as the recent review of public health evaluations demonstrated, only a relatively small number of process evaluations have explicitly adopted this perspective to date (126).

In public health, advocates of a complex systems have argued there is a value to bringing an explicit complex systems lens to evaluation, including process evaluations. As described above, systems thinking and complexity theory may provide a form of 'ordering logic' to an evaluation that helps guide an evaluator, ensuring that concepts from these fields are operationalised in order to coherently inform all stages of the evaluative process (119). Specifically, applying a complex system perspective to process evaluation can, at the beginning of an evaluation, be used to make sense of the system structure, with an emphasis on system boundaries, relationships and perspectives (147). Establishing this context through the explicit application of systems thinking concepts then allows evaluators to develop a sampling strategy that includes participants from across the system, representing a range of different perspectives (148). An evaluator can then generate data that assesses relationships within the system and how these evolve in response to the intervention (142). Doing so begins to help to elucidate the non-linear ways in which an intervention may generate multiple impacts, which may or may not have been envisaged by those designing and implementing the intervention (149). This focus suggests an evaluative timeframe, or the use of different methods, that allows evaluators to capture or model processes that evolve over time (107,125).

Process evaluations can draw on a range of methods and the review of complex systems methods applied to public health evaluations found a number of evaluations that exclusively utilised qualitative methods, as well as a smaller number that used a mix of qualitative and quantitative methods (126). Qualitative methods may be particularly suited to capturing complex dynamics that emerge from implementation and well as generating theories that may inform further intervention development (125,150). There is a relatively large body of literature on applying complex systems approaches that utilise quantitative methods, particularly simulation approaches (e.g. agent-based modelling, system dynamics models, microsimulation), but comparatively less has been written on how to integrate a complex systems perspective with qualitative methods in a process evaluation (126).

## 2.4 Conclusion

While there has been a significant interest in applying complexity theory to evaluation, this has not been without criticism. For example, in response to criticism that the Medical Research Council's (MRC) Guidance on Complex Interventions did not address complexity theory, Craig and colleagues argued that: "complexity science has enjoyed a minor vogue in the health sciences for some years,

and there is no shortage of advocacy ... What is lacking is an account of how to engineer the theory into nuts and bolts of a practical research strategy, let alone any empirical underpinning in the form of successful evaluations using these methods" (Craig et al. quoted in 151 p.412). Indeed, many advocates of complex systems approaches to evaluation have made a similar comment: that the methods, particularly those that are distinct from dynamic simulation models, are under-developed (88) and little exists in terms of practical frameworks or guidance on how to apply a complex systems approach in practice to public health evaluation (88,91,144). In addition, while there have been numerous advocates of a complex systems approach to alcohol research, there is no overview of the size and scope of the body of literature that has done so (87,137). Understanding this is important for helping assess the value of a complex systems approach to the prevention of alcohol-associated harms.

The remainder of this thesis seeks to address these gaps. Specifically, the research outlined in this thesis will cumulatively assess the scope and scale of complex systems literature on alcohol, consider how the theories and concepts from complex systems thinking can be operationalised into 'the nuts and bolts' of a research framework and apply this framework to a process evaluation of an alcohol intervention. The thesis will conclude with a discussion about the value of an explicit complex systems framing and how the process evaluation framework might be extended to produce better evaluative evidence to address wicked public health issues.

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## Chapter 3: Research paper: Consequences of removing cheap, super-strength beer and cider: a qualitative study of a UK local alcohol availability intervention

### 3.1 Introduction

In this chapter, I present a research paper, published in *BMJ Open*, which describes a qualitative study examining the processes by which a local alcohol intervention – Reducing the Strength (RtS) – may generate intended and unintended consequences within the complex system into which it is introduced (1). The article is open access and, in accordance with the terms of the Creative Commons Attribution Licence, it may be reproduced in this thesis (2). This is the first study I conducted for my PhD research and was undertaken when there were relatively few prominent examples of public health evaluation applying a complex systems perspective (3). It was designed to address one objective of my PhD research programme: Objective 6: to theorise and analyse how local alcohol interventions affect the systems within which they occur by exploring intervention pathways to impact with reference to key complex systems concepts. Specifically, the sampling strategy was designed to sample from different actors within the system and the analysis focussed on utilising concepts from complexity theory to understand the pluralistic responses to the intervention, focussing on how these responses may amplify or dampen the capacity of the intervention to generate system change. The topic guides for this study are provided in Appendix B. This evaluation is an example of the co-production approach encouraged by the NIHR SPHR. A public health strategist in the local authority in which RtS was implemented was a member of the research team and he helped shape the research questions and contributed to the data interpretation.

As described in the previous chapter, this PhD research took place alongside a broader programme of SPHR research on alcohol harm prevention. As part of that work, I contributed to a study led by local authority public health practitioners which utilised a mixed-methods approach to evaluate RtS in two local authorities (4). The practitioner-led paper, published in *BMC Public Health*, reports on the impact of the intervention on the cheapest unit of alcohol available in off-licences and assessed retailers' views on participating in the intervention. In contrast, my own evaluation focused on different system actors (specifically homeless drinkers and service providers to that population). The *BMC Public Health* paper is not part of the PhD programme of work; however, I have included it in Appendix C to underscore that the research presented in this thesis is part of a linked programme of research that emphasised co-production with local practitioners. In addition, I will integrate some of the findings from that evaluation with my own evaluation of RtS in the final chapter of this thesis.

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1. McGill E, Marks D, Sumpter C, Egan M. Consequences of removing cheap, super-strength beer and cider: a qualitative study of a UK local alcohol availability intervention. *BMJ Open*. 2016; 6(9):e010759. <https://doi.org/10.1136/bmjopen-2015-010759>
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## RESEARCH PAPER COVER SHEET

Please note that a cover sheet must be completed for each research paper included within a thesis.

### SECTION A – Student Details

Student ID Number	305848	Title	Ms
First Name(s)	Elizabeth Tyner		
Surname/Family Name	McGill		
Thesis Title	Evaluating local-level interventions to address alcohol-related harms in England: the development and application of a complex systems perspective to process evaluations		
Primary Supervisor	Professor Matt Egan		

If the Research Paper has previously been published please complete Section B, if not please move to Section C.

### SECTION B – Paper already published

Where was the work published?	BMJ Open		
When was the work published?	September 2016		
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion			
Have you retained the copyright for the work?*	No	Was the work subject to academic peer review?	Yes

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### **SECTION D – Multi-authored work**

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	Conceived and designed the study; led on ethics amendment; conducted data collection; led on data analysis (with input from ME) and interpretation (with input from all co-authors); drafted the manuscript (with input from ME); and critically revised the manuscript (with input from all co-authors). ME, DM and MP provided supervision.
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### **SECTION E**

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<b>Date</b>	26/02/2021

<b>Supervisor Signature</b>	MATT EGAN
<b>Date</b>	26.02.21

# BMJ Open Consequences of removing cheap, super-strength beer and cider: a qualitative study of a UK local alcohol availability intervention

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## ABSTRACT

**Objectives:** Increasingly, English local authorities have encouraged the implementation of an intervention called ‘Reducing the Strength’ (RtS) whereby off-licences voluntarily stop selling inexpensive ‘super-strength’ ( $\geq 6.5\%$  alcohol by volume (ABV)) beers and ciders. We conceptualised RtS as an event within a complex system in order to identify pathways by which the intervention may lead to intended and unintended consequences.

**Design:** A qualitative study including a focus group and semistructured interviews.

**Setting:** An inner-London local authority characterised by a high degree of residential mobility, high levels of social inequality and a large homeless population. Intervention piloted in three areas known for street drinking with a high alcohol outlet density.

**Participants:** Alcohol service professionals, homeless hostel employees, street-based services managers and hostel dwelling homeless alcohol consumers ( $n=30$ ).

**Results:** Participants describe a range of potential substitution behaviours to circumvent alcohol availability restrictions including consuming different drinks, finding alternative shops, using drugs or committing crimes to purchase more expensive drinks. Service providers suggested the intervention delivered in this local authority missed opportunities to encourage engagement between the council, alcohol services, homeless hostels and off-licence stores. Some participants believed small-scale interventions such as RtS may facilitate new forms of engagement between public and private sector interests and contribute to long-term cultural changes around drinking, although they may also entrench the view that ‘problem drinking’ only occurs in certain population groups.

**Conclusions:** RtS may have limited individual-level health impacts if the target populations remain willing and able to consume alternative means of intoxication as a substitute for super-strength products. However, RtS may also lead to wider system changes not directly related to the consumption of super-strengths and their assumed harms.

## INTRODUCTION

Alcohol is a global health concern, a causal factor in over 200 diseases and conditions<sup>1</sup>

## Strengths and limitations of this study

- This study uses a unique perspective by drawing on complexity theory to develop multilevel theories of change for an innovative alcohol availability intervention.
- Our qualitative methods lead to a pluralistic account of how the alcohol availability intervention may impact multiple outcomes and contexts.
- The study was conducted in a single English local authority, which allows for greater depth of analysis, but may limit the generalisability of the findings.
- The sample of hostel dwelling homeless people is relatively small but gives some of the most vulnerable and isolated community members a voice in the research.

and contributes to healthcare costs,<sup>2</sup> crime and disorder and losses of workplace productivity.<sup>3</sup> Interventions that restrict the economic or physical availability of alcohol have been recommended to reduce alcohol-related harms.<sup>4–7</sup> There is a pattern of research from different national settings supporting the case for national and mandatory interventions that restrict alcohol availability.<sup>5</sup> Nonetheless, alcohol availability interventions are frequently delivered on a local and/or voluntary basis.<sup>5–8</sup> Reviews of alcohol availability interventions and health have found that the evidence base relating to local and voluntary initiatives is inconsistent and underdeveloped.<sup>5</sup> This may be symptomatic of a broader perceived shortage of evidence to support public health decision-making relevant to local government and multisectorial initiatives.<sup>9</sup>

One recent UK alcohol intervention that embodies localist and voluntary characteristics is called ‘Reducing the Strength’ (RtS). With the encouragement of local authorities,



shops licensed to sell alcohol for off-premise consumption ('off-licenses') voluntarily stop selling inexpensive high-strength ( $\geq 6.5\%$  alcohol by volume (ABV)) beers and ciders, including products marketed as 'super-strengths' or 'white ciders'. These products and their marketing have been said to encourage excessive drinking and harmful behaviours among vulnerable sub-populations.<sup>10–12</sup> At the time of the intervention's implementation, a single 500 mL can of super-strength could exceed the (now former) UK health guidelines for daily alcohol consumption, while a single 3 L bottle of cider could exceed the weekly guidelines.<sup>13</sup>

RtS was first launched in Ipswich in 2012, and has been estimated to have been implemented in ~80 local authorities across England,<sup>14</sup> although some suggest this figure is too large, citing approximately 30 schemes in operation (personal correspondence with Robert Anderson-Weaver, Community Safety Officer, Portsmouth City Council, July 2016). Amongst RtS schemes, there has been some variation between areas with regard to the super-strength products targeted and linkages with services for the targeted populations.<sup>15</sup> Guidance for implementing RtS identifies street and homeless drinkers as target populations<sup>15</sup> based on assumptions about their consumption of these low-cost products, their vulnerability to alcohol addiction and perceived social problems around street drinking.<sup>10 16</sup> Numerous local studies of street drinkers and homelessness in the UK have pointed out that these are intersecting but not identical population subgroups.<sup>17 18</sup> Furthermore, homelessness can take different forms including rough sleeping, living in hostels, staying with friends and family, and often involves a residential instability that may lead to frequent changes in residential status.<sup>19–22</sup>

Alcohol availability modifications, such as RtS, are typically population-level interventions designed to encourage or compel changes in alcohol purchasing, consumption and health impacts.<sup>4</sup> In the case of RtS, the physical and economic availability may be affected by the removal of cheap strong drinks from shops within a specific location. If many stores in a local area participate and remove super-strengths from their shelves, the variety of different types of alcohol available for purchase in that area may be reduced. The intervention also attempts to remove some of the very cheapest (measured as cost per unit of alcohol) beverages from the market, which would raise the price of the least expensive alcohol beverage available in participating shops. Even though the intervention itself may represent a relatively simple change to the local alcohol environment, the response of target populations and other agents within that environment is potentially complex.

Rickles, Hawe and others<sup>23 24</sup> have argued that neighbourhood and community interventions can often be considered 'events' in complex systems that may trigger chains of responses and relational changes between individuals or groups.<sup>23 25</sup> The complex system perspective

argues that the most significant aspect of complexity lies not in the intervention itself, but in the system into which the intervention is introduced.<sup>26</sup> Evaluating the impact of events within the system may involve monitoring how different agents within the system respond, considering intended and unintended consequences, and understanding how responses can potentially dampen or amplify the capacity of the intervention to contribute to system changes.<sup>27 28</sup> In this paper, we have conceptualised RtS as an event in a complex system.

This study explores how RtS was perceived and experienced by the target population of homeless drinkers and by service providers who work closely with this population. The aim is not to measure effects but rather to use a systems perspective to qualitatively explore how RtS may lead to intended and unintended consequences within the system in which it was implemented. For practical reasons, we have focused on hostel dwelling homeless people, acknowledging that this subgroup is associated with street drinking but still represents only one type of homelessness and one type of street drinker.<sup>19–22</sup> We also focus on the views and experiences of service providers who work with those drinkers. We consider how both groups perceive the ways in which RtS may (or may not) influence their own activities, their peers' and the broader sociocultural environment that they inhabit.

## METHODS

This study is part of a wider programme of research coproduced with local authority practitioners. An additional publication reports qualitative and quantitative findings relating to impacts on retailers and alcohol sales.<sup>29</sup> The current study investigates the intervention from the perspective of a key target population, homeless people and service providers who work closely with that population. The research was conducted in mid-2014, after the intervention was implemented in late 2013. The study involved a focus group with alcohol service providers and interviews with alcohol service professionals, workers at homeless hostels, street-based services managers and hostel dwelling alcohol consumers (whom we refer to as 'homeless') (n=30). All participants were allocated a pseudonym.

Qualitative methods were considered appropriate for identifying a wide range of potentially relevant issues and providing opportunities for participants to introduce themes not considered at the research design stage.<sup>30</sup> Evaluators have argued that qualitative research is particularly well suited to capturing the complexity of interventions and systems by unpacking processes by which interventions may trigger system changes.<sup>31 32</sup> This complexity may include multiple and unanticipated outcomes over variable time frames, competing aims and values of stakeholders and target populations and non-linear relationships between contexts, processes and outcomes.<sup>23</sup> Qualitative approaches that do not explicitly incorporate a systems lens may still include some or all of these

features, but a systems approach encourages a framework for analysis that explicitly focuses on changes to behaviours and relationships between agents at multiple levels in response to an intervention.<sup>23–28</sup> The flexibility of qualitative methodologies can also help researchers overcome some of the barriers to evaluating local health policy innovation, which can include small delivery scales, rapid delivery timescales<sup>33</sup> and a demand from local decision makers for evidence that is sufficiently contextually rich to be recognisable to them as ‘local’.<sup>9–34</sup>

### Intervention and setting

The study focused on an inner-London borough characterised by high population density, social inequality and a high degree of residential mobility. In late 2013, off-licence shops in three ‘hot spots’ for street drinking were asked to voluntarily stop selling super-strength products. Local authority data showed these areas to have a very high alcohol outlet density and alcohol retailers in these areas primarily consist of small, independent ‘newsagent’ stores who open late and rely on alcohol as a large proportion of their total revenue. According to a local authority audit, super-strength products were often, although not always, the cheapest alcohol products available for purchase in these stores. The RtS intervention was planned and implemented by the borough’s council and police licensing teams and supported by community safety officers. The intervention has five stated aims, which are presented in [box 1](#).

Prior to the intervention, 39% of the 78 off-licenses in the RtS area sold super-strength products. Following the intervention launch event, implementers reported that all but two off-licenses agreed to participate in the scheme. At 6-month follow-up, implementers reported around 95% of off-licenses continued to participate and considered this a substantial reduction in super-strength availability for those areas.

### Recruitment and data collection

Homeless people are recognised as vulnerable and isolated groups, raising ethical and practical issues affecting recruitment and data collection. Service providers were interviewed to draw on their knowledge of homeless drinking behaviours but also to allow identification of contrasting perspectives between the two groups of participants. Participants were recruited through stakeholder

contacts and direct approaches to hostels and services. Homeless participants received information about the study from service providers with an invitation, but no obligation to take part. The mediating role of the service providers meant we were unable to track participants (homeless or otherwise) that were informed of the study but declined to take part. Participants all received an information sheet and verbal information about the study; all recruitment was based on voluntary informed consent.

Most of the fieldwork involved semistructured individual interviews conducted by EM (a research fellow with prior experience of interviews, focus groups and qualitative analysis); each participant was interviewed once. Service providers were not present when homeless participants were interviewed, and participants were not interviewed in front of their peers. Some alcohol service professionals requested a focus group for logistical and time management reasons. Service provider topic guides included sections on alcohol and homeless service provision, homeless people’s drinking behaviours and the RtS intervention. Drinker topic guides covered similar themes but focused more on the participants’ own behaviours and experiences. We asked specifically about super-strength consumption, but also more generally about how drinkers would respond to restricted alcohol availability. Interviews were conducted in a private area in work settings or hostels, audio recorded and transcribed. The researcher also made field notes during and after each interview. Homeless participants received a £10 voucher as compensation for their time.

### Analysis

A total of 723 min of audio was recorded and transcribed; this figure excludes tours around five homeless hostels during which participants provided the researcher with background information. The first author coded the transcripts in NVivo V.10 using the interview guide to group major themes; a second researcher double-checked the coding. We then used concepts from complexity theory to deductively code the transcripts. Specifically, we have used participant perspectives to identify theories of change—including participants’ views on what constitutes potential intended and unintended consequences that could follow from the implementation of RtS.

## RESULTS

In total, 30 people participated in the study ([table 1](#)). The nine alcohol consuming hostel residents were predominantly male and seven had been in the hostel system for over a year. Six reported previous experience of rough sleeping. Four stated that they were regular (daily) consumers of super-strengths while others consumed it less frequently, preferring alternatives such as wine, vodka, or regular beer and cider. A total of 21 service professionals participated in the study, 11 in a

### Box 1 RtS aims in one English local authority

1. To remove ‘super-strength’ from off-licenses;
2. Voluntary variation of existing licences to include a condition not to sell ‘super-strength’;
3. To reduce crime and antisocial behaviour (specifically street drinking and begging);
4. To reduce alcohol-specific admissions including repeat admissions;
5. To highlight the dangers of alcohol, particularly super-strength alcohol, to residents.

**Table 1** Number of participants

	Individual interview	Focus group	Males	Females
<b>Participants</b>				
Homeless drinkers	9	0	8	1
Alcohol service managers and staff	2	11	4	9
Hostel managers and staff	6	0	2	4
Street-based services managers	2	0	2	0

focus group at an alcohol service centre and 10 individual semistructured interviews were conducted with professionals in other services.

Using participant perspectives, we structured our analysis to consider different levels or domains at which the intervention constitutes an ‘event’ and where participants saw potential impacts stemming from the implementation of RtS. This includes the levels of the individual and service provision, as well as potential broader sociocultural implications. The levels of the individual drinker (figure 1) and service provision (figure 2) were inherently built into our sampling strategy, whereas the broader sociocultural context emerged from participants’ accounts.

### Findings at the individual level

Homeless drinkers and service providers presented a range of opinions about which groups they thought the intervention targeted, which included but was not limited to street drinkers, rough sleepers and hostel residents. More broadly, participants tended to assume that super-strength products were consumed by disadvantaged, middle-aged males with high levels of alcohol dependency described by various service providers as

‘problematic’, ‘physically dependent’ or ‘hard-core entrenched’ drinkers.

Drinkers, and some service providers, had noticed the reduction of super-strength availability within the intervention areas and explained that only a limited number of shops continued to sell the products:

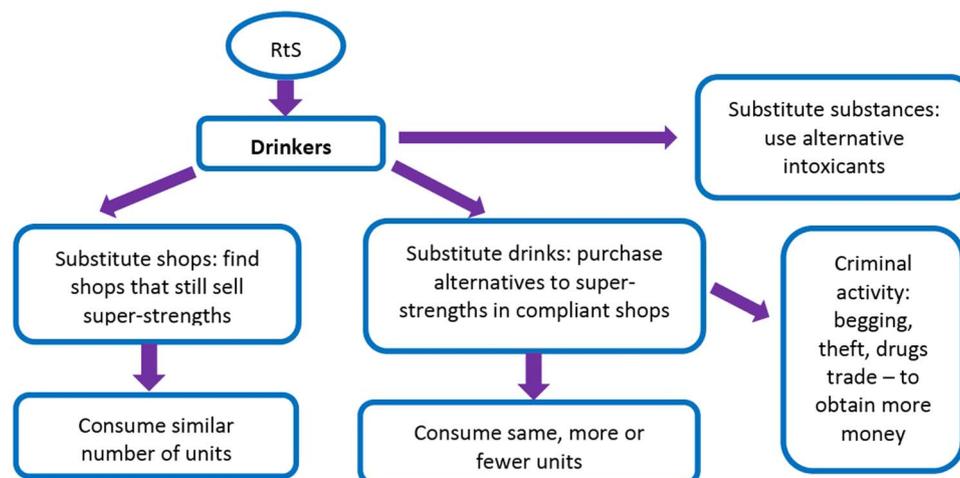
I don’t know if you’re aware of that as well, but you know the strong lagers, i.e. the Special Brew and the Skol Super Light, all the 24 hours shops around here, all the police have completely stopped them from selling it, you can’t buy any strong beers anywhere around here anymore. You know, except for a very select couple. (Christopher, drinker)

now the Reduce the Strength campaign is in effect so a lot of these are no longer selling those brands that I just mentioned. However, there are still one or two doing it. (Luke, street-outreach manager)

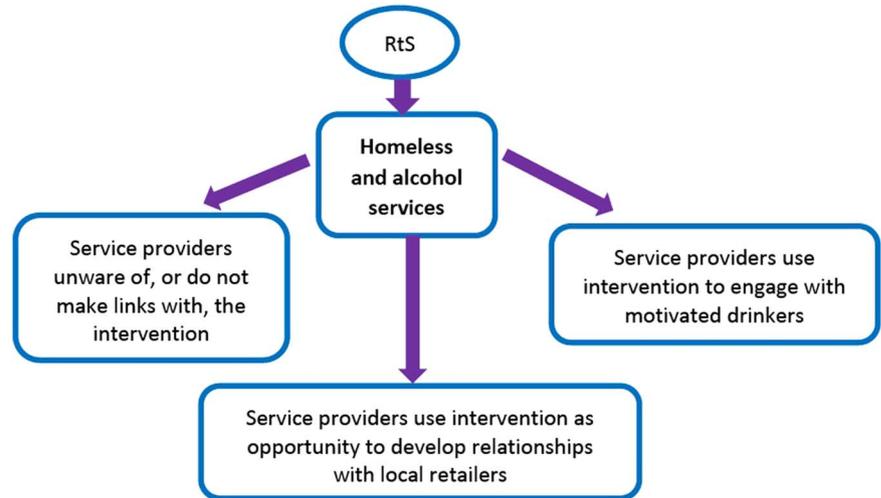
Participants discussed this substantial, but not absolute, restriction in super-strength availability as an event that could lead to a number of substitution responses. Drinkers described still being able to purchase super-strengths by switching from compliant to non-compliant shops. For example, Timothy described how super-strength drinkers walk a greater distance to find stores that continue to sell super-strengths:

That’s what everyone does at the minute, they walk out further afield to get it...they go into the shops that still do sell it, which is only like a handful, not even a handful, a couple of them. (Timothy, drinker)

Drinkers disagreed about whether the necessity of walking longer distances would affect their purchasing behaviour. One said ‘I’ll walk as far as I can to get my same beer’, (Max, drinker) whereas others suggested there was a limit to the distance they would walk and this might vary depending on time of day. Service providers also reported seeing homeless and street drinkers,

**Figure 1** Individual level theories of change.

**Figure 2** Service level theories of change.



and alcohol-service clients still consuming super-strength products.

A second substitution behaviour participants described was substituting drinks within compliant shops. Without prompting, several drinkers attempted to calculate the ways they could continue to consume the same number of units of alcohol within stores participating in RtS. Some suggested they would switch to drinks with higher alcohol contents, such as wine, sherry or vodka. For example, Christopher, a super-strength drinker, described how drinkers can still purchase vodka at compliant stores:

You can't buy any strong beers anywhere around here anymore, except for a very select couple, but it hasn't deterred anyone though has it? Christ, yeah, cos they've still got bottles of vodka in there. (Christopher, drinker)

Other drinkers and service providers, however, questioned whether many homeless drinkers would be able to budget for the higher cost of a larger bottle of spirits (which were assumed to represent better value than smaller bottles) or make a bottle last longer than a day.

Service providers also hypothesised that if a sufficient number of stores participated in the intervention, thus resulting in an absolute reduction in the availability of super-strengths, drinkers might purchase greater quantities of cheaper, weaker beer or cider. However, drinkers largely rejected this idea as they perceived such drinks to be insufficiently strong to achieve a feeling of intoxication, or prevent withdrawal symptoms. One drinker called 'normal' strength beers 'a waste of time' (Christopher) and another described them as 'piss water' (Joshua).

Several drinkers and service providers also suggested that more drinkers would engage in alternative substance abuse, as many had histories of codependency. This could include illegal drugs or products not intended for consumption, such as cleaning products or solvents:

So I have one beer or one [butane] gas, but what I worry about there is once I've finished that beer, then I've probably by that time nearly gone through half of that one gas...When I really am getting anxiety attacks from the alcohol comedown and all that kind of stuff, the gas really douses it, you know? (Christopher, drinker)

I think the people who need alcohol and haven't got any money...can do extreme things [such as] drink a hand sanitizer in hospitals...I think it's a least bad thing if people can drink something that's at least commercially produced and safe. (Lauren, alcohol service professional)

Participants acknowledged that purchasing more expensive drinks or alternative substances could result in unintended consequences for drinkers and perhaps the broader community should drinkers turn to crime or begging to obtain these products. One super-strength drinker, who distanced himself from these behaviours, argued that other homeless drinkers would 'try and blag or steal, or whatever it takes, you know to get it, as I said, it won't make much difference'. (Kevin, drinker). Service providers also considered these possibilities, arguing:

I think the other thing that would happen is that you could see offending go up. (Lauren, alcohol service professional)

If the money's not there they might turn to committing crime. (William, alcohol service manager)

On the other hand, a hostel employee argued that any potential spike in more visible or risky forms of crime would only be short lived:

In terms of sustainability it probably depends on the risk associated with whatever they're doing. So things like pickpocketing is quite high risk because you're quite likely to attract the attention of the police and so that's probably not sustainable. (Peter, hostel staff)



### Findings at the service level

Within the complex system in which RtS is implemented, there are also consequences for service provision (figure 2). The integration of RtS with existing homeless or alcohol services was a particular concern for service providers who largely saw the intervention as too limited to effectively address excessive alcohol consumption. Several participants attempted to reframe the problem away from alcohol availability and instead emphasised either psychological problems or wider social ‘causes’ of alcohol misuse such as poverty and homelessness:

I don't think [RtS] acknowledges the psychological reasons why people drink, I don't think it acknowledges all the kind of needs that are being met, albeit in a mal-adaptive way by alcohol. (Adam, hostel manager)

Service providers who were sceptical about the potential benefit of RtS did note that it might be used as a tool to engage drinkers who were already seeking help. For example, the intervention could be used to help talk to their drinkers about reducing alcohol consumption in conjunction with support plans:

it helps us because you could in your harm minimisation support plans say drink at different times, drink a lower strength beer, drink less amount and only go to that shop...if you know they're not selling strong drinks you can make it all part of the task-oriented support plan. (Thomas, hostel manager)

Service providers tended to agree that in this particular roll-out of RtS, there was a missed opportunity for public services, including the alcohol services, hostel services and the council, to engage and interact more closely with the business sector. Some of these service providers had not heard of RtS and felt that explicit links between different stakeholders could have initiated positive changes. If implemented to encourage service linkage, RtS was seen as an opportunity to work more closely with local shop managers to assist dependent drinkers through alcohol supply regulation:

I can't understand why we [the alcohol service] weren't asked to participate because we have a lot of volunteers and services that would have been able to contribute by going around to some of the shops as well because I think it's been about trying to get the shop owners to take responsibility for the community. (Eleanor, alcohol service professional)

### RtS within the wider sociocultural environment

Participants also described how RtS may have implications beyond individual drinkers and service provision for homeless drinkers. Specifically, participants situated RtS within a broader sociocultural context, of which they are a part, and described how the intervention may influence social norms around drinking. Participants also considered, as individuals targeted by RtS and service providers working with that population, the

ethics of social policies, such as RtS, that target specific groups of individuals.

### Social change: making alcohol the new tobacco

Service providers positioned the intervention within the broader culture of drinking in England. The participants argued that even if RtS had little immediate impact on local drinking behaviour, it might still contribute to a long-term process of social change and public awareness around alcohol-related harms. One hostel manager said that RtS could be ‘part of a whole move of this awareness of how dangerous drink is. So I think it will have an effect but I think it's going to be part of a long term social change. I think in the short term it's going to be very patchy’. (Thomas, hostel manager)

Several providers drew on the history of tobacco and argued that political action and interventions around smoking ultimately changed cultures around smoking, particularly around the public acceptability of smoking in public. Service providers saw parallels between tobacco policy and RtS:

...and then the culture has changed as well...because the first place that implemented no smoking in public places was California and I think at the time in England the general perception was it was almost like a communist style, sort of undemocratic thing that would be unimaginable...[It] was a shock but then the culture changed and actually now everyone just thinks it's the norm. (Patrick, alcohol service professional)

### Ethical considerations of targeted policies

Service providers and drinkers believed RtS contributed to a broader strategy of targeting disadvantaged populations. Several service providers justified this targeting on the grounds that people who consume super-strength disproportionately use public services, cause antisocial behaviour and are vulnerable to environmental health risks:

...people that are actually dying or you know been affecting the community in a big way, I think those are the specific target groups that they're looking at. Those people that are actually impacting on the community, causing a lot of disruption, causing a lot of offending. (Jessica, hostel manager)

Among the drinkers, there was confusion surrounding why super-strength drinks were targeted when other drinks such as spirits or wine have higher alcohol contents. Several homeless participants had the view that targeting the most disadvantaged with availability restrictions was a social injustice, and one hostel manager expressed concerns about how alcohol-related harms among more affluent members of the population were not addressed by the intervention:

It's a bit unfair...the middle, upper class [have their] nose up in the air with a nice glass of claret or a glass of rosé or whatever, they drink as much as I do. So, please do not tell me I'm the only alcoholic. (Kevin, drinker)

some people could argue it could be a bit of a class sort of thing really demonising poor people. (Nathan, hostel manager)

## DISCUSSION

We have conducted qualitative research to obtain different stakeholder perspectives on the potential impacts of RtS following its implementation in a London borough. We have deliberately constructed a pluralistic account based on the understanding that the intervention is an event in a complex system. RtS is assumed to make positive and negative contributions in advancing health and social policy goals relating to reducing alcohol harms.

Participants suggested that at the individual level, the target population were likely to adopt substitution behaviours to seek to reduce the impact of the intervention on their intoxication. Such adaptations could involve finding stores still selling super-strengths or continuing to shop at participating stores and substituting drinks, including drinks with higher prices. Recent research on dependent drinkers' purchasing behaviour in Scotland found drinkers seek the cheapest alcohol beverages from their local stores and adapt their purchasing behaviour based on price, the alcohol environment and drink preferences. The authors conclude that 'heavy drinkers are astute, skilled and flexible shoppers' (ref. 35, p. 1578). Our findings on substitution behaviours in response to RtS corroborate these conclusions. Participants also suggested, with some differences of opinion, responses around illicit drug and substance abuse, or crime and antisocial behaviours that could potentially affect individuals, retailers and communities.

At the service level, we found different viewpoints about how successfully the intervention had linked with other services. Some participants felt the intervention, as delivered in this local authority, had missed opportunities for service providers to engage with a range of stakeholders. However, some participants believed that RtS could offer opportunities for public and private sector stakeholders to strengthen or modify relationships in order to further encourage joined-up services to tackle deeply entrenched alcohol problems.

Participants also contextualised the intervention within a broader sociocultural environment and, as members of that culture, suggested how RtS may lead to broader cultural changes. Drawing on the history of tobacco policymaking, some participants suggested that local initiatives, such as RtS, could be a contributor to cultural changes surrounding the acceptability of harmful alcohol consumption. From this perspective, small interventions were considered to be important as part of a cumulative escalation of action and debate around alcohol: a different kind of impact to that normally considered by intervention effectiveness evaluations. As further evidence of this 'escalation', the Portman Group, a UK association funded by the alcohol industry, recently issued guidance discouraging the sale of single cans of super-strengths that exceed daily

drinking guidelines for men and women.<sup>36–38</sup> However, drinkers and service providers in this study highlighted how the highly targeted product restriction ignored other more commonly consumed alcohol products, and the problems of excessive drinking that exist across the whole population. Policies such as RtS may be seen as indicative of cultural associations of 'problem drinking' with more marginalised populations.

Findings from our study add to a small body of research on highly targeted alcohol availability interventions. For example, in remote Australian communities, where the sale of cask wine in containers over 4 L was banned, mixed methods evaluations found that while there was significant substitution, either to other drinks or to other localities, that there was still an overall reduction in alcohol consumption not entirely offset by the substitution.<sup>39–41</sup> A UK study exploring public acceptability of policies to reduce alcohol consumption found participants repeatedly attempted to reframe problems related to alcohol availability in favour of a broader perspective that links alcohol harms with social and cultural characteristics and values.<sup>42</sup> Similar reframings can be found in some of the comments made by participants in this study. A related study found evidence of public concern that people who are sufficiently motivated will circumvent interventions,<sup>43</sup> a process which may encourage uptake of additional risky behaviours.<sup>42</sup> Our findings on individual-level responses corroborate these findings.

## Strengths and limitations

For pragmatic reasons, we interviewed homeless alcohol consuming individuals who reside in hostels but recognise that other groups, such as rough sleepers and independent-living super-strength consumers, are also affected by the intervention. Our participants already engage, to varying degrees, with some services, by virtue of living within the hostel system. Drinkers who live independently, or are disengaged from services, may have provided different accounts of how they experienced the intervention. Informal discussions with implementers revealed that they felt they did engage with a range of alcohol and homeless services, whereas our findings from the service providers provide a different view. Future work could fruitfully bring together these perspectives.

We used a single case study site. The choice between a single or comparative case study is to some extent a trade-off between depth of analysis in a single site and greater breadth that may result from multiple sites. Our sample, though small, was sufficient for us to generate multiple theorised pathways to impact including substitution behaviours and other responses to RtS which, we believe, can be plausibly considered by practitioners in other settings. We may speculate as to whether or not our findings covered all possible pathways (and so claim data saturation), but we have no clear way of determining this. Those pathways we did identify tended to recur in multiple interviews and gave us confidence that we



had identified responses that appear particularly relevant for theorising potential impacts.

Some of the participants' responses were grounded in direct personal experience, but some less so. Although the intervention achieved high levels of compliance from shops, participants reported being able to continue purchasing super-strength products with relative ease. While this was itself an important finding, we also asked participants about their hypothetical responses, should RtS be implemented by all local shops. It might be assumed that when participants' responses are grounded in their experience, this may constitute more powerful evidence than the speculative responses, although both shed light on how they perceive the intervention—in its current form and in a hypothetical more full realised form—and both are subject to potential biases or may be interpreted as telling us more about how people represent themselves than how they actually behave.<sup>44</sup>

We have used interviews and a focus group to obtain participant perspectives on intended and unintended consequences following the implementation of RtS. Given the sensitive nature of the topic and some of the behaviours we asked about, there is a potential for social desirability bias. While we recognise this as a limitation that may have been addressed through the use of ethnographic methods, we also note that participants spoke openly about their experiences and behaviour, at times presenting themselves in a 'negative' light.

While our study identified different types of substitution behaviours that could potentially be used to circumvent the intervention, additional qualitative and quantitative research is required to measure the extent to which different types of substitution occurred.

## CONCLUSIONS

The use of qualitative research methods has allowed us to create a pluralistic account of how RtS may affect the components of the system in which it is implemented, and has illustrated the mechanisms by which such changes may occur. We argue that the small scale of implementation and the limited range of products affected make it plausible that RtS could, by itself, make only a modest impact on alcohol harms. We base this on the apparent ease and willingness of drinkers to use substitution behaviours, including switching shops, drinks or substances in order to circumvent the availability restrictions. These individual responses are reactions to the physical and economic dimensions of alcohol availability. An approach that ensured full shop compliance across larger geographical scales could restrict drinkers' ability to substitute to non-compliant shops. Hence, we hypothesise that the local and voluntary nature of RtS could be barriers to effectiveness, although a well-conducted quantitative evaluation is required to test this.

However, our systems approach has also encouraged us to consider effects on services as well as effects on individual drinkers. Although RtS in this local authority was seen

as a 'missed opportunity' for service providers to engage with a range of stakeholders, some front line staff believed that RtS has the ability to facilitate new forms of engagement between public and private sector interests and promote further awareness of alcohol harms. Hence, some stakeholders suggest that a small, local intervention, such as RtS, can potentially contribute to wider system changes irrespective of, or indirectly related to, the intervention's effectiveness in achieving its formally stated goals.

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**Contributors** EM conducted the interviews and focus group, led on the analysis and drafted this manuscript. ME contributed to the analysis and to the manuscript draft. EM, DM, CS and ME have provided input into data interpretation, critically revised the manuscript and approved the final version.

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**Competing interests** DM is a joint Public Health Strategist/Assistant Professor covering the intervention area. At the time of writing, CS was a Public Health Strategist in the intervention area and was involved in developing, supporting and evaluating the work discussed in the article.

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Elizabeth McGill, Dalya Marks, Colin Sumpter and Matt Egan

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## Chapter 4: Research paper: Applying a complex systems perspective to alcohol consumption and the prevention of alcohol-related harms in the 21st century: a scoping review

### 4.1 Introduction

In this chapter I present my second research paper, a scoping review which was published in *Addiction* (1). This scoping review was conducted after I had completed the Reducing the Strength (RtS) evaluation described in the previous chapter and when alcohol researchers were increasingly arguing that alcohol research required a fundamental paradigm shift that embraces and applies complex systems approaches to understanding and intervening to reduce alcohol consumption and associated harms (2). However, to date no review had established the extent to which a complex systems perspective had been applied in alcohol research and the characteristics of these studies. The scoping review was therefore conducted in order to address Objective 2 of this research programme: to describe the scale and scope of research on alcohol consumption and associated harms from a complex systems perspective and to identify evidentiary gaps in this literature base. The findings were used to inform the analysis of my second process evaluation of an alcohol intervention (presented in Chapter 6) and to illustrate the value of a complex systems approach in alcohol research specifically, and public health, more generally (described further in Chapter 7). Permission to reproduce this article in this thesis and the article's online supplementary material, which includes the review protocol, search strategy and Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist can be found in Appendix D.

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1. McGill E, Marks D, Sumpter C, Egan M. Consequences of removing cheap, super-strength beer and cider: a qualitative study of a UK local alcohol availability intervention. *BMJ Open*. 2016; 6(9):e010759. <https://doi.org/10.1136/bmjopen-2015-010759>
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Student ID Number	305848	Title	Ms
First Name(s)	Elizabeth Tyner		
Surname/Family Name	McGill		
Thesis Title	Evaluating local-level interventions to address alcohol-related harms in England: the development and application of a complex systems perspective to process evaluations		
Primary Supervisor	Professor Matt Egan		

If the Research Paper has previously been published please complete Section B, if not please move to Section C.

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### **SECTION E**

<b>Student Signature</b>	Elizabeth McGill
<b>Date</b>	26/02/2021

<b>Supervisor Signature</b>	MATT EGAN
<b>Date</b>	26.02.21

This is the accepted version of the following article: McGill, E., Petticrew, M., Marks, D., McGrath, M., Rinaldi, C., and Egan, M. (2020) Applying a complex systems perspective to alcohol consumption and the prevention of alcohol-related harms in the 21st century: a scoping review. *Addiction*, <https://doi.org/10.1111/add.15341>. which has been published in its accepted form at <https://onlinelibrary.wiley.com/doi/10.1111/add.15341>. This article may be used for noncommercial purposes in accordance with the Wiley Self-Archiving Policy [<http://www.wileyauthors.com/selfarchiving>].

## **Applying a complex systems perspective to alcohol consumption and the prevention of alcohol-related harms in the 21<sup>st</sup> century: a scoping review**

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Running head: A complex systems lens in alcohol research

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## Abstract

**Background and Aims:** A complex systems perspective has been advocated to explore multi-faceted factors influencing public health issues, including alcohol consumption and associated harms. This scoping review aimed to identify studies that applied a complex systems perspective to alcohol consumption and the prevention of alcohol-related harms in order to summarise their characteristics and identify evidence gaps.

**Methods:** Studies published between January 2000 and September 2020 in English were located by searching for terms synonymous with 'complex systems' and 'alcohol' in the Scopus, MEDLINE, Web of Science and Embase databases, and through handsearching and reference screening of included studies. Data were extracted on each study's aim, country, population, alcohol topic, system levels, funding, theory, methods, data sources, timeframes, system modifications and type of findings produced.

**Results:** Eighty-seven individual studies and three systematic reviews were identified, the majority of which were conducted in the United States or Australia in the general population, university students or adolescents. Studies explored types and patterns of consumption behaviour and the local environments in which alcohol is consumed. Most studies focused on individual and local interactions and influences, with fewer examples exploring the relationships between these and regional, national and international sub-systems. The body of literature is methodologically diverse and includes theory-led approaches, dynamic simulation models and social network analyses. The systematic reviews focussed on primary network studies.

**Conclusions:** The use of a complex systems perspective has provided a variety of ways of conceptualising and analysing alcohol use and harm prevention efforts, but its focus ultimately has remained on predominantly individual- and/or local-level systems. A complex systems perspective represents an opportunity to address this gap by also considering the vertical dimensions that constrain, shape and influence alcohol consumption and related harms, but the literature to date has not fully captured this potential.

**Key words:** complex systems, alcohol consumption, alcohol harms, prevention, scoping review, dynamic simulation modelling, social network analyses

## Introduction

Alcohol consumption and associated harms represent a complex public health issue that affect individuals, communities and nations<sup>1</sup>. Alcohol is the seventh largest risk factor for disability and premature death worldwide and contributes to noncommunicable and infectious diseases<sup>2</sup>. The harms associated with alcohol affect individuals through acute and chronic conditions, as well as their families and broader communities, through, for example, domestic abuse and neglect, adverse effects on relationships, anti-social behaviour, violence, crime and workplace productivity losses<sup>1,3-9</sup>. Such alcohol-related harms are not evenly distributed across populations; individuals with lower socioeconomic status (SES) tend to experience greater alcohol-associated harms compared to those with a higher SES, despite similar or lower levels of alcohol consumption<sup>10</sup>.

A public health approach to alcohol harm prevention emphasises a combination of targeted interventions for high-risk drinkers, changing population behaviours and addressing their upstream determinants<sup>11-13</sup>. The application of a 'complex systems perspective' to alcohol research brings an explicit focus to how micro, meso and macro determinants interact with each other between and across system levels to create alcohol harms. Complex systems are characterised by non-linearity and feedback loops; changes within the system may result in larger or smaller impacts depending on how the system adapts in ways to amplify or dampen the effects<sup>14,15</sup>. These responses may be unpredictable, leading to unanticipated impacts<sup>16</sup>. A complex system evolves over time and can be characterised by emergent properties, a sort of 'collective behaviour' that cannot be reduced to individual actors' behaviour<sup>14,17-19</sup>.

A complex systems perspective, therefore, focuses on the dynamic and evolving relationships between actors within a system, and between the system and its broader environment<sup>20</sup>. Rather than focusing on individuals, or even specific sub-population or population groups, a key tenet of a complex systems perspective is recognising the broader systemic factors that influence populations and individuals' behaviour<sup>15</sup> with a specific emphasis on interactions between system levels and elements<sup>21</sup>. A population-perspective is therefore not necessarily a complex systems perspective; in the latter, the system is the primary unit of inquiry.

A number of researchers have argued that public health alcohol research would benefit from a paradigm shift: one that forefronts the real-world systems in which alcohol consumption and harms are created and shaped by a complex web of interrelating factors<sup>22-24</sup>. Proponents argue that most alcohol research is reductionist, being too focused on high-risk populations, individual-level (e.g. behavioural and psychological) or easily modifiable risk factors while failing to account for the dynamic and interrelated factors within the social, cultural, economic, regulatory, political and physical environments in which alcohol is consumed and harms are experienced<sup>25-28</sup>. Alcohol prevention efforts may therefore prove ultimately ineffective<sup>22,23</sup>, or be misleading<sup>24</sup>, if they rely solely on traditional epidemiological methods that assume linear causal pathways<sup>22,23</sup>. Utilising a complex systems perspective could, in principle, allow policymakers to develop strategies that intervene across the numerous systems that influence alcohol-related harms<sup>26,28-31</sup>. Some researchers have embraced this approach, but to date, no review has systematically documented these efforts. We therefore conducted a scoping review<sup>32-35</sup> to characterise how a complex systems perspective has been applied to research on alcohol consumption and the prevention of alcohol-related harms.

A scoping review is used to assess the size and scope of a literature base in order to assess its characteristics and identify evidence gaps<sup>33,35</sup>. In contrast with a systematic review, a scoping review does not aim to appraise and synthesise the literature, and it was therefore not an aim to combine the results of the identified studies<sup>35</sup>. Within our broad aim, we focused on four research questions: 1) which public health alcohol topics have had a complex systems perspective applied to them? 2) what systems of inquiry and populations are represented? 3) what types of systems approaches have been utilised? and 4) what gaps remain?

## Methods

We conducted a scoping review, following Arksey and O'Malley's framework: 1) identifying and refining research questions and the review's scope (defined above); 2) identifying studies; 3) selecting studies; 4) charting the data; and 5) collating, summarising and reporting the results<sup>32</sup>. The protocol for the review is available in Supplementary Material 1 and was not pre-registered.

### Identifying relevant studies

Relevant studies were identified through searches in electronic databases, handsearching and screening the references of included studies. Electronic searching was conducted in Scopus, MEDLINE, Web of Science and Embase covering January 2000 – September 2020, using terms and synonyms for complex systems and alcohol. The search dates reflect the increased interest in complex systems and public health in the 21<sup>st</sup> century<sup>36</sup>. The search strategy can be found in Supplementary Material 2.

### Study selection

Studies were eligible for inclusion if they: 1) took an approach that was informed by a complex systems perspective; 2) primarily concerned alcohol consumption and/or the prevention of alcohol harms from a public health perspective; and 3) were published between January 2000 and September 2020 in English. Papers applying a socio-ecological model, which considers individuals' behaviour and health outcomes as being situated within multi-scale social environments<sup>37</sup>, were excluded, unless the authors explicitly considered interactions between system levels and elements. Public health relevance was conceptualised broadly and included studies that explicitly advocated, developed or evaluated prevention efforts, as well as papers which developed theoretical or causal models of alcohol consumption and/or related harms. Articles about alcohol's effect on individuals' physiological systems, treatment for alcohol-related disorders and studies conducted in animals were excluded. Protocols, commentaries and conference abstracts were excluded, although full conference papers were eligible for inclusion.

We identified three recent systematic reviews that explored the association between social network characteristics and processes and alcohol consumption in adolescents<sup>38,39</sup> and adults<sup>40</sup>. Instead of duplicating these efforts, we decided to exclude individual network studies and focus on the findings from these three reviews as they relate to our review questions.

Titles and abstracts were initially screened for inclusion and the full text of all potentially relevant studies were then reviewed; EM conducted the screening and MM independently screened 10% of the titles/abstracts and full text studies. Covidence software was used to facilitate the screening process<sup>41</sup>.

### Charting the data

Charting the data was an iterative process and the template we designed was revised during the extraction process to better capture relevant data<sup>34</sup>. EM and CR independently extracted data on 10% of studies to pilot and revise the template; EM extracted data from the remainder of publications. We counted each individual published article we identified as a study, even if multiple papers were written by the same authors and/or utilised the same underlying models in order to identify what it might add to the discourse on how a complex systems perspective is advocated and applied to alcohol research.

We extracted data on each study's aim, country, population(s), alcohol topic(s), system levels, funders, theory, methods, data sources, timeframes, system modifications and types of findings produced. We conceptualised five broad system levels: sub-local, local, regional, national and international. Broadly, we considered sub-local systems to contain individuals, their family, friends and social networks. Local systems may vary greatly in scale but we used the term to refer to neighbourhoods, towns or cities. We conceptualised regional systems as being on a larger geographical scale, such as states, provinces or regions. System modifications refer to any planned system change – hypothetical or implemented, including policies, interventions or services. The types of findings referred to a characterisation of the study's results, rather than the specific conclusions; this included, for example, arguments for a specific approach, simulated impacts of an intervention, or findings from a process evaluation. As this was a scoping review that aimed to understand the scope and scale of the literature, no formal quality appraisal tool was applied to the included studies<sup>32,34,35</sup>.

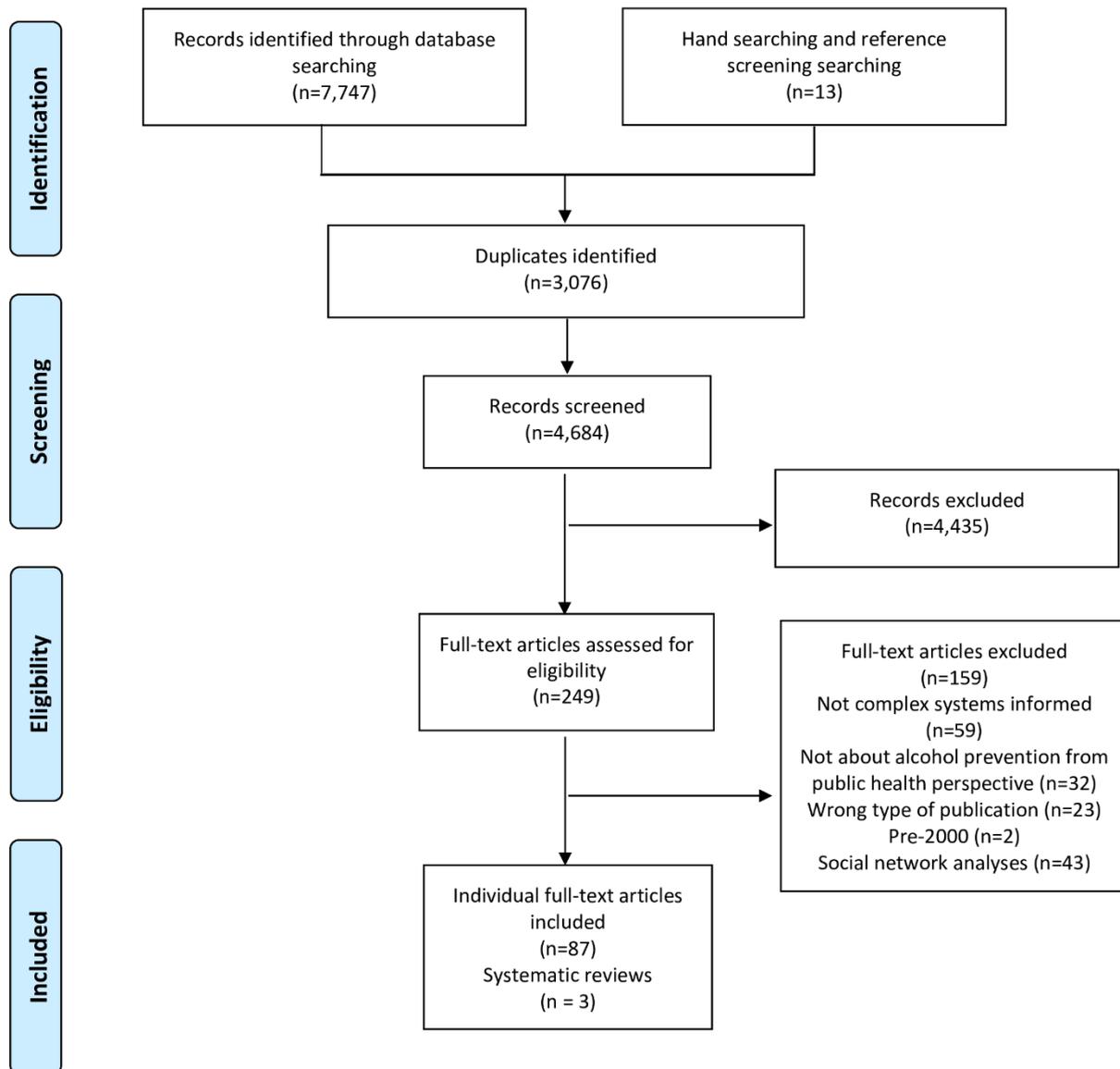
### Collating and summarising

Keeping with our aim, we then analysed the extracted data to produce a descriptive summary of the characteristics of the included studies, which we present in both tabular (Tables 1-4) and narrative form<sup>32</sup>. Then, using the research questions as a guide to our analysis, we synthesised the means by which a complex systems perspective has been utilised in alcohol consumption and harm prevention research.

### Results

A total of 87 individual studies were identified for inclusion in this scoping review; in addition, we identified three systematic reviews on network effects on alcohol consumption (see Figure 1). Tables 1 and 2 present an overview of the characteristics of each of the individual identified studies, grouped by complex systems approach and denote which papers belong in a cluster. The characteristics of the systematic reviews are presented in Table 4 and we report on those separately at the end of the Results.

Figure 1: PRISMA flow diagram



The studies we identified conceptualised, described or modelled systems of interest to alcohol-harm prevention research primarily in the United States (US) (n=38)<sup>22,23,29,42-76</sup>, Australia (n=17)<sup>28,31,77-91</sup>, and the United Kingdom (UK) (n=7)<sup>26,92-97</sup>. We also found examples of generic alcohol systems (n=16)<sup>24,93,98-111</sup>, as well as examples from Sweden (n=2)<sup>112,113</sup>, South Africa (n=2)<sup>114,115</sup>, Canada (n=1)<sup>116</sup>, Denmark (n=1)<sup>117</sup>, Nepal (n=1)<sup>118</sup> the Netherlands (n=1)<sup>119</sup>, and South Korea (n=1)<sup>120</sup>.

**Insert Tables 1 and 2 approximately here**

### Populations of interest

A range of population groups were represented within the systems and some studies focused on more than one population of interest. Thirty-nine studies included the general population<sup>24,26,28,31,42,43,45,47,49,51,57,59,70,71,73-77,87-91,97-101,103,105,108-112,116,118,119</sup>. Studies also focused specifically on university students (n=14)<sup>22,23,44,48,58,60-64,66-68,104</sup>, adolescents (n=12)<sup>29,52,54-56,69,72,79,107,113,115,120</sup>, younger adults (n=10)<sup>50,72,78,79,81,83,84,92,96,120</sup>, heavy drinkers (N=5)<sup>45,46,78,83,84</sup>, older adults (n=1)<sup>46</sup> and persons with substance use disorders (n=4)<sup>56,65,102,114</sup>, as well as more specifically

defined groups including sporting club administrators and participants<sup>80</sup>, street drinkers<sup>95</sup> and American Indian adoptees<sup>53</sup>. Some studies focused on those who work within the alcohol and drug workforce<sup>57,85,86,94,106</sup>. Other studies included alcohol retailers and the alcohol industry<sup>24,82,93,95,103,112</sup>, as well as policymakers and different types of organisations<sup>80,82,121</sup>.

### Alcohol topics

The identified studies focused on different facets of alcohol from a public health perspective. Many studies were concerned with alcohol consumption<sup>42,44,45,49,50,52,54,55,60,69,72,77,79,92,101,103,107,113,115,117,118,120</sup>, including specific types of consumption, such as intoxication<sup>73,78,99</sup>, alcohol misuse<sup>22,23,29,46,56,100,114</sup>, binge drinking<sup>26,96,104,119</sup> or particular patterns, types and contexts of drinking<sup>43,48,51,58,59,61-64,66-68,74-76,81,98,105</sup>. Some studies considered the impact of those consumption patterns, including acute and chronic health and social harms to individual drinkers and those in their communities<sup>28,31,46,49,70,71,85,87-90,108,109,111</sup>, including, for example, mental health outcomes<sup>53,65,110</sup>, aggression<sup>78,83,84</sup>, injuries and violence<sup>42,45,57,87,97,112,116</sup>. Other studies explored the influence of the environments in which alcohol is regulated, sold and consumed, including characteristics and density of alcohol retailing outlets<sup>28,42,43,45,47,51,57,66,68,70,71,77,78,80,82,83,87,95,103,108,112,116</sup>, transportation policies and regulation<sup>47,70,71,84,91,108,109</sup> and multinational commercial interests and practices that seek to influence regulation, social norms and drinking environments<sup>24,93,121</sup>. Finally, a small group of studies looked at the development and practices of the alcohol workforce<sup>86,94,102,106</sup>.

### System levels of interest

The studies we identified described systems that could be categorised as sub-local, local, regional, national or international; or systems that included elements that belonged to more than one of these levels. Studies that considered only one system level primarily focused on the sub-local often considering social influences on individuals' drinking behaviours<sup>44,50,52,53,55,56,64,65,92,96,104,107,114,117,119</sup>. We also identified examples that focused solely on local<sup>51,57,70,71,79,86,100,108,109,111-113,116</sup>, regional<sup>47</sup> and national<sup>85,121</sup> systems. Studies focusing on sub-local or local systems varied in their timeframes; for example one study used an agent-based model (ABM) to generate an in-depth understanding of how drinking evolves over the course of a single evening in response to peer influences<sup>64</sup> whereas another ABM explored the impact of alcohol taxation policies and social connectedness interventions on depression and alcohol misuse amongst older adults over five years<sup>46</sup>.

While the majority (n=56) of the studies included more than one system level in their analysis<sup>22-24,26,28,29,31,42,43,45,46,48,49,54,58-63,66-69,72-78,80-84,87-91,93-95,97-99,101-103,105,106,110,115,118,120</sup>, most researchers limited this analysis to two systems, usually the sub-local and local. Some authors focused primarily on elements within the sub-local system and included a single broader 'cultural' element<sup>69,72,120</sup>. Other researchers, particularly those creating dynamic simulation models, sought to understand how individuals respond and are influenced by environmental characteristics, and how these responses influence others within the system over time. For example, some ABMs simulated the impact of taxation on alcohol consumption and violent victimisation in one city<sup>45</sup> or changes in public transport hours on verbal aggression<sup>84</sup>; another study informed by complexity theory considered the ways in which a retailer intervention reducing local alcohol availability could result in individuals engaging in different substitution behaviours<sup>95</sup>.

We identified some studies that explored relationships between system elements at more than two levels<sup>22,24,60,74-76,80,82,91,93,94,103,105,106,115,118</sup>. For example, one analysis considered the ways in which the practices of multinational corporations who manufacture, advertise, and sell unhealthy commodities such as alcohol, seek to influence public health policy and regulation which shapes broader cultural norms and local environments, ultimately affecting individuals' alcohol consumption<sup>93</sup>.

We had planned to analyse variation in studies based on funding, but identified only one paper that reported funds from an organisation that receives funding from the alcohol industry<sup>79</sup>.

### Complex systems approaches

The identified studies utilised a range of complex systems approaches, which we grouped into: 1) theory-led approaches and 2) dynamic simulation modelling.

#### *Theory-led approaches*

Forty-one studies were identified that can be broadly classified as 'theory-led approaches' to preventing alcohol-related harms from a complex systems perspective. Table 3 gives a description of the theories and their application in this literature. Twelve studies reported being informed by systems theory<sup>57,71,80,85,102,106,108,109,112,113,117,118</sup>, which authors also referred to as systems thinking, a systems perspective or a systems approach. Systems theory was used to either inform prevention approaches, or to analyse interventions from a systems perspective. These papers included Harold Holder's seminal work on community alcohol systems, wherein a community is conceptualised as giving rise to alcohol consumption and associated harms, therefore necessitating a systems approach to prevention which focuses on understanding the relationships between many influences on drinking<sup>70,71</sup>. Ten studies, also drew on insights from complexity science<sup>24,93,108,109,111</sup>, with some explicit applications of complexity theory<sup>79,82,86,95</sup>. Eleven studies were informed by ecological systems theories<sup>49-51,54,69,72,94,103,110,115,120</sup>, including one that developed a behavioural ecological model of alcohol consumption<sup>49</sup> and another that created a developmental ecological model of alcoholism<sup>110</sup>. Five studies applied family systems theory<sup>52,53,55,56,114</sup> and the two final theory-led approaches we identified included theories of practice<sup>105</sup> and information theory<sup>47</sup>.

#### **Insert Table 3 approximately here**

A range of different data collection methods were used in the theory-led approaches. Data were generated in many studies through qualitative methods, including interviews<sup>79,80,82,86,95,112,114,115,117,118</sup>, focus groups<sup>82,95,115,118</sup>, journal entries<sup>117</sup>, documentary review<sup>86,121</sup>, media analyses<sup>121</sup>, observations<sup>82</sup>, sense-making workshops<sup>118</sup> and participatory mapping exercises<sup>29</sup>. A number of the theory-led approaches conducted survey research<sup>47,51,53,56,79,82,113 52,54,55,69</sup>, either designing and utilising new tools, using validated scales, or drawing on secondary data sets. A number of authors conducted literature reviews, both systematic<sup>72,120</sup> and non-systematic<sup>24,49,70,71,93,94,102,103,105,106,108-111</sup>. One study conducted response-to-scenarios research<sup>50</sup> and two others presented descriptions of programmes<sup>57,85</sup>, informed by programme data.

#### *Dynamic simulation modelling*

We identified 46 papers which advocated for, or conducted, dynamic simulation modelling. These refer to computational models which model non-linear causal relationships between system

elements, which may operate at varying temporal and spatial scales in order to understand emergent patterns of system behaviour<sup>22,31</sup>. The majority of the dynamic simulations we identified described the process of developing, or developed, ABMs (n=29)<sup>28,31,42-46,58,60,62,64,74-78,81,83,84,87-90,92,96-98,107,119</sup> or advocated for the use of, or developed, system dynamics (SD) models for alcohol-harm prevention (n=9)<sup>22,23,26,59,60,73,91,99,100</sup>. ABMs model individual agents with different personal characteristics who interact with other agents according to 'rules' that govern their behaviour within a specific environment<sup>42,83</sup>. SD models represent the interrelationships between system elements and how behaviour is governed through feedback loops. In contrast to ABMs, SDs focus less on individual agents and more on "population-level influences and whole-system dynamics"<sup>31 p.2</sup>. ABMs and SD models have been utilised to understand the dynamics of individual and social drinking behaviour<sup>44,64,74-76,81,92,96,99,107,119</sup>, to explore how individuals and their networks interact with their broader environment<sup>22,23,43,59,97,98</sup> and to predict outcomes stemming from the introduction of an intervention or range of policy options<sup>26,28,31,42,45,46,58,62,73,77,78,83,84,87-91</sup>.

We also identified compartmental models which were developed and extended by two research groups interested in exploring the dynamics of drinking behaviours in university students<sup>48,61-63,66-68</sup>. Two cellular automata models were developed which compare the effects of alcohol outlet density on violent offending<sup>116</sup> and to understand how social interaction influences binge drinking in students<sup>104</sup>. Finally, we identified one cusp catastrophe model which modelled the dynamics of relapse<sup>65</sup>.

The dynamic simulation models varied in regard to the degree to which they developed their underlying conceptual models and the extent to which these models were informed by theory or empirical data. Several models were explicitly theory-led<sup>43,58,64,65,74-76,92,116</sup>, whereas the majority drew on implicit theories. Most of the theories informing models were individual-level and concerned individuals' behaviours, particularly peer and social influences on alcohol consumption<sup>58,59,64,65,81,92,96,98,104,107,119</sup>. However, some studies theorised that drinking environments or societal norms and roles may also influence consumption and alcohol-related harms<sup>42,43,74-76</sup>. A large number of the models drew on empirical data, both primary<sup>65,81,96</sup> and secondary data from a range of sources, including academic literature<sup>28,31,44,46,48,61-63,73,78,81,83,84,87,91,97,99,104,116</sup>, censuses<sup>42,45,75,76</sup>, cohort studies, surveys and local and national data from public agencies<sup>26,28,31,42,43,45,46,48,60-63,66-68,74-76,78,81,83,84,87,91,92,97,104,116,119</sup>. Apostolopoulos et al advocated for participatory model building<sup>23</sup> and we identified one model that used stakeholder engagement in the model building process<sup>28,31,87-90</sup>.

### *Social network analyses*

Three recent systematic reviews primarily identified studies conducted in the US examining the influence of social networks on adult<sup>40</sup> and adolescent<sup>38,39</sup> alcohol use. Knox and colleagues identified 17 studies which explored the association between the characteristics of network members or characteristics of the network structure on adult alcohol consumption outcomes<sup>40</sup>. The majority of the studies were conducted in adults under the age of 30 and in university settings<sup>40</sup>. Montgomery and colleagues reviewed studies which explored the association of homophilic social selection, social influence, popularity and network structure on adolescent drinking (n=17) or drinking and smoking (n=7)<sup>38</sup>. A third systematic review conducted by Henneberger and colleagues reviewed stochastic actor-based models to explore the effects of peer selection and peer

socialisation processes on adolescent alcohol (n=21), tobacco (n=23) or drug use (n=6)<sup>39</sup>. Stochastic actor-based models are dynamic and were used in the identified studies to model peer selection and socialisation impacts after controlling for network and behavioural characteristics<sup>39</sup>. Some studies were included in both the Montgomery et al<sup>38</sup> and Henneberger et al<sup>39</sup> reviews. The studies identified in the three reviews conducted analyses of sub-local systems, with an emphasis on the relationship between aspects of social networks and consumption. The included social network analyses drew on theories of social influence on drinking behaviour and utilised primary and secondary cross-sectional and longitudinal survey data.

**Insert Table 4 approximately here**

## Discussion

We identified a large number of studies applying a complex systems perspective to alcohol consumption and the prevention of alcohol-associated harms. Studies examine diverse facets of alcohol, considering both types and patterns of consumption behaviour and the (mostly) local environments in which alcohol is purchased and consumed. The body of literature is methodologically diverse, with examples of theory-led approaches incorporating a range of study design, as well as dynamic simulation modelling. There is also a large body of research exploring network influences on alcohol use.

A key finding of this review is that alcohol systems research tends to focus on individuals and small-scale local systems. A complex systems perspective calls for broader systemic-level analysis and intervention, but the application of this remains underdeveloped – even in studies that take a systems-informed approach. We found few examples of how the local environment is shaped by broader system levels – that is, regional, national and international forces that influence it. This finding mirrors that of a systematic review on the use of ABMs and SD models in obesity research which found that most models focused on individuals, their networks and local environments, with far fewer considering meso- and macro-systems<sup>122</sup>.

Bambra and colleagues have argued that traditional (i.e. not explicitly systems-oriented) place-based research on health inequalities has tended to focus on the individual or the local, while largely ignoring the political and economic forces that influence local policies and environments<sup>123</sup>. Bambra et al. contend that researchers have an obligation to widen their lens or to “scale up” – to move beyond *horizontal* (i.e. local) explanations to *vertical* (i.e. macro/national) explanations – in order to analyse the “complex multi-scalar and interdependent processes operating at the systems level”<sup>123 p.37</sup>. Failing to do so, they argue, means that interventions, will ultimately remain local, while failing to address systemic drivers of health and health inequalities.

The findings from this scoping review lead us to make a similar argument and conclusion for alcohol research. Many of the theories that underpin the public health evidence base are individual-level<sup>15</sup>, and this applies to many of these studies identified in this review which focus on the behavioural and psychological factors that influence consumption and the distribution of alcohol harms<sup>22,24</sup>. Such individual risk factors are often perceived as being more easily modifiable than meso- and macro-systemic structures<sup>22</sup>. Many of the studies identified in this review also focused on the local level, which may reflect the tendency to implement local-level interventions to address alcohol-related

harms<sup>100</sup>. Three reviews of social network effects on alcohol consumption reinforce this observed tendency to focus on sub-local and local systems<sup>38-40</sup>.

In order to theorise and design effective alcohol harm reduction efforts, alcohol systems researchers should consider how to move beyond the individual<sup>22</sup> and the local, and consider the broader systemic levels that shape alcohol-related harm<sup>24</sup> – a shift of focus from horizontal complexity to vertical complexity. These broader systemic levels might include, for example, the influence multinational alcohol industry actors exert on drinking culture through marketing and licensing; as well as how the industry influences individual attitudes and drinking practices through misinformation and lobbying at the macro and micro levels<sup>124,125</sup>. We identified some examples of this, and we recognise that this is not without its challenges, including a possible trade-off of depth for breadth<sup>95</sup>.

### *Limitations and challenges*

The nature of our search strategy meant that we may have missed studies which are compatible with a complex systems lens, but do not use the associated terminology. A review of Canadian health promotion efforts on alcohol and tobacco use found that evaluations frequently assessed aspects of complexity without engaging with the complexity literature<sup>20</sup>. In addition, due to the nebulous terminology associated with complex systems, studies which may be methodologically relevant but do not utilise the terms we used in our search strategy, may have been missed. By relying on systematic reviews of individual network studies, we may have also missed studies that were not captured by those review's search strategies, including studies published after the review's search dates. We also did not include studies published prior to 2000 which excludes earlier applications of a complex systems perspective to alcohol research. A previous review also highlighted that much of the complex systems research is presented at conferences<sup>17</sup>. While we did identify some full conference papers, there may be other work in this area that we did not identify. We also only searched for English-language publications.

This literature base is diverse and it can be challenging to conceptually group studies with different aims, approaches, methods and data sources. Some papers we identified were based on the same (or similar) models, which researchers revised overtime<sup>88</sup> and used to test different scenarios<sup>26</sup>, driven by evidentiary needs<sup>126</sup>. This presents a challenge for evidence synthesis regarding how to account for multiple outputs from one model. In some instances, usual guidance on 'linked' reports<sup>127</sup> may be insufficient.

### **Conclusion**

The use of a complex systems perspective has provided a variety of ways of conceptualising and analysing alcohol use and harm prevention efforts, but it has ultimately not transformed its overall focus, which remains predominantly on the individual or local level. In 2004, Gorman and colleagues argued it is logical that alcohol research focuses on community-level systems; many alcohol interventions are implemented locally and local systems represent a good balance between the simple and complex for a dynamic model. They went on to argue that "whether community-level systems represent the optimal scale for modelling and controlling illicit drug use and misuse (as well

as alcohol use-related outcomes) remains to be seen through empirical research.”<sup>100 p.1726</sup> Sixteen years on, there remain relatively few examples of empirical research that have moved beyond the individual and local level to answer this challenge. A complex systems perspective represents an opportunity to consider the vertical dimensions that constrain, shape and influence alcohol consumption and related harms, but the literature to date has not fully captured this potential. We recommend alcohol researchers rise to this challenge and explore the multiple and interacting horizontal and vertical factors that influence alcohol consumption and the distribution of alcohol-associated harms.

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**Table 1: Study characteristics; theory-led approaches**

<b>Authors and Year Title</b>	<b>Aim</b>	<b>Country. (Population). Alcohol topic</b>	<b>System level(s)</b>	<b>Theory. (Methods). Timeframe</b>	<b>System modifications examined</b>	<b>Types of findings</b>
Anderson et al 2016 <sup>47</sup> <i>Understanding policy diffusion in the U.S.: An information-theoretical approach to unveil connectivity structures in slowly evolving complex systems</i>	To measure the existence and direction of influence of one state's policy or legal activity on others with regards to alcohol, driving safety and impaired driving regulation in the US.	US. (General population). Alcohol regulation and availability; impaired driving regulation	Regional	Information theory. (Information-theoretical framework and a stochastic model for validation). 1980-2000	Enactment and changes to alcohol availability regulation and driving laws	Factors that influence policy diffusion and adoption
BeLue et al 2012 <sup>29</sup> <i>Systems thinking tools as applied to community-based participatory research: a case study</i>	To illustrate the use of systems thinking in a community-based participatory research framework using a case study of a community coalition that addresses problem drinking among adolescents.	US. (Adolescent high school students). Youth alcohol misuse and prevention	Multiple: sub-local and local	Systems thinking; complex adaptive systems. (Participatory research; causal loop diagram exercise). Duration of initiative (unspecified)	None	Argument for use of approach; influences on drinking
Birckmayer 2004 <sup>49</sup> * <i>A general causal model to guide alcohol, tobacco, and illicit drug prevention: Assessing the research evidence</i>	To develop an alcohol, tobacco and other drugs (ATOD) causal model that seeks to identify the variables that are theoretically salient and empirically connected across alcohol, tobacco, and illicit drugs.	US. (General population). Alcohol use and associated harms	Multiple: sub-local and local	Complex systems model. (Non-systematic literature review). Unspecified	None	Development of model
Bogg and Finn 2009 <sup>50</sup> <i>An ecologically based model of alcohol-consumption decision making: evidence for the discriminative and predictive role of contextual reward and punishment information</i>	To develop and test an assessment of alcohol-consumption decision making guided by insights from ecological systems theory and reinforcement sensitivity theory.	US. (Young adults aged 18-30). Alcohol consumption	Sub-local	Bronfenbrenner's ecological systems theory; reinforcement sensitivity theory. (Response to scenarios). Week	None	Influences on drinking
Brennan et al 2016 <sup>101</sup> <i>Social marketing's consumer myopia: applying a behavioural ecological model to address wicked problems</i>	To describe a behavioural ecological systems approach to enhance understanding of social markets.	Generic. (General population). Alcohol consumption; sales	Multiple: local and national	Behavioural ecological systems theory. (Non-systematic literature review). Unspecified	None	Argument for approach; development of model; influences on drinking
Chun et al 2013 <sup>69</sup> <i>Psychoecological model of alcohol use in Mexican American adolescents</i>	To propose and test a structural model based on Bronfenbrenner's ecological systems theory to	US. (Hispanic adolescents).	Multiple: sub-local and national	Ecological systems theory. (Cross-sectional survey design with validated	None	Development and testing of model

<b>Authors and Year Title</b>	<b>Aim</b>	<b>Country. (Population). Alcohol topic</b>	<b>System level(s)</b>	<b>Theory. (Methods). Timeframe</b>	<b>System modifications examined</b>	<b>Types of findings</b>
	understand alcohol use among Hispanic adolescents.	Adolescent alcohol consumption		questionnaires). Unspecified		
Galvani et al 2017 <sup>94</sup> <i>Social work and substance use: ecological perspectives on workforce development</i>	To offer a theoretical analysis of the extent to which social work structures and systems support social workers to work effectively with people using substances problematically.	UK. (Social workers). Social work education and practice	Multiple: sub-local, local and national	Bronfenbrenner ecological systems theory. (Non-systematic literature review). Unspecified	None	Influences on social work practice
Gruenwald 2007 <sup>103</sup> † <i>The spatial ecology of alcohol problems: niche theory and assortative drinking</i>	To summarise theoretical perspectives that explain associations between concentrations of alcohol outlets and alcohol-related problems; to propose a conceptual model of the social ecology of alcohol use.	Generic. (General population, commercial actors). Alcohol consumption; outlet density; outlet characteristics; commercial interests	Multiple: sub-local, local, national and international	Niche theory; assortative drinking; social ecology theory. (Non-systematic literature review). Unspecified	None	Development of theoretical model
Gruenwald et al 2014 <sup>51</sup> † <i>Testing a social ecological model of alcohol use: the California 50-city study</i>	To assess relationships between demographic and personality characteristics of individual drinkers and environmental characteristics at the city level to measures of drinking patterns and use of drinking contexts.	US. (General population). Drinking patterns; drinking contexts; outlet density	Local	Social ecology theory. (Archival and survey data from 50 cities). Single time point	None	Environmental influences on drinking
Haggard et al 2015 <sup>112</sup> <i>Implementation of a multicomponent Responsible Beverage Service programme in Sweden - a qualitative study of promoting and hindering factors</i>	To identify factors that either promote or hinder implementation of a multicomponent Responsible Beverage Service programme in Swedish municipalities.	Sweden. (General population, bar staff). Responsible beverage services; violence and injuries	Local	Systems thinking. (Semi-structured interviews). Single time point	Responsible Beverage Service programme	Process evaluation findings
Hlomani-Nyawasha et al 2020 <sup>115</sup> <i>Factors influencing alcohol use among female in-school adolescents in the Western Cape, South Africa</i>	To explore the factors influencing alcohol use among female adolescent students as guided by the	South Africa. (Female adolescents).	Multiple: sub-local, local, national	Bronfenbrenner ecological systems theory. (Semi-structured interviews;	None	Multi-level influences on drinking

<b>Authors and Year Title</b>	<b>Aim</b>	<b>Country. (Population). Alcohol topic</b>	<b>System level(s)</b>	<b>Theory. (Methods). Timeframe</b>	<b>System modifications examined</b>	<b>Types of findings</b>
	ecological systems theory of Bronfenbrenner.	Alcohol consumption		focus groups). Single time point		
Holder 2001 <sup>108</sup> * <i>Prevention of alcohol problems in the 21st Century: challenges and opportunities</i>	To describe a systems approach to substance abuse treatment and prevention and to present findings from a systems-informed community system prevention effort.	Generic. (General population). Community mobilisation; drink driving; responsible beverage service; underage drinking; retailer density and characteristics	Local	Systems approach. (Non-systematic literature review). Unspecified	Drink driving laws; changes to alcohol availability; responsible beverage service; underage drinking policies; enforcement	Argument for approach; evaluation results
Holder 2001 <sup>71</sup> * <i>Community prevention trials: a respectful partnership.</i>	To review the theoretical basis for a systems approach to community prevention and to evaluate a systems-informed intervention.	US. (General population). See Holder 2001 <sup>108</sup>	Local	Systems approach. (Non-systematic literature review). Unspecified	See Holder 2001 <sup>108</sup>	Argument for approach; evaluation results
Holder 2002 <sup>70</sup> * <i>Prevention of alcohol and drug "abuse" problems at the community level: What research tells us</i>	To present an alternative model for reducing alcohol-involved problems at the local level and a review of research evidence about effectiveness.	US. (General population). See Holder 2001 <sup>108</sup>	Local	Systems approach and complex adaptive systems. (Non-systematic literature review). Unspecified	See Holder 2001 <sup>108</sup>	Argument for and illustration of approach
Holder et al 2005 <sup>111</sup> * <i>Community systems and ecologies of alcohol problems</i>	To outline the theoretical bases underlying the community systems approach to alcohol and to introduce the application in computer modelling.	Generic. (General population). Alcohol problems and prevention	Local	Complex systems / systems approach. (Non-systematic literature review). Unspecified	Drink driving interventions	Argument for approach; illustration of approaches
Holder 2010 <sup>109</sup> * <i>Substance abuse treatment as part of a total system of community response</i>	To present a systems approach to substance abuse treatment and prevention.	Generic. (General population; high risk drinkers; individuals with substance-based disorders). Substance abuse prevention and treatment; alcohol-related traffic injuries	Local	Systems approach. (Non-systematic literature review). Unspecified	Multiple - example of preventing alcohol-related motor vehicle crashes	Development of system model

<b>Authors and Year Title</b>	<b>Aim</b>	<b>Country. (Population). Alcohol topic</b>	<b>System level(s)</b>	<b>Theory. (Methods). Timeframe</b>	<b>System modifications examined</b>	<b>Types of findings</b>
Hong et al 2011 <sup>72</sup> <i>Substance abuse among Asian American youth: An ecological review of the literature</i>	To understand the risk and protective factors that are associated with substance use among Asian American youth, using Bronfenbrenner's ecological systems theory.	US. (Asian American adolescents and young adults age 10-24). Alcohol consumption	Multiple: sub-local and national	Bronfenbrenner's ecological systems theory. (Systematic literature review). Unspecified	None	Risk and protective factors for drinking
Hong et al 2011 <sup>120</sup> <i>Alcohol and tobacco use among South Korean adolescents: An ecological review of the literature</i>	To review existing studies on the risk factors for alcohol and tobacco abuse among South Korean adolescents within the context of ecological systems theory.	South Korea. (Adolescents and young adults age 10-24). Alcohol consumption	Multiple: sub-local and national	Bronfenbrenner's ecological systems theory. (Systematic literature review). Unspecified	None	Prevalence of alcohol use; risk and protective factors for drinking
Kelly et al 2011 <sup>79</sup> <i>Charismatic cops, patriarchs and a few good women: Leadership, club culture and young peoples' drinking</i>	To examine the roles that community-based sporting clubs in the Australian state of Victoria play in shaping young people's understandings and uses of alcohol.	Australia. (Adolescents young adults involved in sports clubs aged 14-24). Adolescent alcohol consumption; alcohol environments	Local	Complexity science; complex adaptive systems. (Interviews). Single time point	None	Argument for approach; influences on environment and drinking
Knai et al 2018 <sup>121</sup> <i>The Public Health Responsibility Deal: using a systems-level analysis to understand the lack of impact on alcohol, food, physical activity, and workplace health sub-systems</i>	To use a systems approach to make sense of the evaluative findings of the UK's Responsibility Deal in order to explore why the initiative did not reach its objectives.	UK. (Organisations in public, private and third sector). Voluntary pledges to improve public health	Multiple: sub-local, local, national and international	Systems approach. (Literature review; interviews; case studies with interviews and document review; media analysis; adherence to pledges). 3 years	Voluntary organisational commitments within a public-private partnership framework	Process evaluation findings
Knai et al 2018 <sup>93</sup> <i>Systems thinking as a framework for analyzing commercial determinants of health</i>	To use a complex systems perspective to analyse the commercial determinants of NCDs; to (1) conceptualise the problem of NCDs and (2) develop effective policy interventions.	Generic. (Corporate actors). Commercial determinants	Multiple: sub-local, local, national, international	Systems thinking; complex systems. (Non-systematic literature review). Unspecified	None	Argument for, and worked example, of approach

<b>Authors and Year Title</b>	<b>Aim</b>	<b>Country. (Population). Alcohol topic</b>	<b>System level(s)</b>	<b>Theory. (Methods). Timeframe</b>	<b>System modifications examined</b>	<b>Types of findings</b>
Knauth et al 2006 <sup>52</sup> <i>Effect of differentiation of self on adolescent risk behaviour: test of the theoretical model</i>	To test the credibility of a theoretical model based on the Bowen family systems theory to explain adolescent risk behaviour.	US. (Adolescents age 14-19). Adolescent alcohol use	Sub-local	Family systems theory. (Cross sectional survey using validated questionnaires). Single time point	None	Development and testing of model
Kühn and Slabbert 2017 <sup>114</sup> <i>The effects of a father's alcohol misuse on the wellbeing of his family: views of social workers</i>	To explore and describe the effects of alcohol misuse by a father on the wellbeing of his family, as viewed by social workers.	South Africa. (Fathers who misuse alcohol). Alcohol misuse	Sub-local	Family systems theory. (Interviews). Single time point	None	Effects of alcohol misuse
Landers et al 2017 <sup>53</sup> <i>American Indian and White adoptees: are there mental health differences?</i>	To explore the presence of mental health problems of American Indian persons compared to White persons who were separated from their birth families during childhood.	US. (American Indian adoptees). Alcohol addiction and recovery	Sub-local	Family systems theory; attachment theory. (Questionnaire). Single time point	None	Predictors of alcohol addiction and recovery
MacLean et al 2013 <sup>86</sup> <i>Factors contributing to the sustainability of alcohol and other drug interventions in Australian community health settings</i>	To identify factors that support the sustainability of interventions implemented to enhance responses to alcohol and other drug misuse in Australian community health settings.	Australia. (Alcohol and drug workforce). Alcohol intervention sustainability	Local	Complexity theory. (Interviews; documentary analysis). Varied; up to 6 years	Enhancing organisational systems and processes; workforce development; community education	Process evaluation findings
McGill et al 2016 <sup>95</sup> <i>Consequences of removing cheap, super-strength beer and cider: a qualitative study of a UK local alcohol availability intervention</i>	To use a systems perspective to qualitatively explore how Reducing the Strength may lead to intended and unintended consequences within the system in which it was implemented.	UK. (Consumers of super-strength beers and ciders; retailers). Alcohol availability and consumption; street drinking; voluntary initiatives	Multiple: sub-local and local	Systems thinking; complexity theory. (Interviews; focus group). Single time point	Removal of a particular type of drink	Process evaluation findings
Meier et al 2018 <sup>105</sup> <i>All drinking is not equal: How a social practice theory lens could enhance public health research on alcohol and other health behaviours</i>	To call for a new approach to alcohol epidemiology and intervention research informed by theories of practice	Generic. (General population). Drinking practices	Multiple: sub-local, local and national	Theories of practice. (Non-systematic literature review). Unspecified	None	Argument for theoretical approach

<b>Authors and Year Title</b>	<b>Aim</b>	<b>Country. (Population). Alcohol topic</b>	<b>System level(s)</b>	<b>Theory. (Methods). Timeframe</b>	<b>System modifications examined</b>	<b>Types of findings</b>
Nygaard 2001 <sup>117</sup> <i>Intervention in social networks: A new method in the prevention of alcohol-related problems</i>	To present the method, findings, and perspectives of a project based on systems theory aiming at preventing alcohol-related problems through intervention in social networks.	Denmark. (Adult 'social drinkers'). Alcohol consumption	Sub-local	Systems theory. (Interviews; journal entries). Two waves; 6 months apart	Encouraging abstinence from alcohol consumption	Impacts of the intervention
Petticrew et al 2017 <sup>24</sup> <i>Alcohol advertising and public health: Systems perspectives versus narrow perspectives</i>	To challenge overreliance on narrow forms of evidence and approaches to investigating causality to inform decision-making and to advocate for a new framework for alcohol research that takes a broader systems perspective.	Generic. (General population, alcohol industry actors). Alcohol advertising	Multiple: sub-local, local, national and international	Systems perspectives; complex systems. (Non-systematic literature review). Unspecified	None	Argument for approach
Roche and Nicholas 2017 <sup>106</sup> <i>Workforce development: An important paradigm shift for the alcohol and other drugs sector</i>	To describe and outline the implications of a major paradigm shift in the conceptualisation of alcohol and drug (AOD) workforce development that embraces a systems perspective.	Generic. (AOD workforce). Workforce for prevention and treatment AOD	Multiple: sub-local, local, national and international	Systems approach. (Non-systematic literature review). Unspecified	Workforce restructuring	Argument and description of approach
Rowe and Bavinton 2011 <sup>82</sup> <i>Tender for the night: after-dark cultural complexities in the night-time economy</i>	To addresses the confusing, contradictory influence of a polarized night-time economy policy agenda and expose the contrasting multi-layered complexities of the diverse cultural practices of urban nightlife.	Australia. (Users and components of the night time economy). Nightlife culture	Multiple: sub-local, local and regional	Complexity theory. (Interviews; focus groups; observations; online questionnaire). 2 years	Policies approaches to the night-time economy	Argument for theoretical approach
Sharma et al 2020 <sup>118</sup> <i>The role of tobacco and alcohol use in the interaction of social determinants of non-communicable diseases in Nepal: a systems perspective</i>	To describe the role of tobacco and alcohol use in the interaction of social determinants of NCDs in Nepal.	Nepal. (General population). Alcohol consumption	Multiple: local, regional, national, international	Systems approach. (Key informant interviews; focus groups; sense-making sessions; qualitative system dynamics).	None	Interaction between social determinants of health and alcohol use

<b>Authors and Year Title</b>	<b>Aim</b>	<b>Country. (Population). Alcohol topic</b>	<b>System level(s)</b>	<b>Theory. (Methods). Timeframe</b>	<b>System modifications examined</b>	<b>Types of findings</b>
Simoneau and Bergeron 2000 <sup>110</sup> <i>An etiologic model of alcoholism from a developmental ecological perspective</i>	To create an etiologic model of alcoholism over an individual's lifespan.	Generic. (General population). Alcohol dependence	Multiple: sub-local and national	Developmental ecological perspective. (Non-systematic literature review). Life course	None	Development of conceptual model
Sipsma et al 2012 <sup>54</sup> <i>Future expectations among adolescents: a latent class analysis</i>	To investigate whether an empirically-driven, multidimensional approach to conceptualizing future expectations can substantively contribute to our understanding of adolescent risk behaviour.	US. (Adolescents age 15+). Alcohol consumption	Multiple: sub-local and local	Bronfenbrenner's ecological systems theory. (Data from longitudinal survey). Single time point	None	Probability of becoming intoxicated
Soloski et al 2016 <sup>55</sup> <i>Gender differences: emotional distress as an indirect effect between family cohesion and adolescent alcohol use</i>	To explore the relationship between family cohesion, emotional distress, and adolescent alcohol use.	US. (Adolescents). Alcohol consumption	Sub-local	Family systems theory. (Data from longitudinal survey). Single time point	None	Influences on drinking
Stafström et al 2006 <sup>113</sup> <i>A community action programme for reducing harmful drinking behaviour among adolescents: The Trelleborg Project</i>	To evaluate a 3-year community intervention programme informed by systems thinking by measuring changes in drinking patterns in a 15–16-year-old population.	Sweden. (Adolescents age 15-16). Alcohol consumption	Local	Systems thinking. (Cross-sectional, questionnaires at several timepoints). 3 years	Community action programme	Impact of intervention
Su et al 2018 <sup>56</sup> <i>Influence of parental alcohol dependence symptoms and parenting on adolescent risky drinking and conduct problems: a family systems perspective</i>	To use a family systems approach to consider spillover and crossover effects of fathers' and mothers' alcohol problems and parenting behaviours in relation to adolescents' risky drinking and conduct problems.	US. (Alcohol dependence parents and adolescents age 12-17). Parental drinking; adolescent risky drinking and conduct	Sub-local	Family systems theory. (Validated clinical questionnaire). Single time point	None	Influences on drinking and related harms
Sun 2000 <sup>102</sup> <i>Direct practice with substance abusing mothers in the child welfare system: A system perspective</i>	To explore the needs and related issues of substance abusing mothers in the welfare system.	Generic. (Substance abusing mothers). Child welfare; guidelines for social workers	Multiple: sub-local and local	Systems perspective. (Non-systematic literature review). Unspecified	None	Practice guidelines

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Thompson et al 2017 <sup>80</sup> <i>Examining alcohol management practices in community sports clubs: a systems approach</i>	To investigate the influence of macro-level regulatory systems on alcohol management for community sport organisations.	Australia. (Sporting club administrators and participants). Responsible alcohol management	Multiple: local, regional and national	Systems thinking. (Semi-structured interviews). Single time point	None	Influences on policy
Wallack 2006 <sup>57</sup> <i>A community approach to the prevention of alcohol-related problems: The San Francisco experience</i>	To describe the San Francisco Prevention Project, a community level intervention informed by a systems perspective which is designed to prevent alcohol-related problems.	US. (General population, public health workforce). Street drinking, regulation of outlets, family violence, availability	Local	Systems perspective. (Review of social - epidemiological literature; local data analysis; semi structured interviews and participatory workshops). Unspecified	Community intervention to prevent alcohol-related problems	Programme development and description
Wilson et al 2014 <sup>85</sup> <i>The Australian Prevention Partnership Centre: Systems thinking to prevent lifestyle-related chronic illness</i>	To describe The Australian Prevention Partnership Centre and its approach to chronic-disease prevention using systems thinking.	Australia. (Public health researchers and workforce). Alcohol harm prevention	National	Systems thinking. (Programme description). Single time point	Partnership approach to improve chronic disease outcomes	Programme description

\*Birkmayer et al 2014 <sup>49</sup>, Holder et al 2001 <sup>108</sup>, Holder et al 2001 <sup>71</sup>, Holder et al 2002 <sup>70</sup>, Holder et al 2005 <sup>111</sup>, Holder et al 2010 <sup>109</sup>

†Gruenewald 2007 <sup>103</sup>, Gruenewald et al 2014 <sup>51</sup>

**Table 2: Study characteristics; dynamic simulation modelling**

<b>Authors and Year Title</b>	<b>Aim</b>	<b>Country. (Population). Alcohol topic</b>	<b>System level(s)</b>	<b>Method. (Model underpinnings). Timeframe</b>	<b>System modifications examined</b>	<b>Types of findings</b>
Ackleh et al 2009 <sup>61</sup> *	To present the procedure and results of parameter estimation and to	US. (University students).	Multiple: sub-local and local	Continuous, deterministic, dynamical systems compartmental model.	Reducing environmental wetness;	Simulated impacts of interventions

<b>Authors and Year Title</b>	<b>Aim</b>	<b>Country. (Population). Alcohol topic</b>	<b>System level(s)</b>	<b>Method. (Model underpinnings). Timeframe</b>	<b>System modifications examined</b>	<b>Types of findings</b>
<i>Ecosystem modeling of college drinking: parameter estimation and comparing models to data</i>	examine the effect of two hypothetical intervention policies.	Consumption; types of drinkers		(Academic literature; survey data). 10 and 12 years	university policies on drinking	
Apostolopoulos et al 2018 <sup>22</sup> † <i>Moving alcohol prevention research forward—Part I: introducing a complex systems paradigm</i>	To outline the limitations of current approaches in alcohol prevention research and to use alcohol misuse in college students to illustrate how a complex systems approach addresses them.	US. (University students). Alcohol misuse	Multiple: sub-local, local, regional and national	Computational modelling methodologies. (Ecosocial; syndemic; and complex systems theories). Unspecified	None	Arguments for paradigm shift and approach
Apostolopoulos et al 2018 <sup>23</sup> † <i>Moving alcohol prevention research forward—Part II: new directions grounded in community-based system dynamics modelling</i>	To describe computational modelling methodologies, explain the value of community-based system dynamics modelling in alcohol prevention research, and explain how to build alcohol misuse simulation models.	US. (University students). Alcohol misuse	Multiple: sub-local and local	Community-based system dynamics modelling. (Stakeholder workshops; best available data; expert-driven assumptions; historical data; scientific literature). Unspecified	Changing social norms around drinking	Process and illustration of system dynamics modelling
Atkinson et al 2017 <sup>31</sup> ‡ <i>Dynamic simulation modelling of policy responses to reduce alcohol-related harms: rationale and procedure for a participatory approach</i>	To describe the participatory process of developing a dynamic simulation model of possible policy actions to reduce alcohol-related harms in New South Wales.	Australia. (General population). Prevention and treatment of alcohol-related harms (acute and chronic)	Multiple: sub-local and local	Consensus-building in simulation models. (Expert opinion; national and state data; survey data; accepted formulas; theoretical models; systematic reviews; meta-analyses; economic data). Unspecified	'Lockouts'; retail hours and density restrictions; bans on advertising; minimum pricing; responsible beverage service enforcement	Rationale and procedure for developing a participatory dynamic simulation model
Atkinson et al 2018 <sup>28</sup> ‡ <i>Harnessing advances in computer simulation to inform policy and planning to reduce alcohol-related harms</i>	To develop a decision support tool to test alcohol policy scenarios and to compare estimated impacts over time of a range of trading hour policy options on indicators of acute and chronic alcohol-related harms.	Australia. (General population). Acute and chronic alcohol harms; licensing hours; venue policies	Multiple: Sub-local and local	Agent-based model. (See Atkinson et al 2017 <sup>31</sup> ). 5 years	Changes in venue closing time; 'lockouts'	Development of model; simulated impacts of interventions
Atkinson et al 2018 <sup>87</sup> ‡ <i>Impacts of licensed premises trading hour policies on alcohol-related harms</i>	To use dynamic simulation modelling to compare estimated impacts over time of trading hour policy options on various indicators of acute	Australia. (General population). Acute harms;	Multiple: sub-local and local	Agent-based model. (See Atkinson et al 2017 <sup>31</sup> ). 5 years	Changes in venue closing times	Simulated impacts of interventions

<b>Authors and Year Title</b>	<b>Aim</b>	<b>Country. (Population). Alcohol topic</b>	<b>System level(s)</b>	<b>Method. (Model underpinnings). Timeframe</b>	<b>System modifications examined</b>	<b>Types of findings</b>
	alcohol-related harm in New South Wales.	violence; licensing hours				
Castillo-Carniglia et al 2019 <sup>42</sup> <i>Limiting alcohol outlet density to prevent alcohol use and violence: estimating policy interventions through agent-based modelling</i>	To estimate the association between closing alcohol outlets and alcohol use and alcohol-related violence.	US. (General population). Alcohol consumption; violence; outlet density	Multiple: sub-local and local	Agent-based model. (Census data; state & local data; survey data; ecological niche theory). Unspecified	Capping and reducing outlet density	Simulated impacts of interventions
Clapp et al 2018 <sup>99</sup> § <i>A system dynamic model of drinking events: multi-level ecological approach</i>	To present an empirically grounded dynamic conceptual model to better understand drinking events.	Generic. (General population). Drinking events; blood alcohol level.	Multiple: sub-local and local	Systems dynamics model. (Academic literature; peer review; field data). 3 hours	None	Conceptual model for future studies
Fitzpatrick et al 2012 <sup>62</sup> * <i>Forecasting the effect of the Amethyst Initiative on college drinking</i>	To forecast the effect of the Amethyst Initiative (initiative to reduce the legal drinking age) on college drinking.	USA. (University students). Types of drinker; legal drinking age	Multiple: sub-local and local	Continuous dynamical systems compartmental model. (Academic literature; survey). 10 years	Reducing legal drinking age	Simulated impacts of intervention
Fitzpatrick and Martinez 2012 <sup>43</sup> ¶ <i>Agent-based modelling of ecological niche theory and assortative drinking</i>	To develop a preliminary approach to modelling dynamic properties of the spatial assortment of alcohol outlets.	US. (General population). Characteristics and number of alcohol outlets; drinking habits	Multiple: sub-local and local	Agent-based model. (Theory-led model: Gruenwald <sup>103</sup> ; local surveys and data). 1 year, 5 years	Varying outlet numbers and attributes	Development of model; simulated impacts of interventions
Fitzpatrick et al 2015 <sup>64</sup> ¶ <i>The big impact of small groups on college drinking</i>	To develop a theoretically-informed agent-based simulation model of a single drinking event to examine college drinking.	US. (University students). Drinking behaviour	Sub-local	Agent-based model. (Theory-led model: social norms; identity control and peer influence). 4 hours	None	Influences on drinking behaviour
Fitzpatrick et al 2016 <sup>58</sup> ¶ <i>On the effectiveness of social norms intervention in college drinking: the roles of identity</i>	To develop an agent-based computational simulation that uses identity control theory and peer influence to model interactions that affect drinking in college students and to simulate the impact of a social norms campaign.	US. (University students). Consumption; heavy episodic drinking	Multiple: sub-local and local	Agent-based model. (Theory-led model: social norms theory, identity control theory, and peer influence). 4 hours	Social norms campaigns	Influences on drinking behaviour; simulated impacts of intervention

<b>Authors and Year Title</b>	<b>Aim</b>	<b>Country. (Population). Alcohol topic</b>	<b>System level(s)</b>	<b>Method. (Model underpinnings). Timeframe</b>	<b>System modifications examined</b>	<b>Types of findings</b>
Freebairn et al 2017 <sup>89</sup> ‡ <i>Knowledge mobilisation for policy development: Implementing systems approaches through participatory dynamic simulation modelling</i>	To describe the experience of using participatory simulation modelling as a knowledge mobilisation tool in Australian real-world policy settings.	Australia. (General population). Drinking behaviours; acute and chronic harms	Multiple: sub-local and local	Process of conducting participatory dynamic simulation modelling. (See Atkinson et al 2017 <sup>31</sup> ). Unspecified	Interventions to address alcohol harms	Description, example and argument for approach
Freebairn et al 2018 <sup>88</sup> ‡ <i>Decision makers' experience of participatory dynamic simulation modelling: methods for public health policy</i>	To report on the experience of end-user decision makers who participated in three participatory simulation modelling for health policy case studies and their perceptions of the value and efficacy of this method.	Australia. (General population). Drinking behaviours; acute and chronic harms	Multiple: sub-local and local	Semi-structured interviews to understand participatory dynamic simulation modelling. (See Atkinson et al 2017 <sup>31</sup> ). Unspecified	Interventions to address alcohol harms	Views on approach
Garrison and Babcock 2009 <sup>44</sup> <i>Alcohol consumption among college students: an agent-based computational simulation</i>	To develop an agent-based computer model to study how students' attitudes, their experiences while drinking, and their interactions with others increase or decrease alcohol consumption.	US. (University students). Consumption; influences on drinking	Sub-local	Agent-based model. (Data from student drinking diaries). 8-16 semesters (15 weeks each)	None	Influences on drinking
Giabbanelli and Crutzen 2013 <sup>119</sup> <i>An agent-based social network model of binge drinking among Dutch adults</i>	To use an agent-based social network model to test a number of hypotheses on important aspects of binge drinking in the adult Dutch population.	Netherlands. (Adult general population). Binge drinking	Sub-local	Agent-based model. (Longitudinal national data; peer selection and peer influence; drinking motives). Unspecified	Intervention to change pressure to drink	Influences on drinking
Giraldo et al 2017 <sup>59</sup> § <i>Modeling and analysis of group dynamics in alcohol-consumption environments</i>	To construct a system model that characterises how the dynamics of the social interactions, individual characteristics, and environment translate into changes in the drinking patterns of individuals.	US. (General population). Drinking patterns	Multiple: sub-local and local	System dynamics model. (Theory on group behaviour; field data on drinking). Single drinking event	None	Prediction of drinking patterns
Gonzalez Villasanti et al 2020 <sup>73</sup> §	To provide a system dynamics model to accurately represent a drinking event and provide guidelines for	US. (General population). Drinking events;	Multiple: sub-local and local	System dynamics model. (Academic literature, cognitive perspectives,	Behavioural interventions	Development of model; simulated

<b>Authors and Year Title</b>	<b>Aim</b>	<b>Country. (Population). Alcohol topic</b>	<b>System level(s)</b>	<b>Method. (Model underpinnings). Timeframe</b>	<b>System modifications examined</b>	<b>Types of findings</b>
<i>A dynamic multilevel ecological approach to drinking event modelling and intervention</i>	feedback-based behavioural interventions.	blood alcohol content levels.		perceptual control theory, experimental data). Single drinking event	during drinking events	impacts of intervention
Gorman et al 2004 <sup>100</sup> <i>Implications of systems dynamic models and control theory for environmental approaches to the prevention of alcohol- and other drug use-related problems</i>	To set out what a systems-based understanding of alcohol- and drug use-related problems will require and discuss its implications for public policy and prevention programming.	Generic. (General population). Prevention of alcohol misuse	Local	Systems dynamics model. (Complexity and control theory). Unspecified	Possibility of modelling different interventions	Argument for theory and approach
Gorman et al 2006 <sup>98</sup> <i>Agent-based modelling of drinking behaviour: a preliminary model and potential applications to theory and practice</i>	To develop an agent-based simulation model to examine agent–environment interactions that support the development and maintenance of drinking behaviour.	Generic. (General population). Drinking behaviour; drinking states	Multiple: sub-local and local	Agent-based model. (Social influence literature). 1,000 days	Introduction of a new alcohol outlet	Influences on drinking; simulated impact of intervention
Hufford et al 2003 <sup>65</sup> <i>Relapse as a nonlinear dynamic system: application to patients with alcohol use disorders</i>	To use catastrophe theory (subset of nonlinear dynamical systems theory) to describe and predict the relapse process.	US. (Patients with alcohol use disorders). Sub-local	Addiction; alcohol relapse process	Cusp catastrophe model. (Cusp catastrophe theory; primary data). 6 months	None	Model; influences on relapse
Jackson et al 2012 <sup>104</sup> <i>Drinking with friends: a cellular automata approach to modeling peer influence on binge drinking behavior</i>	To use a cellular automata model to simulate the effects of peer influences on binge drinking behaviour to understand alcohol consumption in students.	Generic. (University students). Binge drinking	Sub-local	Cellular automata model. (Academic literature; survey data). 600 (unspecified) time steps	None	Influences on drinking
Keyes et al 2019 <sup>45</sup> <i>Assessing the impact of alcohol taxation on rates of violent victimization in a large urban area: an agent-based modelling approach</i>	To use simulation to estimate the impact of alcohol taxation on drinking, non-fatal violent victimization and homicide in New York City.	US. (General population; heavy drinkers). Consumption; non-fatal violent victimisation; homicide' taxation.	Multiple: sub-local and local	Agent-based model. (Census data; cohort studies; national surveys; local surveys; local data). 10 years	Taxation	Simulated impacts of interventions
Ip et al 2016 <sup>60</sup> <i>Agent-based modeling of college drinking behavior and mapping of system dynamics of alcohol reduction using both environmental and</i>	To describe an agent-based model that explores the dynamic of college drinking and the use of system dynamic modelling to explore the causal relationship between personal	US. (University students). Consumption	Multiple: sub-local, local and regional	Agent-based model and use pf system dynamics modelling. (Adapted ABM from Gorman et al 2006 <sup>98</sup> ;	Marketing of alcohol; availability of alcohol; university	Influences on drinking

<b>Authors and Year Title</b>	<b>Aim</b>	<b>Country. (Population). Alcohol topic</b>	<b>System level(s)</b>	<b>Method. (Model underpinnings). Timeframe</b>	<b>System modifications examined</b>	<b>Types of findings</b>
<i>individual-based intervention strategies</i>	/ environmental factors and alcohol consumption.			national survey). 240 months	culture around alcohol	
Lamy et al 2011 <sup>77</sup> <i>An agent-based model of alcohol use and abuse: SimARC</i>	To create a social simulation, which integrates three levels of analysis (micro, meso, macro) in order to get a better understanding of alcohol use and misuse.	Australia. (General population). Consumption; taxation	Multiple: sub-local and local	Agent-based model and causal loop diagrams. (Theory that alcohol-related harms caused by interactions across system levels). 1 year	Taxation	Impacts of simulated interventions
Mubayi et al 2010 <sup>68</sup> # <i>Impact of relative residence times in highly distinct environments on the distribution of heavy drinkers</i>	To estimate the effects of social influence, social context, and residence time on the initiation and maintenance of moderate and heavy drinking.	US. (University students). Drinking behaviour; types of drinkers; alcohol environment	Multiple: sub-local and local	Deterministic compartmental Model. (National and regional data). 6 years	None	Development of model; influences on drinking
Mubayi et al 2011 <sup>66</sup> # <i>Types of drinkers and drinking settings: an application of a mathematical model</i>	To use US college drinking data and a simple population model of alcohol consumption to explore the impact of social and contextual parameters on the distribution of light, moderate and heavy drinkers.	US. (University students). Drinking behaviour; types of drinkers; alcohol environments	Multiple: sub-local and local	Deterministic compartmental Model. (National and regional data). 4 years	None	Development of model; influences on drinking
Mubayi and Greenwood 2013 <sup>67</sup> # <i>Contextual interventions for controlling alcohol drinking</i>	To understand the influence of environment-specific multiple control programs involving interventions in distinct college environments.	US. (University students). Types of drinkers	Multiple: sub-local and local	Deterministic and stochastic compartmental models. (National and regional data). 1 and 1.25 years	'Intervention rates' in low and high-risk drinking environments	Simulated impact of interventions
O'Donnell et al 2017 <sup>90</sup> ‡ <i>Participatory simulation modelling to inform public health policy and practice: rethinking the evidence hierarchies</i>	To describe the benefits of dynamic simulation modelling and its unique approach to evidence synthesis, through the example of alcohol-related chronic disease and acute harms prevention.	Australia. (General population). Drinking behaviours; acute and chronic harms	Multiple: sub-local and local	Description of participatory simulation modelling as an evidence synthesis tool. (See Atkinson et al 2017 <sup>31</sup> ). Unspecified	None	Argument for approach

<b>Authors and Year Title</b>	<b>Aim</b>	<b>Country. (Population). Alcohol topic</b>	<b>System level(s)</b>	<b>Method. (Model underpinnings). Timeframe</b>	<b>System modifications examined</b>	<b>Types of findings</b>
Ormerod and Wiltshire 2009 <sup>96</sup> <i>Binge drinking in the UK: A social network phenomenon</i>	To examine the extent to which the sudden emergence of the binge drinking problem in the UK can be explained as a social network phenomenon.	UK. (Young adults age 18-24). Binge drinking	Sub-local	Agent-based model. (Primary data collection (survey); social network theory). Unspecified	None	Influences on drinking
Perez et al 2012 <sup>81</sup> <i>SimAmph: An agent-based simulation model for exploring the use of psychostimulants and related harm amongst young Australians</i>	To describe SimAmph, an agent-based simulation model which simulates patterns of drug use and related harm amongst young Australians.	Australia. (Young adults). Alcohol and drug use	Multiple: sub-local and local	Agent-based model. (Primary research; academic literature; national survey; economic data; social engagement theories). 200 weeks	None	Influences on drinking and drug use
Probst et al 2020 <sup>74</sup> ** <i>The normative underpinnings of population-level alcohol use: an individual-level simulation model</i>	To test the ability of social norm mechanisms to predict changes in population-level drinking patterns.	US. (General population). Drinking patterns	Multiple: sub-local, local, national	Agent-based model. (Social norms theory; survey data). 20 years	Normative interventions: decrease perception bias, reduce desire to drink, public campaign	Development of conceptual model; mechanisms of drinking patterns; simulated impacts of interventions
Purshouse et al 2014 <sup>92</sup> <i>Evolutionary parameter estimation for a theory of planned behaviour microsimulation of alcohol consumption dynamics in an English birth cohort 2003 to 2010</i>	To present a theory-driven model that can reproduce alcohol consumption dynamics observed in a population over time.	UK. (Young adults age 18-24). Alcohol consumption	Sub-local	Agent-based model. (Theory-driven model: theory of planned behaviour; national surveys). 8 years	None	Influences and predictors of drinking
Rasul et al 2011 <sup>63</sup> * <i>Heavy episodic drinking on college campuses: does changing the legal drinking age make a difference?</i>	To extend Schribner et al's 2009 compartmental model to evaluate the consequences of lowering the legal drinking age.	US. (University students). Legal drinking age; types of drinkers	Multiple: sub-local and local	Continuous, deterministic, dynamical systems compartmental model. (Academic literature; survey data). Unspecified	Lowering the legal drinking age	Simulated impact of intervention
Redfern et al 2013 <sup>97</sup> <i>An open-data, agent-based model of alcohol related crime</i>	To create an agent-based simulation model of alcohol-related violent crime to predict areas of likely violent crime.	UK. (General population). Violence	Multiple: sub-local and local	Agent-based model. (Academic literature; geographical and crime data). 10 hours	None	Predictions of alcohol-associated harms

<b>Authors and Year Title</b>	<b>Aim</b>	<b>Country. (Population). Alcohol topic</b>	<b>System level(s)</b>	<b>Method. (Model underpinnings). Timeframe</b>	<b>System modifications examined</b>	<b>Types of findings</b>
Salmon et al 2020 <sup>91</sup> <i>Computational modelling and systems ergonomics: a system dynamics model of drink driving-related trauma prevention</i>	To develop a system dynamics model that simulates the behaviour of a drink driving-related trauma system and explore the potential impact of different road safety policy interventions.	Australia. (General population). Drink driving	Multiple: sub-local, local, regional, national	System dynamics model. (Academic literature, public data on road crashes; subject expert consultation). 30 years.	Road safety policy; population-level public health interventions to reduce prevalence of alcohol misuse	Development of model; simulated impacts of interventions
Scribner et al 2009 <sup>48</sup> * <i>A systems approach to college drinking: Development of a deterministic model for testing alcohol control policies</i>	To use a systems approach to understand the dynamics of student drinking behaviour and thus forecast the impact of campus policy to address the problem.	US. (University students). Consumption; types of drinkers	Multiple: sub-local and local	Continuous, deterministic, dynamical systems compartmental model. (Academic literature; survey data). 20 years	University policies on drinking	Development of model; drinking styles; simulated impacts of interventions
Schuhmacher et al 2014 <sup>107</sup> <i>Using an agent-based model to simulate the development of risk behaviors during adolescence</i>	To build an agent model to understand how friendship groups evolve, the role of behavioural similarity in friendship formation and how homogeneity among peers emerges.	Generic. (Adolescents). Adolescent consumption	Sub-local	Agent-based model. (Theories and literature on adolescent engagement in risky behaviours). 200 days	None	Model for future use; simulated trajectory of adolescent alcohol use
Scott et al 2016 <sup>78</sup> †† <i>SimDrink: an agent-based NetLogo model of young, heavy drinkers for conducting alcohol policy experiments</i>	To show a proof-of-concept agent-based model 'SimDrink', built in NetLogo, which simulates a population of young heavy drinkers on a night out in Melbourne to inform policy decisions.	Australia. (Young adults age 18-25) heavy drinkers). Consumption; intoxication; aggression; venue policies	Multiple: sub-local and local	Agent-based model. (Academic literature and fieldwork; city- and population-specific study; local data). One night	Public transport, 'lockouts,' enforcement; outlet closing times; drink prices	Simulated impacts of interventions
Scott et al 2016 <sup>84</sup> †† <i>The effects of extended public transport operating hours and venue lockout policies on drinking-related harms in Melbourne, Australia: Results from SimDrink, an agent-based simulation model.</i>	To test the effects of improved public transport and venue lockouts on a range of alcohol-related harms among a population of young adults engaging in heavy drinking in Melbourne.	Australia. (Young adults age 18-25, heavy drinkers). Aggression; venue ejections; consumption; transport harms;	Multiple: sub-local and local	Agent-based model. (Academic literature and fieldwork; city- and population-specific study; local data). Night out starting at 5 pm	Changes to public transport hours; 'lockouts'	Simulated impacts of interventions

<b>Authors and Year Title</b>	<b>Aim</b>	<b>Country. (Population). Alcohol topic</b>	<b>System level(s)</b>	<b>Method. (Model underpinnings). Timeframe</b>	<b>System modifications examined</b>	<b>Types of findings</b>
Scott et al 2017 <sup>83</sup> †† <i>Using simulation modelling to examine the impact of venue lockout and last-drink policies on drinking-related harms and costs to licensees</i>	To estimate the public health gains and licensee costs of venue lockout and last-drink policies in a population of young adults engaging in heavy drinking.	Australia. (Young adults age 18-25) heavy drinkers). Aggression; consumption; retailers' revenue	Multiple: sub-local and local	Agent-based model. (Academic literature and fieldwork; city- and population-specific study; local data). Saturday night starting at 5 pm	'Lockouts;' last-drink policies	Simulated impacts of interventions
Spicer et al 2012 <sup>116</sup> <i>Bars on blocks: a cellular automata model of crime and liquor licensed establishment density</i>	To illustrate a cellular automata model which simulates how densities of licenced premises may affect violent offending within an entertainment district in Vancouver, British Columbia.	Canada. (General population). Violence and disorder; outlet density	Local	Cellular automata model. (Theoretical literature; local data). 2,000 days	Groupings of licenced venues	Simulated impacts of interventions
Stankov et al 2019 <sup>46</sup> <i>Depression and alcohol misuse among older adults: exploring mechanisms and policy impacts using agent-based modelling</i>	To explore how multi-level factors impact the prevalence of depression and alcohol misuse among urban older adults and to simulate the impact of alcohol taxation policies and interventions that increase social connectedness.	US. (Older urban adults age 65+; older heavy drinkers age 65+). Depression; alcohol misuse	Multiple: sub-local and local	Agent-based model. (Data from longitudinal cohort study and environmental data; academic literature). 5 years	Social connection interventions; taxation	Simulated impacts of interventions
Tawileh et al 2008 <sup>26</sup> <i>A system dynamics approach to assessing policies to tackle alcohol misuse</i>	To describe the development of an influence diagram for alcohol misuse and to demonstrate the utility of this approach through a simulation model.	UK. (General population). Consumption; binge drinking	Multiple: local and national	System dynamics model. (Validated with government statistics and quantitative data). 27 years	Alcohol taxation policy; licensing restrictions; bar and pub opening hours; awareness campaigns	Illustration of approach; simulated impacts of interventions
Vu et al 2020 <sup>76</sup> ** <i>A software architecture for mechanism-based social systems modelling in agent-based simulation models</i>	To develop a mechanism-based social systems model and to demonstrate how to populate the model by showing the development of a simulation of a single mechanism-based theory that aims to explain long term changes in population alcohol use.	US. (General population). Alcohol consumption patterns.	Multiple: sub-local, local, national	Agent-based model. (Social norms theory; social roles theory; survey and census data). 20 years	None	Development of model; argument for approach; explanation of dynamics of alcohol use patterns

<b>Authors and Year Title</b>	<b>Aim</b>	<b>Country. (Population). Alcohol topic</b>	<b>System level(s)</b>	<b>Method. (Model underpinnings). Timeframe</b>	<b>System modifications examined</b>	<b>Types of findings</b>
Vu et al 2020 <sup>75</sup> ** <i>Multiobjective genetic programming can improve the explanatory capabilities of mechanism-based models of social systems</i>	To propose and demonstrate a new model discovery framework using a complex systems modelling case study of change and stasis in societal alcohol use patterns in the US over the period 1980–2010.	US. (General population). Alcohol consumption patterns.	Multiple: sub-local, local, national	Agent-based model. (Social role theory; survey and census data). 30 years.	None	Development of model; argument for approach; mechanisms which drive alcohol use

\*Ackleh et al 2009 <sup>61</sup>, Fitzpatrick et al 2012 <sup>62</sup>, Rasul et al 2011 <sup>63</sup>, Scribner et al 2009 <sup>48</sup>

†Apostolopoulos et al 2018 <sup>22</sup>, Apostolopoulos et al 2018 <sup>23</sup>

‡Atkinson et al 2017 <sup>31</sup>, Atkinson et al 2018 <sup>28</sup>, Atkinson et al 2018 <sup>87</sup>, Freebairn et al 2017 <sup>89</sup>, Freebairn et al 2018 <sup>88</sup>, O'Donnell et al 2017 <sup>90</sup>

§Clapp et al 2018 <sup>99</sup>, Giraldo et al 2017 <sup>59</sup>, Gonzalez Villasanti et al 2020 <sup>73</sup>

¶Fitzpatrick and Martinez 2012 <sup>43</sup>, Fitzpatrick et al 2015 <sup>64</sup>, Fitzpatrick et al 2016 <sup>58</sup>

#Mubayi et al 2010 <sup>68</sup>, Mubayi et al 2011 <sup>66</sup>, Mubayi and Greenwood 2013 <sup>67</sup>

\*\*Probst et al 2020 <sup>10</sup>, Vu et al 2020 <sup>76</sup>, Vu et al 2020 <sup>75</sup>

††Scott et al 2016 <sup>78</sup>, Scott et al 2016 <sup>84</sup>, Scott et al 2017 <sup>83</sup>

**Table 3: Main theories in theory-led approaches**

Theory	Description	Application of theory in alcohol-harm prevention research
<b>Systems theory</b>	A system is made up of interconnected elements bounded in some way within a broader context. Systems theory emphasises the relationships between elements and understanding how different parts of the system interact and influence one another <sup>36,128</sup> .	<p>Argument for systems-thinking lens in prevention and treatment efforts <sup>71,108,109</sup>.</p> <p>Development of specific systems-informed approaches to interventions and programmes <sup>57,71,85,113,117</sup>.</p> <p>Systems approach to drug and alcohol workforce development <sup>106</sup> and practitioner guidelines <sup>102</sup>.</p> <p>Systems theory used to inform analytical framework <sup>80,112,117,118</sup>.</p>
<b>Complex adaptive systems and complexity theory</b>	A complex adaptive system (CAS) is made up of elements who interact with each other over time, without a central organising authority, to generate behaviour at the system level that cannot be reduced to the actions of individual actors. Relationships within a CAS are non-linear and may be unpredictable, as elements and the system adapt and co-evolve in response to internal and external stimuli; responses within the system may amplify or dampen system changes, depending on the system's capacity to absorb or respond to change <sup>129-132</sup> . Complexity theory is "the interdisciplinary understanding of reality as composed of complex open systems with emergent properties and transformational potential" <sup>133 p.97</sup> .	<p>Argument for use of complex systems lens in alcohol-harm prevention research and practice <sup>24,70</sup> and development of a complex systems model of alcohol use and associated harms <sup>49</sup>.</p> <p>Complex adaptive systems used as an analytical lens, drawing on theory to visualise the system structure, represent causal pathways and feedback loops and identify possible intervention points <sup>29,93,121</sup>.</p> <p>Use of complexity theory to inform sampling strategy, data collection methods and/or analysis <sup>79,82,86,95</sup>.</p>
<b>Ecological systems theories</b>	Ecological systems theories emphasises the wider influences – operating at different systemic levels - on an individual's behaviour and their health <sup>134</sup> . Within alcohol harm prevention research, used to understand the contexts that influence drinking and associated harms <sup>51,103</sup> .	<p>Theoretical lens used to situate and understand influences on young people's drinking behaviour in college students <sup>50</sup>, South African female adolescents <sup>115</sup>, Asian American <sup>72</sup>, South Korean <sup>120</sup>, Mexican American <sup>69</sup> and American adolescents <sup>54</sup>.</p> <p>Theoretical lens to develop a behavioural ecological model for alcohol consumption <sup>49</sup> and developmental ecological model of alcoholism <sup>110</sup>.</p> <p>Theoretical framework to inform social workers' development <sup>94</sup>.</p>
<b>Niche theory</b> <b>Assortative drinking</b>	<p>Niche theory explains how specialist markets emerge; consumers have different types of demands and in response, the market diversifies and segments, creating niche markets for different consumer bases <sup>103</sup>.</p> <p>Assortative drinking highlights the phenomena that individuals tend to drink with people similar to themselves and visit establishments with clientele that resemble them <sup>103</sup>.</p>	Niche theory and the concept of assortative drinking used to explain and make sense of the association between environmental characteristics and alcohol consumption and related harms in a social-ecological model <sup>51,103</sup> .
<b>Family systems theory</b>	Families are viewed as a system and the theory gives special consideration to how the individual family members interact and	To explore adolescent alcohol use in the context of their parents' substance misuse <sup>56</sup> or in relation to family cohesion and emotion distress <sup>55</sup> .

Theory	Description	Application of theory in alcohol-harm prevention research
	relate to each other with a key assumption that family members are interdependent and influence each other <sup>135,136</sup> .	<p>To make sense of substance misuse by parents and its effect on the family's general well-being <sup>114</sup>.</p> <p>To create a theoretical mode of adolescent alcohol use and test it using empirical data <sup>52</sup>.</p> <p>Along with attachment theory, to generate predictor variables in order to understand differences in alcohol addiction amongst American Indian adoptees compares to white adoptees <sup>53</sup>.</p>
<b>Theories of practice</b>	Emphasises the shared group practices in which people engage. These practices are embedded in daily life and are generally stable. In order to create change within the system, normal routines need to be disrupted <sup>105,137</sup> .	Argument for the use of the theories of practice to better understand alcohol consumption trends and design more effective interventions, moving away from theories of individual behaviour change. <sup>105</sup> .
<b>Information theory</b>	Information theory is used to understand how much and in what ways information is stored and communicated. A key concept is entropy <sup>47,138</sup> .	To explore how alcohol regulations and driving laws in one state influence neighbouring states in the United States <sup>47</sup> .

**Table 4: Study characteristics; social network systematic reviews**

<b>Study</b>	<b>Aim</b>	<b>Search dates</b>	<b>Countries. (Population). Alcohol topic</b>	<b>System level(s)</b>	<b>Method. (Data sources)</b>	<b>System modifications examined</b>	<b>Types of findings</b>
Henneberger et al 2020 <sup>39</sup> <i>Peer influence and adolescent substance use: a systematic review of dynamic social network research</i>	To systematically review the extent to which the emerging body of empirical research applying stochastic actor-based models supports the association between peer selection and socialization and adolescent substance use.	No restriction	US, Italy Finland, Netherlands, UK. (Adolescents; 10-18). Alcohol use, tobacco use, drug use.	Sub-local	Stochastic actor-based models. (Longitudinal survey data)	None	Association between peer selection and socialisation and adolescent alcohol use
Knox et al 2019 <sup>40</sup> <i>Using social network analysis to examine alcohol use among adults: A systematic review</i>	To review empirical studies that used social network analysis to assess the influence of social network characteristics on drinking behaviours in adults.	Up to March 2019	US, Germany, Belgium, Netherlands, South Africa (Adults, majority young adults and university students). Alcohol consumption	Sub-local	Social network analyses. (Cross sectional and longitudinal survey data)	None	Association of social network characteristics with alcohol consumption
Montgomery et al 2020 <sup>38</sup> <i>Peer social network processes and adolescent health behaviors: a systematic review</i>	To review studies that investigated the association between peer network processes and health behaviours in adolescents, particularly in relation to the extent to which specific network processes were observed across common adolescent health behaviours.	Up to October 2018	US, Italy, Finland, Taiwan, Indonesia. (Adolescents; 13-18) Adolescent drinking and adolescent drinking and smoking	Sub-local	Social network analyses. (Cross sectional and longitudinal survey data)	None	Social network predictors of drinking and drinking and smoking behaviours in adolescents

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## Chapter 5: Research paper: Qualitative process evaluation from a complex systems perspective: a systematic review and framework for public health evaluators

### 5.1 Introduction

In this chapter I present my third research paper which was published in *PloS Medicine* (1). The article is open access and, in accordance with the terms of the Creative Common Attribution Licence, it may be reproduced in this thesis (2). I conducted this work concurrently to the scoping review presented in the previous chapter. At the time, public health researchers were increasingly advocating for the application of complex systems thinking to public health research and evaluation (3), but there was a growing recognition that the methods for doing so, particularly those distinct from simulation modelling, were poorly described and under-developed (4,5). To address this gap, I first conducted a systematic review of process evaluations from a complex systems perspective and analysed how each of the identified studies operationalised concepts from systems thinking and complexity science to inform the evaluative process. Then, drawing on the identified studies and broader complex systems literature, I developed a two-phase framework for qualitative process evaluation from a complex systems perspective. Collectively, this paper addresses two objectives of this PhD research programme: Objective 3: to identify and appraise process evaluations of public health interventions that utilise qualitative methods and apply a complex systems perspective; and Objective 4: to develop a methodological framework for process evaluation from a complex systems perspective. The article's online supplementary material, which includes the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist, example search strategy and two case study examples illustrating the systems thinking and complexity science traditions, can be found in Appendix E.

Following the development of the framework, I then sought to apply it to a process evaluation of a local alcohol intervention: the Late Night Levy (LNL). The LNL process evaluation is described in Chapter 6.

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## RESEARCH PAPER COVER SHEET

Please note that a cover sheet must be completed for each research paper included within a thesis.

### SECTION A – Student Details

Student ID Number	305848	Title	Ms
First Name(s)	Elizabeth Tyner		
Surname/Family Name	McGill		
Thesis Title	Evaluating local-level interventions to address alcohol-related harms in England: the development and application of a complex systems perspective to process evaluations		
Primary Supervisor	Professor Matt Egan		

If the Research Paper has previously been published please complete Section B, if not please move to Section C.

### SECTION B – Paper already published

Where was the work published?	PLoS Medicine		
When was the work published?	November 2020		
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion			
Have you retained the copyright for the work?*	No	Was the work subject to academic peer review?	Yes

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### **SECTION D – Multi-authored work**

<p>For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)</p>	<p>Conceived and designed the study; executed the search strategy; screened and selected studies for inclusion (VE, TP or ME conducted independent full text screening); extracted data on all included studies (VE or TP double checked extraction); critically appraised all included studies (DM or ME conducted independent critical appraisal); conducted the synthesis; developed the evaluative framework; drafted the manuscript; and critically revised the manuscript (with input from all co-authors). ME, DM and MP provided supervision.</p>
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### **SECTION E**

<b>Student Signature</b>	Elizabeth McGill
<b>Date</b>	26/02/2021

<b>Supervisor Signature</b>	MATT EGAN
<b>Date</b>	26.02.21

## RESEARCH ARTICLE

# Qualitative process evaluation from a complex systems perspective: A systematic review and framework for public health evaluators

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**Data Availability Statement:** Data were extracted from the primary studies, all of which are published and are listed in [Table 1](#).

## Abstract

### Background

Public health evaluation methods have been criticized for being overly reductionist and failing to generate suitable evidence for public health decision-making. A “complex systems approach” has been advocated to account for real world complexity. Qualitative methods may be well suited to understanding change in complex social environments, but guidance on applying a complex systems approach to inform qualitative research remains limited and underdeveloped. This systematic review aims to analyze published examples of process evaluations that utilize qualitative methods that involve a complex systems perspective and proposes a framework for qualitative complex system process evaluations.

### Methods and findings

We conducted a systematic search to identify complex system process evaluations that involve qualitative methods by searching electronic databases from January 1, 2014–September 30, 2019 (Scopus, MEDLINE, Web of Science), citation searching, and expert consultations. Process evaluations were included if they self-identified as taking a systems- or complexity-oriented approach, integrated qualitative methods, reported empirical findings, and evaluated public health interventions. Two reviewers independently assessed each study to identify concepts associated with the systems thinking and complexity science traditions. Twenty-one unique studies were identified evaluating a wide range of public health interventions in, for example, urban planning, sexual health, violence prevention, substance use, and community transformation. Evaluations were conducted in settings such as schools, workplaces, and neighborhoods in 13 different countries (9 high-income and 4 middle-income). All reported some utilization of complex systems concepts in the analysis of qualitative data. In 14 evaluations, the consideration of complex systems influenced

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intervention design, evaluation planning, or fieldwork. The identified studies used systems concepts to depict and describe a system at one point in time. Only 4 evaluations explicitly utilized a range of complexity concepts to assess changes within the system resulting from, or co-occurring with, intervention implementation over time. Limitations to our approach are including only English-language papers, reliance on study authors reporting their utilization of complex systems concepts, and subjective judgment from the reviewers relating to which concepts featured in each study.

## Conclusion

This study found no consensus on what bringing a complex systems perspective to public health process evaluations with qualitative methods looks like in practice and that many studies of this nature describe static systems at a single time point. We suggest future studies use a 2-phase framework for qualitative process evaluations that seek to assess changes over time from a complex systems perspective. The first phase involves producing a description of the system and identifying hypotheses about how the system may change in response to the intervention. The second phase involves following the pathway of emergent findings in an adaptive evaluation approach.

## Author summary

### Why was this study done?

- Process evaluations are used in public health to understand how and why an intervention works (or does not work), for which population groups, and in which settings.
- Process evaluations often use qualitative methods—such as interviewing people and observing people in their daily and work routines—in order to draw their conclusions.
- Researchers in public health have contended that we need to do research in a manner that considers the broader system in which policies and interventions take place—something we call a “complex systems perspective.”
- To date and to our knowledge, there is no specific framework that describes how researchers can use a complex systems perspective when they conduct a process evaluation with qualitative methods.

### What did the researchers do and find?

- We conducted a systematic literature review that looked for examples of qualitative process evaluations that self-identify as using a complex systems perspective to evaluate public health interventions.
- We found 21 different evaluations of many different types of public health interventions, including interventions to address student and employee health, sexual health, child development and safety, community empowerment, violence prevention, and substance use.

- We found that these evaluations describe the systems in which public health efforts take place but are less effective at analyzing how changes affecting health occur within these systems.

### What do these findings mean?

- There is little evidence of a commonly shared understanding of how best to bring a complex systems perspective to process evaluations using qualitative methods, particularly, how to assess how interventions interact with a changing system.
- We developed a 2-phase framework to guide researchers who want to apply a complex systems perspective to qualitative process evaluations.
- This review excluded studies that do not self-identify as using a complex systems perspective so we may have missed literature that uses this perspective but not the associated terminology.

## Introduction

There has been a growing call [1] for the application of complex systems approaches to intervention planning, service delivery, and evaluation in order to aid understandings of intervention implementation and impacts in real-world environments [2–4]. Complex systems have been framed as a kind of antidote to reductionist approaches to health research [5]. Finding ways to bring a complex systems perspective to public health evaluation could, it is hoped, shed new light on how to address public health challenges in a complex world. A complex systems perspective can be applied to many different types of research design and methodology. In this paper, we focus on how such a perspective has been applied to process evaluations that utilize qualitative methods. The remainder of this section elaborates on what is meant by complex systems and process evaluations and discusses why qualitative methods are a particular area of interest for public health evaluators interested in complex systems.

## Complex systems

Systems are combinations of elements that interact. A distinction is often made between “complex” systems and systems that are “simple” or “complicated” [6–8]. What make complex systems unique are a number of attributes, including nonlinearity, their dynamic and unpredictable nature, and the ways in which they co-evolve with their environment and produce emergent outcomes [9–11]. Elements within a complex system (for example, individuals, organizations, activities, and environmental characteristics) interact with each other and are connected in nonlinear ways [6,12–14]. Over time, the behavior of system elements leads the individual elements and the system as a whole to adapt and co-evolve with the broader environment—that is, the system is dynamic [6,7, 12,13]. There may or may not be a central authority within the system, such as a president, local authority, or management team, but a complex system is assumed to adapt and behave in ways that cannot be reduced to simple, organizational hierarchies. Because of this, a complex system and its elements are considered to be self-organizing [6]. The individual interactions among system elements collectively

generate emergent, system-level behavior wherein the system displays attributes that cannot be reduced to its individual parts [2,6,12,15].

Research into complex systems takes place across academic disciplines and has roots in both *systems thinking* and *complexity science*. Although often grouped together because of some conceptual similarities, systems thinking and complexity science can be considered as distinct yet overlapping traditions [16,17]. Systems thinking may be best described as an orientation that prompts researchers to take a holistic, rather than reductionist view, of phenomena and study them in the context of their real-world systems that are open to and interact with surrounding systems. Systems thinking draws on theories, concepts, and methods from a range of disciplinary fields [18]. Complexity science, on the other hand, is more strongly rooted in the mathematical sciences and has drawn on complexity theory, which emphasizes uncertainty and nonlinearity, to create and refine specific methodological approaches to modeling complex systems in order to estimate and predict their emergent behavior over time. Systems thinking prompts researchers and practitioners to consider the boundaries of the system they are studying or in which they are working [19] and places an emphasis on the interactions and relationships between system elements and the system with its broader environment [1,6]. Further applying concepts from complexity science prompts a consideration of how those interactions create nonlinear chains of cause and effect, are unpredictable, unfold over time, and give rise to system-level emergent outcomes [20].

Complexity has been part of the vocabulary of public health evaluators for decades [16,21]. However, public health evaluations have tended to focus on the complexity of interventions rather than of the systems within which interventions are implemented [22]. A “complex intervention” is one that has a number of interacting parts, targets different organizational levels or groups of people, and aims to affect a number of outcomes [16,17]. In contrast, a complex systems perspective considers complexity as an attribute of the system. The intervention itself may also be complex, for example, a coordinated program of interventions that affect different parts of a system. However, simple interventions can also be theorized to have complex consequences if they are implemented within and interact with a complex system. For example, a single change in a law affecting the price of products that affect health (such as an alcohol or sugar sweetened beverage tax) can be described as an (initially) simple intervention that quickly becomes connected to a complex chain of interactions between industry, retailers, public opinion, consumer behavior, media and policy—each of which may have an impact on future implementation and effects of the intervention itself [15,23]. The way a complex system responds to an intervention may lead to emergent consequences that could amplify or dampen the intervention’s impacts, change the characteristics and behavior of the system over time, and affect future decision-making [15,24]. From a complex systems perspective, the role of the evaluator is to make sense of the interplay between the complex system and the (simple or complex) intervention to help explain health and other impacts and inform future decisions about implementation [1].

## Process evaluations and qualitative methods

Traditional evaluations of simple or complex public health interventions often focus on measuring impacts on a single (or small number) of prespecified health and health-related outcomes [10]. However, impact evaluations alone offer little opportunity to explore the mechanisms behind an intervention’s success or failure, particularly when impacts are unevenly distributed among different population groups. For this reason, other forms of evaluation, particularly process evaluation, have been developed and utilized in order to understand intervention implementation and the mechanisms by which interventions may lead to impacts

across a population [17,25]. There is no single definition of a process evaluation, but the Medical Research Council's (MRC) Guidance on Process Evaluations of Complex Interventions argues they "can be used to assess fidelity and quality of implementation, clarify causal mechanisms, and identify contextual factors associated with variation in outcomes" [26 p. 30]. A process evaluation is often, although not always, conducted alongside an outcome or impact evaluation that quantifies the impact of an intervention on a range of outcomes [16].

Process evaluations of public health interventions may benefit from an explicit adoption of a complex systems perspective. The application of systems thinking and insights from the complexity sciences can provide a means through which to evaluate and understand the non-linear ways in which interventions may lead to a number of impacts within a system. This could include impacts considered to be of interest when the evaluation is initially planned and impacts that emerge as potentially important as the evaluation progresses. By bringing an explicitly relational focus to the evaluation design and placing the wider context in the foreground of the analysis [24], a complex system approach to a process evaluation may help to make sense of intervention mechanisms within a real-world context. An explicit complex systems perspective may also help evaluators construct a narrative that explores the trajectory of a given system. This could include considering how the intervention acts as an event that prompts a series of changes in the way a complex system behaves [15]. Furthermore, it could include consideration of how the intervention itself changes, as system elements and the system as a whole adapt and respond to it [15,24].

Although process evaluations can include quantitative assessments of intervention outputs, they typically draw on a range of qualitative methods. Qualitative methods are well suited for unpacking complex causal chains, understanding changes in implementation, representing varying experiences of the intervention, and generating new theories to inform future decision-making [17]. Proponents of explicitly using complexity theory within qualitative designs argue doing so "has potential to capture and understand complex dynamics that might otherwise be unexplored" [27 p. 3]. Bringing a complex systems perspective to a qualitative process evaluation could have a range of methodological implications. For example, it could involve mapping the system of interest, a sampling strategy that seeks to recruit participants relevant to different parts of that system, a form of data collection geared towards assessing relationships within a system, and an analysis framework that incorporates concepts drawn from systems thinking and complexity science.

There is a large body of literature on quantitative methods for complex systems approaches and some examples of such methods being applied to the study of policies and interventions that may affect population health [28–33]. Many of these approaches build simulation models that estimate and predict the impact of interventions on outcomes of interest [34]. These approaches have been developed within the complexity sciences and include methods such as system dynamics modeling, microsimulation modeling, and agent-based modeling [3,20,35,36]. Although these methods may begin with some qualitative work, such as participatory workshops to map a system of interest, their aim is to generate quantitative estimates of future or hypothetical impacts [31]. Compared with quantitative methods, there is little consensus, and less has been written on how to explicitly draw on a complex systems approach for process evaluations that use qualitative methods. This represents an underdeveloped area for complex systems evaluation.

This systematic review therefore aimed to identify the concepts and methods currently used in public health evaluations that apply a complex systems perspective to process evaluations involving qualitative methods. Specifically, this review sought to answer 3 research questions: (1) What types of public health interventions have been subjected to process evaluations that use qualitative methods and apply a complex systems perspective? (2) What are the qualitative

methods used in this body of literature? (3) What concepts and theories associated with complex systems are used in process evaluations that use qualitative methods? Drawing on this body of literature, we then had a secondary aim of developing a framework for qualitative process evaluation from a complex systems perspective. We sought to develop an evaluative framework that researchers (working in academic or practice settings) can use as an overarching structure to guide evaluative efforts [37]. In our Discussion section, we therefore present our framework and provide some guidance for researchers on the potential role of qualitative data in identifying and understanding aspects of complexity within process evaluations.

## Methods

### Data sources and screening

Relevant process evaluations were identified through several different search methods. First, we conducted an expert consultation whereby we contacted 32 academics with an interest or experience in complex systems thinking and its application to public health and asked them to identify any relevant examples of complex systems evaluations. The academics were identified through an ongoing familiarization with the literature on complex systems and public health, as well as through our own professional networks. In the original consultation, we did not request permission to be named, but those who did provide permission during the review process are named in the Acknowledgments. We then identified 2 relevant systematic reviews on systems thinking and public health [35] and complexity theory applied to evaluation [20]. From the studies identified in these reviews, we selected evaluations that met our inclusion criteria (next). Finally, we conducted an electronic search covering January 1, 2014–September 30, 2019 using 3 databases: Scopus, Medline, and Web of Science. The search dates were set to capture evaluations published after the 2 systematic reviews. The electronic search strategy included terms and synonyms for systems thinking, complexity science, evaluation, and public health and was restricted to English-language publications. An example of the full search strategy can be found in [S1 Text](#). This study is reported as per the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline ([S1 PRISMA Checklist](#)).

Titles and abstracts were screened initially by one reviewer, and all potentially relevant studies were independently screened by 2 reviewers. In cases in which a decision was not clear cut, or the reviewers disagreed, a discussion was held with a third reviewer. The review had 4 inclusion criteria, which we describe in more detail next. In brief, studies were included in the review if they (1) self-identified as taking a systems- or complexity-informed approach; (2) were relevant to public health; (3) were process evaluations of interventions with empirical findings; and (4) utilized qualitative methods.

Studies were eligible for inclusion if they self-identified as using a systems and/or complexity perspective at any stage of the evaluative process, including during the design, data collection, analysis, or interpretation phases. We took a broad view of public health to include upstream determinants of population health, which include alcohol, the built environment, community health, community safety, education, employment, environmental health, food, health promotion, housing, illicit substances, obesity, policing, regeneration, sexual health, social welfare, tobacco, trading standards, transport, and urban planning. Studies that covered topics not included in the aforementioned list were considered if they concerned population health; decisions in these instances were made between 3 reviewers. Studies concerning treatment in health service settings were excluded. Studies were only included if they reported empirical findings of a process evaluation; protocols and discussion pieces describing evaluations without presenting results were excluded. Process evaluations alongside outcome evaluations were eligible for inclusion, although our analysis focused solely on the process evaluation

component. Finally, studies were eligible for inclusion if they used qualitative methods, which included interviews, group interviews or focus group discussions, (participant) observation, document review, free form responses on questionnaires, and participatory and visual methods, including for example, mapping workshops and photography. Evaluations employing mixed methods (wherein qualitative data were integrated into the assessment of the intervention alongside other methods) were included, as long as there was a substantive component that generated and analyzed qualitative data. To operationalize this criterion, we considered the ways in which the mixed methods research was designed, and we included studies that generated qualitative and quantitative data concurrently to evaluate an intervention (*triangulation design*); studies in which the researchers primarily utilized a qualitative design with some supporting quantitative output or outcome data (*embedded design*); studies in which the qualitative data were used to make sense of intervention outcomes (*explanatory design*); or studies in which qualitative research was used to generate hypotheses about the intervention that could be tested quantitatively (*exploratory design*) [26,38]. Studies utilizing these mixed method designs were eligible for inclusion even if the authors did not label the design or describe the rationale for the chosen approach. A substantive qualitative component referred to the authors both describing the qualitative methods, including data collection and analysis, as well as presenting qualitative data. Covidence software was used to help facilitate the screening process [39].

### Data extraction and synthesis

The analysis began with an in-depth reading of, and familiarization with, the included studies, with specific attention paid to the ways in which they drew on systems thinking and/or complexity science and the methods utilized to achieve their evaluative aims. Data were extracted on each study using a template designed for this review. Specifically, data on the study's research question, public health area, country, intervention, the application of complex systems thinking, the methods and analytical approach, and system map (if presented) were extracted (see Table 1). The "complex systems perspective and evaluation stage" column shows how systems thinking and/or complexity science featured in each evaluation and at which stage in the evaluation (i.e., design, data collection, analysis). The system map column reports the studies that included a map of the system and describes what the map detailed. If the evaluators published a logic model, it is noted in this column. Where studies gave rise to more than one publication, we considered them "linked" and extracted data from across the identified studies. The data extraction process was completed by one reviewer and double checked by a second.

Alongside the data extraction process, a list of concepts from systems thinking and complexity science was generated through an ongoing familiarization with these bodies of literature. A number of papers and books that are frequently referenced within the public health literature on complex systems were selected during this familiarization period [1,6,7,9,12,15,22,40], and from this, a master list of systems and complexity terms was generated. Our aim was that this list captured the key principles associated with each of the traditions and could be used by those wishing to gain a familiarization with systems thinking and complexity science. We found that not all authors describe the same concepts within these traditions and they often use different language. As a result, there was a subjective element to generating the list with the research team making choices about which concepts to feature and how to define them. In particular, although many authors describe "context" as a key systems thinking concept, and we initially also included it in our list, we ultimately chose to exclude it due to its substantial overlap with many other concepts. "Context" describes the factors in the

Table 1. Characteristics of the included studies.

Study	Aim	Public health area	Country	Complex systems perspective and evaluation stage	Qualitative methods	System map
Alfandari 2017 [43], Alfandari 2019 [44]	To qualitatively evaluate the extent to which a national reform in Israeli child protection decision-making committees strengthened professional judgment through introducing a new standard tools package into practice.	Social work	Israel	Systems approach utilized as a conceptual framework to inform design and analysis	Observations, semi-structured interviews, and review of case records and reports.	None
Bartelink and colleagues 2018 [47], Bartelink and colleagues 2019 [46]	To explore the processes through which HPSF and the school context adapt to one another in order to generate and share knowledge and experiences on how to implement changes in the complex school system to integrate school health promotion.	School health	Netherlands	Systems concepts informed research questions, program theory, data collection methods and analysis	Interviews, observations, document review, and informal conversations.	Bespoke system diagram depicting the program theory
Burman and Aphane 2016 [48]	To use the Cynefin framework to situate emergent knowledge action spaces into appropriate decision-making domains, to inform subsequent phases of a bio-social HIV/AIDS risk reduction project.	School health, sexual health	South Africa	Cynefin framework used to guide the analysis and further intervention development	Group exercise and semi-structured group interviews.	Cynefin framework diagram
Crane and colleagues 2019 [51,52]	To describe and apply a pragmatic approach to evaluating the Get Healthy at Work initiative in New South Wales, Australia.	Workplace health	Australia	Systems thinking informed evaluation design, research questions and analysis	Focus groups, in-depth interviews, and observations.	Bespoke system diagram depicting program implementation levels and interaction points and program implementation cycle
Czaja and colleagues 2016 [53]	To use a systems engineering approach to identify the requirements for implementing community programs to prevent drug or HIV sex risk behaviors.	Sexual health, substance use	United States	Used systems engineering approach to develop research questions and inform analysis	In-depth interviews.	Bespoke system diagram of system elements and levels
Dickson-Gomez and colleagues 2018 [54]	To examine the implementation of a national HIV combination prevention strategy in El Salvador funded by the Global Fund to Fight AIDS, tuberculosis and malaria.	Sexual health	El Salvador	Used a “dynamic systems framework” to analyze data	In-depth interviews.	Bespoke system diagram with elements and linkages
Durie and Wyatt 2013 [42]	To evaluate a learning program designed to create transformational community change.	Community empowerment and transformation	United Kingdom (England)	Complexity theory informed intervention and evaluation design, including research questions, sampling strategy and analysis	Semi-structured interviews, nonparticipant observation, and community sessions.	None
Evans and colleagues 2015 [49]	To use a formative process evaluation to examine how a school-based intervention aimed at improving children and young people’s social and emotional competencies moved through different phases of innovation within the complex school system.	School health	United Kingdom (Wales)	Diffusion of innovation theory applied as theoretical framework in data collection and analysis stages	Semi-structured interviews and observations.	None
Figuerio and colleagues 2016 [55]	To describe the development and proof of concept process of the critical event card analytical tool and to apply it to the development of leisure infrastructure in a poor urban environment.	Health equity policy Physical activity	Brazil	Drew on actor-network theory and applied the “critical event card” as an analytical tool to situate intervention within a complex system	Study seminar to create critical event timelines, interviews, and document review.	Bespoke timeline of critical events with interactions between components

(Continued)

Table 1. (Continued)

Study	Aim	Public health area	Country	Complex systems perspective and evaluation stage	Qualitative methods	System map
Fisher and colleagues 2014 [57]	To assess the extent to which an alliance of health and human service networks was able to promote effective action on the social determinants in an Australian urban region.	Urban planning	Australia	Complex systems perspective applied to data collection tools, analysis and interpretation of findings	Questionnaire, short interviews, and semi-structured interviews.	Bespoke system diagram showing interaction of factors across and within levels of the system
Haggard and colleagues 2015 [59]	To identify factors that either promote or hinder implementation of a multicomponent "Responsible Beverage Service" program in Swedish municipalities.	Substance use	Sweden	Systems thinking informed intervention; applied The Consolidated Framework for Implementation Research (with systemic components) to analysis	Semi-structured interviews.	None
Kearney and colleagues 2016 [65]	To evaluate how multiple system layers interact and influence each other within a gender-based violence prevention program in schools and explore how the evaluation further affected program implementation.	Violence prevention	Australia	Whole system approach informed intervention; applied conceptual approaches from systems science to guide data collection and analysis	Focus groups, interviews, and audit tool.	None
Knai and colleagues 2018 [63]	To use a systems approach to make sense of the evaluative findings on the UK's Responsibility Deal in order to explore why the initiative did not reach its objectives.	Public-private partnership for health	United Kingdom (England)	Systems approach applied to the integration and analysis of data from several independent, but linked evaluation strands	Literature review, interviews, organizational case studies, document review, media analysis, and analysis of pledges.	Causal-loop diagram Logic model
McGill and colleagues 2016 [60], Sumpter and colleagues 2016 [61]	To determine how a systems perspective can be used to explore the intervention's intended and unintended consequences within the local system and the effect of the intervention on alcohol availability.	Substance use	United Kingdom (England)	Systems perspective informed evaluation design and sampling strategy; complexity concepts used to generate research questions and structure analyses	Interviews, focus group, and local authority audits.	Bespoke system diagrams showing possible pathways to impact
Orton and colleagues 2017 [64]	To assess how a systems approach can be used to help understand how change processes that emerge as area-based empowerment initiatives embed and co-evolve within a series of local contexts.	Community empowerment and transformation	United Kingdom (England)	Systems approach used to inform sampling strategy and to inform analysis	Document review, interviews, observations, group exercises, focus groups, and participatory mapping.	None
Pérez-Escamilla and colleagues 2018 [62]	To examine the process of scaling up 3 major country-level early childhood development programs through the application of a "complex adaptive systems" framework.	Child development	Chile, India, South Africa	Used complex adaptive system constructs to develop data collection tool and used framework to guide the analysis	In-depth interviews and document review.	None
Rothwell and colleagues 2010 [41]	To assess the implementation of the WNHSS at national, local, and school levels, using a systems approach drawing on the Ottawa Charter.	School health	United Kingdom (Wales)	Intervention and setting conceptualized as complex adaptive system; socio-ecological model used to guide design, sampling strategy and analysis of findings	Document review, interviews, workshops, and observations.	Bespoke system diagram of the system structure
Schelbe and colleagues 2018 [45]	To describe the application of systems theory as a framework for examining a college campus-based support program for former foster youth.	Social work	United States	Applied systems theory to evaluation design and analysis and interpretation of findings	In-depth interviews and member checking.	None

(Continued)

Table 1. (Continued)

Study	Aim	Public health area	Country	Complex systems perspective and evaluation stage	Qualitative methods	System map
Shankardass and colleagues 2018 [56]	To present a systems framework to evaluate the implementation of Health in All Policies initiatives and to apply the framework to a case study of the Finnish policy "Health 2015."	Health equity policy Substance use	Finland	Applied a framework informed by systems thinking and realism to the analysis of data	Literature review and interviews.	Bespoke system diagram of the system structure
van Twist and colleagues 2015 [58]	To use a case of urban regeneration projects in the Netherlands to account for the "by-effects" of policy.	Urban planning	Netherlands	Developed framework informed by a complexity concept ("by-effects") which informed data collection methods and was used to structure analysis	Narrative interviews.	None
Walton 2016 [50]	To retrospectively explore the extent to which complexity concepts were applied in an evaluation of a school health promotion intervention.	School health	New Zealand	Applied complexity frame of reference to previous evaluation findings	Document review and key informant interviews.	None

HPSF, Healthy Primary School of the Future; WHNSS, Welsh Network of Healthy School Schemes.

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environment that affect the system, particularly historical, temporal, geographical, political, and social factors [13]. As a result, arguably the entire system represents the "context," and it therefore does not represent a meaningful category when trying to describe and analyze a changing system. In addition, we recognize that there is conceptual overlap between many of the concepts and that the boundaries between them may be somewhat fluid. In the Discussion section a glossary of terms and how they might be applied within a process evaluation using qualitative methods are presented.

### Critical appraisal

No tools exist to assess the quality of process evaluations informed by a complex systems perspective. Therefore, for this review, we critically appraised how systems thinking and complexity science were employed in each paper. Specifically, we assessed the degree to which each study identified through the search strategy described, captured, measured, or applied each concept in a meaningful way. The decisions were depicted using a traffic light color scheme. A green color code was applied when a study explicitly applied a concept at any stage of the evaluation process, including the design and planning stage, data collection, analysis, or interpretation. For example, a study would receive a green code if it explicitly described the boundaries of the system under inquiry at any stage in the evaluation. Evaluators might use the idea of boundaries, for instance, to shape the evaluation scope by designating clear system boundaries to bound the evaluation, or the concept might be applied within the interpretation of the data, to gain, for example, an understanding of how system elements view the boundaries of their own system. A yellow coding represented a study in which there was some attempt to apply a concept, but it was limited or addressed in an implicit manner. A red color code represented instances in which the concept was not utilized. The aim of this appraisal was not to be overly critical about individual studies but rather to understand the ways in which concepts from systems thinking and complexity science are applied in this body of literature. This process required us to make judgments, and in some instances, the decisions were not necessarily clear cut. In order to increase the validity of this process, 2 reviewers (EM and DM; or EM and ME) independently assessed each study, and disagreements were reconciled through discussion.

## Results

### Evaluation characteristics

A total of 21 unique evaluations (in 25 separate publications) were identified (see Fig 1). Their characteristics are presented in Table 1, and in-depth descriptions of 2 evaluations, one rooted in systems thinking [41] and another in complexity science [42], are presented in S2 Text. The in-depth descriptions were written to give clear examples of how these approaches have been

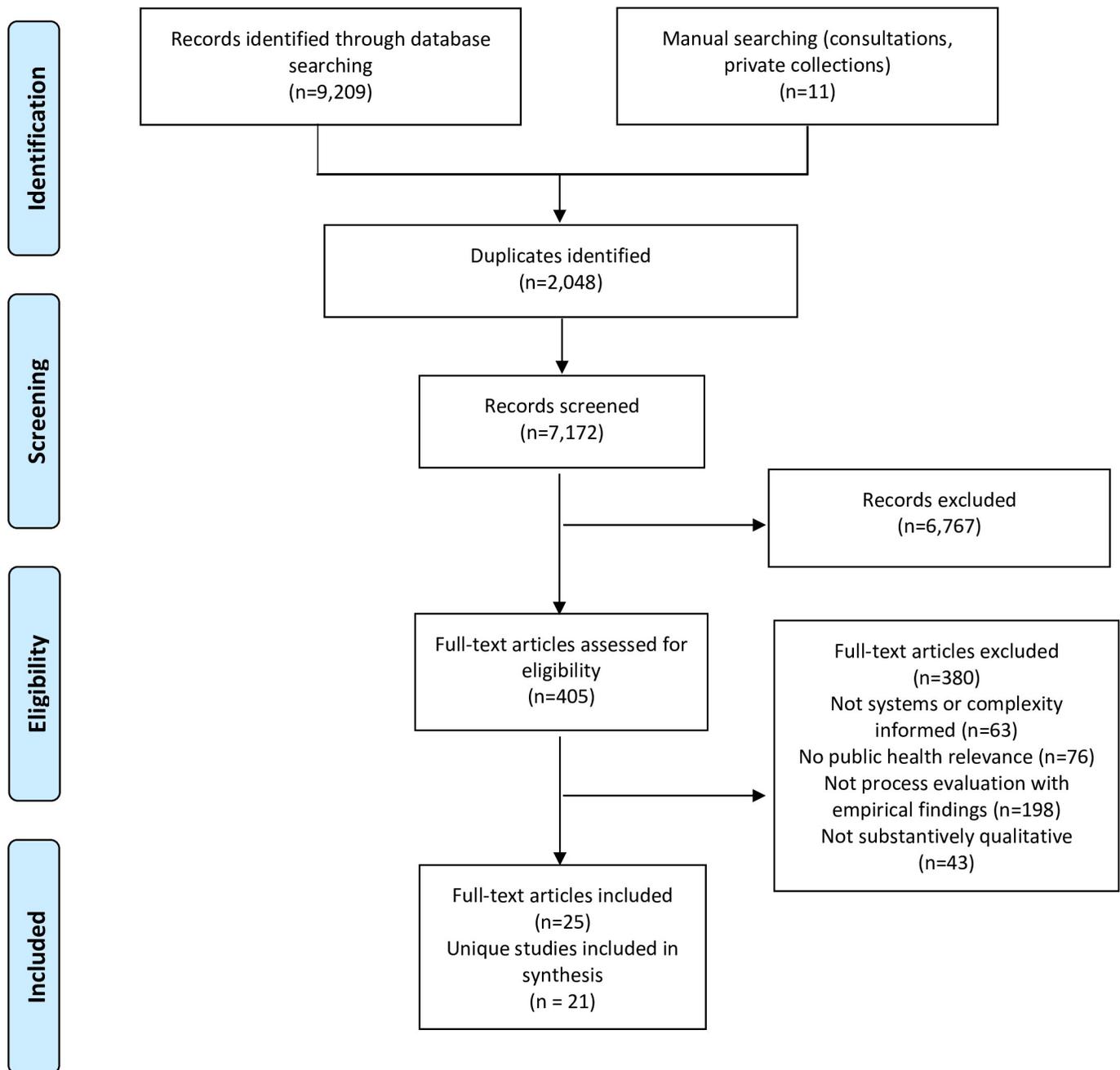


Fig 1. Flow diagram for inclusion of studies.

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applied in practice. A range of public health topics were represented in the sample, including social work [43–45], school health [41,46–50], workplace health [51,52], sexual health [48,53,54], health equity policy [55,56], urban planning [57,58], substance use [53,56,59–61], child development [62], public–private partnerships [63], community empowerment and transformation [42,64], and violence prevention [65]. The studies were conducted in 13 countries, which included 9 high-income and 4 middle-income settings: Australia [51,52,57,65], Brazil [55], Chile [62], El Salvador [54], Finland [56], India [62], Israel [43,44], the Netherlands [46,47,58], New Zealand [50], South Africa [48,62], Sweden [59], the United Kingdom [42,49,60,61,63,64,41], and the United States [45,52].

The primary studies in this review were notable for their diversity in terms of the theories and frameworks used to inform the evaluation design and the focus of the analysis. Prominent theories included explicit applications of complexity theory [42,50,60] and diffusion of innovation theory [49]. Studies also used a number of frameworks to structure the analysis and to draw out evaluative findings. This included existing frameworks such as the Cynefin framework [48], Consolidated Framework for Implementation Research [59], a complex adaptive systems framework [54,62], and the socioecological model [41]. Other evaluations featured bespoke frameworks for analysis, including ones that focused on the role of critical events in an intervention's trajectory [55], a systems framework focusing on governmental subsystems [56], and a framework that was used to identify and categorize different types of “by-effects” or unintended consequences [58].

The process evaluations in this literature base varied in terms of the stage of evaluation planning and conduct in which they drew on complex systems thinking concepts and frameworks. Although the reporting was not always clear, 14 evaluation teams used some facets of systems thinking and complexity science when planning and designing their evaluations [41–47,49,51–53,57,58,60–62,64,65], which ranged from asking systems-oriented research questions to informing the sampling strategy (e.g., a conscious effort to sample different elements or from different levels within the system) and data collection tools (i.e., interview topic guides). Other evaluators used complex systems concepts, theories, or frameworks solely to structure their analyses [48,50,54–56,59,63].

The evaluations identified also drew on a wide range of qualitative methodologies. Ten studies applied a case study design [41–45,50–52,56,60–62,64]. The nature and boundary of a case varied from evaluation to evaluation. Some studies ( $n = 3$ ), for example, defined a case based on geographical boundaries, and each case represented a geographical locality [42,60,61,64]. Other case study examples included individual families [43,44] or schools [41] or the specific application of a policy [56].

Evaluators utilized a number of different methods for data collection, and 13 applied a mixed methods approach, which included using multiple qualitative data collection methods [41–45,48–50,55–58,62,64]. Seven studies employed a mix of qualitative and quantitative methods [46,47,51–53,59–61,63,65], although all of these studies had substantive qualitative findings. Not all evaluators articulated their rationales for choosing and combining certain qualitative methods, but in general, the different methods were employed to access, understand, and analyze different elements, structures, and relationships within the system. For example, speaking to a range of different actors within the system, through interviews (semi-structured, in-depth, or narrative) and focus groups [41–65], was used to assess different perspectives about an intervention, relationships, and theories of change within the broader system and to make sense of system trajectories. Documentary review and analysis were also relatively common, being used in 7 studies [41,43,44,46,47,50,62–64], and a range of documents were reviewed including media reports, community plans, evaluation documents, and case reports. Documents were used to understand intervention development and

implementation and to generate data at different levels within systems, for example, with some evaluators choosing to review national-level documentation and subsequently conduct regional or local-level interviews [41]. Seven of the evaluations identified also conducted both participant and nonparticipant observation, which ranged from observations of meetings to community events [41–44,46,47,49,51,52,64]. In addition to these researcher-led qualitative methods, some evaluators ( $n = 10$ ) utilized more participatory research techniques, including research seminars and workshops, mapping exercises, the creation of intervention timelines, and other types of group exercises [41,42,48,55,64]. Participatory methods were utilized both as a means of bringing in the perspective of those affected directly by the intervention, as well as a method to check and present interim findings.

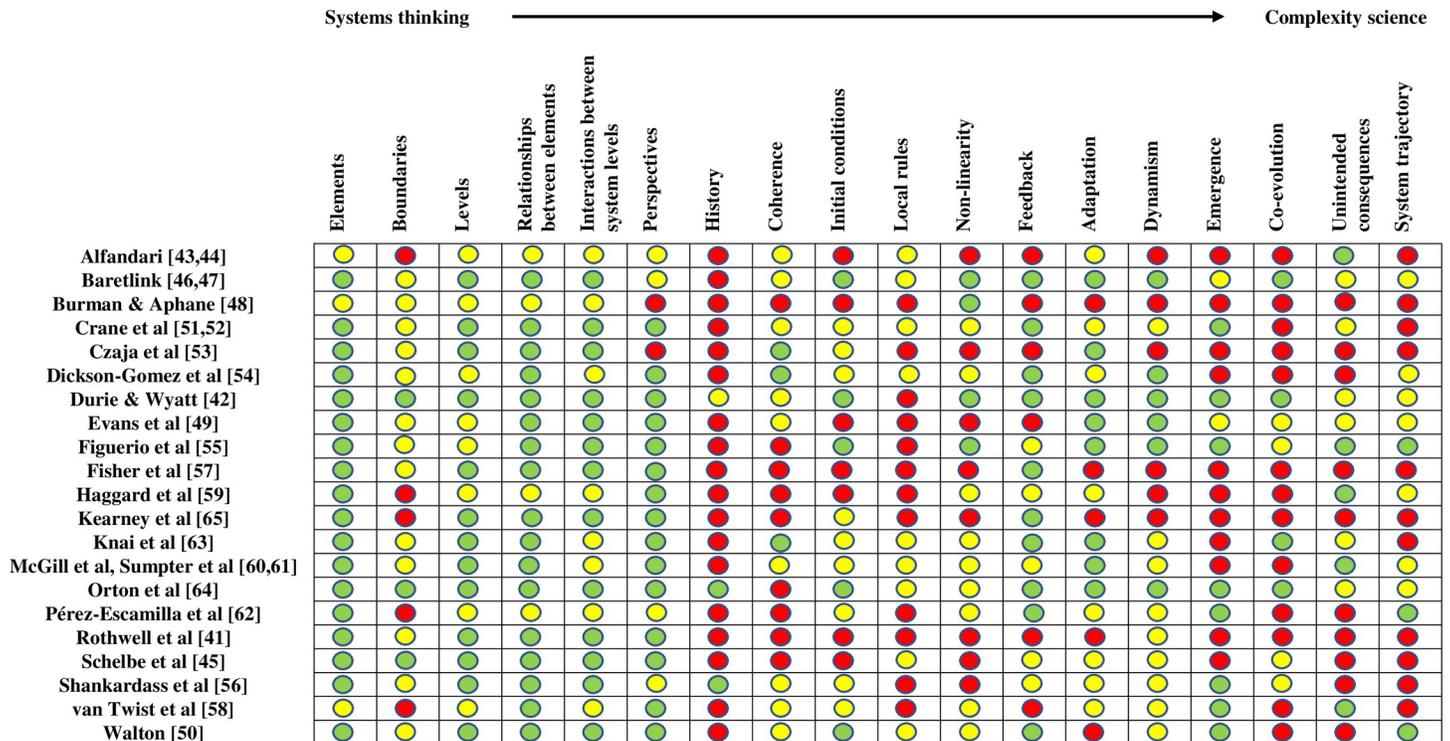
Several of the identified process evaluations were conducted alongside or after impact/outcome evaluations of the same intervention. Knai and colleagues integrated data from several evaluative strands including impact and process evaluations [63]. Five studies reported accompanying outcome evaluations, but those results were not presented alongside the process evaluation reports [43,44, 46,47,59,64]. Three studies presented outcome data alongside their process evaluations [50–52, 60,61]. Finally, 2 papers reported independent outcome evaluations that were not linked to their own process evaluations [49,58].

The identified evaluations varied in the extent to which they produced and utilized system maps; 11 produced system maps of some description [41,46–48,51–57,60,63]; of these, only one used a formal system mapping technique: a causal-loop diagram [63]. The other system maps were bespoke maps that depicted different types of logic models [60,63], maps of the system structure [41,53,54], and maps that showed interactions between system elements [51,54,55,57].

### Application of concepts from systems thinking and complexity science

Evaluations varied in the extent to which they applied concepts from systems thinking and complexity science to their evaluation design or analysis and concepts from systems thinking were utilized to a far greater extent than complexity concepts. Fig 2 shows this using a traffic light coloring scheme. The figure is structured with different concepts from systems thinking and complexity science in each of the columns. The concepts are presented as belonging along a continuum, with systems thinking on the far left-hand side and complexity science on the far right-hand side. Moving along the spectrum, from systems thinking to complexity science, represents a movement from static to dynamic. Key systems thinking concepts, on the left-hand side of the figure, are the structure of a system, its elements, and the relationships between them. Utilizing these allows researchers to create relatively static depictions of a system. Moving toward the middle of the figure, concepts from complexity science are introduced, which include attributes and dimensions of an intervention, and then a system undergoing change. The far right-hand side of the figure includes concepts that feature within the complexity sciences to computationally model complex systems in order to simulate and predict behavior and outcomes and to understand an evolving system.

The evaluations identified in this review consistently applied key concepts from systems thinking: the identification and description of the system structure, including the different system elements and their differing perspectives. Thinking systemically also means making sense of the boundaries of a system and making decisions about what constitutes “the system” and what might be considered within or outside of the system. Although system maps are not a necessary element of systems thinking, they can be helpful for making sense of and depicting system boundaries, as articulated by both those acting within the system (“first-order” boundary judgments) and those studying it (“second-order” boundary judgments) [66]. Few evaluations ( $n = 3$ ) in the sample [42,45,64] had explicit discussions of boundaries and the ways in



**Fig 2. Included studies and the degree to which they apply concepts from systems thinking and complexity science.** Each color-coded circle denotes the degree to which an evaluation applied the associated concept to any stage of the evaluation process. Green: study explicitly applied the concept; yellow: study attempted, or implicitly applied the concept; red: concept was not applied.

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which, or indeed if, boundary judgments were made. By contrast, 11 studies produced some form of system diagram [41,46–48,51–57,60,63], implying that boundary judgments were likely at least implicitly considered by evaluators. The identified papers focused analytically on the relationships between systems elements. Such a focus is understandable and indeed, a prerequisite for being labeled as a system approach; without a focus on relationships and interactions—the key tenet of systems thinking—the approach fails to be systemic.

Somewhat surprisingly, only 4 fewer evaluations explicitly utilized a range of complexity concepts to assess changes within the system resulting from, or co-occurring with, intervention implementation over time [42,46,47,50,55]. By their nature, public health problems and the systems in which they are created and shaped are complex [40], and as a result, we might expect to see a more explicit attempt to use complexity concepts to generate evidence on public health interventions. Complexity science introduces a number of additional concepts that may be of value to researchers who seek to evaluate the mechanisms by which public health interventions have impacts in real-world environments. These concepts are used to describe, analyze, measure, and estimate attributes of change. The change first occurs within and across the system elements, and these collective changes result in emergent system change.

In the body of literature identified in this review, concepts from the complexity sciences, such as those that are used to understand change within systems, were utilized less frequently compared with concepts that could be used to describe static “snapshots” of systems. Although some papers were notable for applying a number of complexity concepts [42,46,47,50,55], the majority drew on only a few complexity-informed concepts in order to describe key mechanisms that might drive system change, such as a feedback loop. Researchers did not always

provide a rationale for how the concepts had been chosen or specifically considered within the context of data collection and analysis. An exception to this was one study that created an explicit analytic framework to identify and explain a range of by-effects (unintended consequences stemming from an intervention) [58]. The framework categorized policy achievements as foreseen or unforeseen and desired or undesired [58]. Within the evaluations identified, the complexity concepts that were most frequently used included nonlinearity, feedback, and adaptation.

## Discussion

We conducted a systematic search to identify examples of public health evaluations that apply a complex systems perspective to process evaluations involving qualitative methods. We then reviewed the systems and complexity concepts and methods currently used in this literature and found that evaluations of this nature draw on systems thinking to describe and analyze a system's structure at one point in time, whereas fewer draw on concepts from complexity science to assess change in a system over time.

We identified evaluations of a wide range of interventions affecting population health or their social determinants. These include interventions in school, workplace, and neighborhood settings in high- and middle-income countries, addressing behavior change, urban planning, community empowerment, health policy, and public-private partnerships. Public health process evaluations with a complex systems perspective have roots in a range of different disciplines and draw on a number of theories and frameworks to understand intervention implementation in real-world settings. The kinds of qualitative methods used in the included studies are in many ways similar to those found in other (i.e., not focused on complex systems) forms of qualitative research: for example, in-depth and semi-structured interviews, focus groups, document review, and participatory methods. As such, the methods are not particularly novel, but rather, this body of literature is characterized by existing tools being paired with a complex systems perspective.

Half of the included studies produce some form of visual representation of the system they sought to describe. In most cases, these maps did not use formal system mapping techniques, and the diagrams varied greatly from study to study. Concepts associated with complex systems also seemed to be applied by many of the included studies in an ad hoc manner, rather than drawing from established theories and frameworks associated with the complex systems literature. Most studies claimed that their systems perspective was planned at the design stage of their evaluation, but few reported basing their approach around an established systems theory or framework [42,48,50,54]. Evaluators' attempts to utilize a complex systems perspective were most evident in the analysis stage of included studies, typically in the form of concepts from systems thinking and (less frequently) complexity science referred to in the analysis of qualitative data.

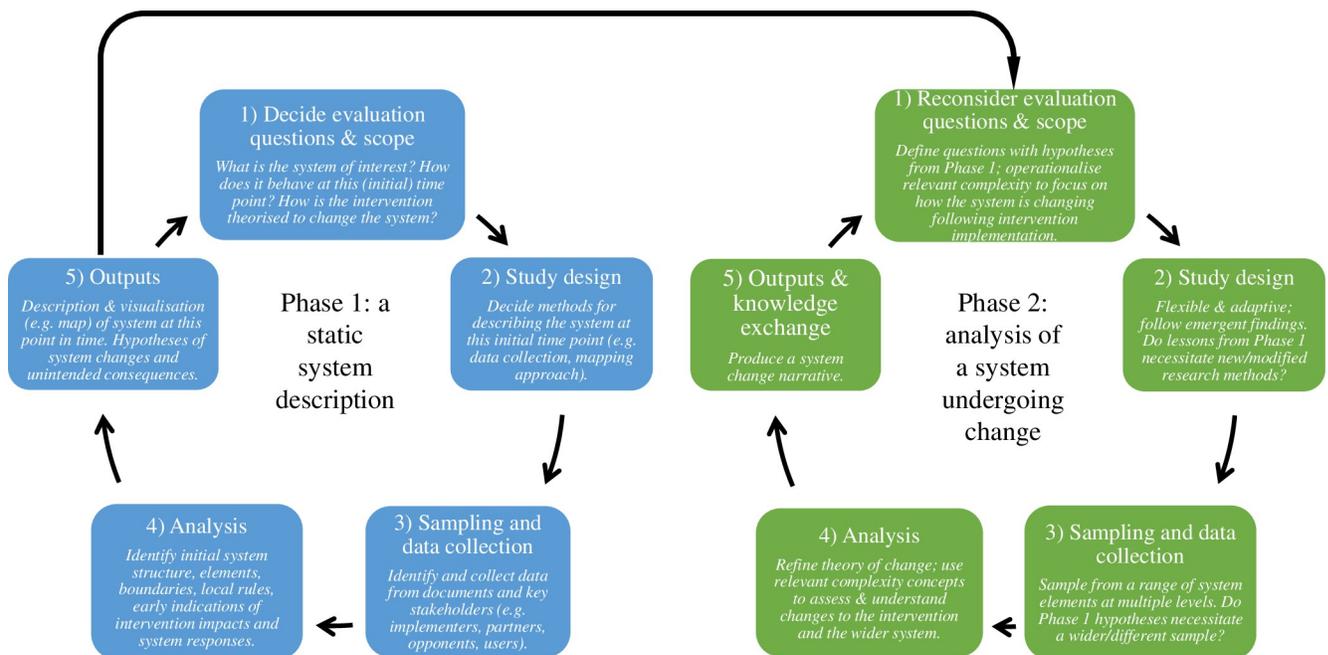
Included papers primarily utilized concepts from systems thinking to produce relatively static descriptions of systems and the interventions introduced within them. Although most evaluations concerned themselves to some degree with understanding mechanisms of, or barriers to, change, many did not make extensive use of the conceptual tools associated with complexity science that could help their attempts to better understand and unpack changes to the system of interest. In addition, although the evaluations identified in this body of literature drew on a range of qualitative methods, with many evaluators using a mix of qualitative methods within one evaluation design, it was often unclear why certain methods were chosen and the value added by each method.

From this summary of the review's main findings, we suggest that approaches to designing, conducting, and reporting qualitative process evaluations that have a complex systems

perspective are frequently underdeveloped and poorly specified. It is unclear to what extent systems thinking and complexity science influenced the key evaluation stages of study design, sampling, and data collection. The underlying theories informing evaluations are often unclear. The tendency to focus on systems concepts that describe a static system, rather than those best suited for assessing system change, seems counterintuitive, given that process evaluations are intended to assess mechanisms of change. We note that this rather critical assessment applies to many but not all of the studies we identified.

We would argue that all these studies are, in a sense, finding their way within an emerging field in which standards of best practice have yet to be established. We also believe that a contribution to the field would be a framework that seeks to address some of the problems identified in this review. Several authors have noted that although there are growing calls to utilize a complex systems approach, there have been fewer attempts to describe specific approaches or frameworks for doing so [35,71]. In particular, we advocate integrating a complex systems approach at the beginning of an evaluation design, to ensure that the perspective informs the evaluators' theoretical position, the evaluation focus, sampling strategy, data collection methods, analysis, and interpretation of findings.

In order to advance this area of public health evidence generation, we now consider some potential ways forward by proposing a framework for qualitative process evaluations from a complex systems perspective. Fig 3 shows our proposed evaluation framework, which involves 2 distinct phases. The first phase is intended to produce a static system description at an early time point. This is then followed by a second phase focused on analyzing how that system undergoes change. Specific steps in the evaluation are shown in the squares with directions and prompts to the evaluators at each step provided in italics. The figure underscores the ways in which the outputs of Phase 1 inform the direction and scope of inquiry during Phase 2. Table 2 also shows the role of qualitative methods in a process evaluation and how these map onto the application of concepts from systems thinking and complexity science.



**Fig 3. Framework for a process evaluation from a complex systems perspective.** Evaluation stages are shown in squares; the italicized font provides directions and prompts for evaluators at each stage.

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**Table 2. Applying concepts from systems thinking and complexity science in a process evaluation.**

Concept	Definition	Process evaluation from a complex systems perspective	Methods
<i>Phase 1: A static system description (informed by systems thinking)</i>	<p><b>Elements</b> Entities within a system, include, for example: people ("agents"), organizations, resources, etc. [12].</p> <p><b>Boundaries</b> Decisions about what is included, and excluded in the system under observation; first-order judgments are boundary judgments made by actors within the system; second-order judgments are made by the evaluator [19].</p> <p><b>Levels</b> A description of the structure of the system—may or may not be hierarchical [67].</p> <p><b>Relationships</b> Connections or interactions between system elements [13].</p> <p><b>Interactions</b> How system elements relate to each other and interact across system levels, or the broader context [14].</p> <p><b>Perspectives</b> Different viewpoints of stakeholders within the system [18].</p> <p><b>History</b> The context before the initial conditions [68].</p> <p><b>Coherence</b> The extent to which elements' goals, activities and functions aligns with other another [69].</p> <p><b>Initial conditions</b> How the system operates at "baseline"; these initial conditions set a system on a particular trajectory [24].</p> <p><b>Local rules</b> The principles that guide interactions and behavior of system elements [14].</p>	<p>Identify components of the system; begin a master list of system elements.</p> <p>Assess first-order boundary judgments; combine primary data and evaluation considerations (e.g., scope of the evaluation, intended audience, pragmatic issues) to create "second-order" boundary judgment; create and revise system map as tool to guide boundary discussions, judgments and depiction.</p> <p>Describe the structure of a system. This can include identifying system levels (considering both vertical and horizontal dimensions) and exploring the ways in which system elements within and between levels relate and interact with one another. System structures and connections may be depicted in a (bounded) diagram.</p> <p>Sample from a range of system elements; identify, assess, and report on a range of viewpoints.</p> <p>Cast evaluative perspective beyond immediate system of inquiry and identify the broader context in which the system is located, as well as the context prior to intervention implementation.</p> <p>Assess the degree to which system elements pursue the same goals and the ways in which their actions may promote or undermine each other's interests.</p> <p>Output of the initial stage of data collection and analysis; a relatively descriptive account that incorporates above concepts to depict the system of inquiry at a static point in time (often when an intervention is first implemented).</p> <p>Identify "if-then" statements or rules governing patterns of behavior in the system and of the system as a whole; use to understand and explain the ways in which interactions between system elements give rise to actions and behavior in the system.</p>	<p>Concepts from systems thinking can be used to develop a <b>static system description</b>. A range of qualitative data generation methods are helpful to understand and produce a description of the system structure, including interviews, focus groups, workshops, (participant) observation and documentary analysis. For example, an evaluator could interview agents within the system to understand their views on the boundaries of the system, their role within the system and how their activities are influenced by other system elements, historical and contextual factors; observe a range of system activities to identify local rules and to assess coherence within the system; and conduct a documentary review (of intervention documents, relevant policies, reports, etc.) to understand the history of the system and to situate the system within its broader context.</p>
<i>Phase 2: Analysis of a system undergoing change (informed by complexity science)</i>	<p><b>Nonlinearity</b> Inputs into the system do not necessarily result in correspondingly sized effects in the system; nonlinear relationships do not follow simple input-output line [40].</p> <p><b>Feedback</b> Positive or negative response that may alter the intervention and its impacts. Positive feedback loops: change amplifies further change; negative feedback loops: change dampens down further change [6].</p> <p><b>Adaptation</b> Adjustments in system behavior in response to internal and external change [6].</p> <p><b>Dynamism</b> Change in the state of the system that happens over time; time and evolution [7].</p> <p><b>Emergent properties</b> Properties of a complex system that cannot be directly predicted from the elements within it and are more than just the sum of its parts; collective behaviors [70].</p> <p><b>Co-evolution</b> System change in response to its environment or another system; both systems change and evolve as a result [13].</p> <p><b>Unintended consequences</b> As a result of nonlinearity and feedback loops, complex systems are characterized by unanticipated processes and outcomes [22].</p> <p><b>System trajectories</b> Includes path dependency [68], attractor state [12], phase space [68], phase transition [24] and bifurcation/tipping points [14]. Qualitatively, the path a system follows through time, moving through different states, including periods of stability and instability [7].</p>	<p>Analyze interactions between systems elements to understand chains of cause and effect; define, draw and refine a theory of change which describe and depict the processes through which actions result in impacts, incorporating instances of feedback; evaluator may wish to draw causal-loop diagrams to visualize feedback loops.</p> <p>Over a time period, both hone in on system elements and widen out evaluative gaze to system as a whole; ask "how do elements change their interactions with other system elements over time in response to the intervention?"; "how does the system change in response to the intervention?"; "to what extent does the system absorb the intervention?";</p> <p>Spend sufficient time in the field generating data to analyze system change over time; conceptualize both the system and evaluation as dynamic.</p> <p>Move evaluative focus from system elements to system as a whole and ask: "what types of system-level properties have emerged over time following the introduction of the intervention?"; explore system-level properties that cannot be attributed to individual elements.</p> <p>Look both vertically and horizontally; look at system elements and the system as a whole and ask: "in what ways does the system—and the environment it is in—change in response to the intervention?"</p> <p>Maintain an open stance and be open to unexpected impacts; follow-up on possible impacts that may not feature in the original theory of change.</p> <p>Narrative of a system undergoing change; output of data analysis is a "system story" that incorporates concepts from systems thinking and complexity science.</p>	<p>Concepts from complexity science can be used to <b>analyze a system undergoing change</b>. Data collection will have a prospective element, with data generated longitudinally or at more than one time point in order to assess the ways in which the intervention and the system adapt and co-evolve with each other and the broader context.</p> <p>Qualitative data generation methods may include interviews, focus groups, workshops, (participant) observation and documentary analysis. These methods can be used to track changes over time and understand the processes by which change occurs. The data generated can be used to produce a narrative of the system undergoing change that underscores the factors that either amplify or dampen change; how the system and intervention adapt and evolve over time; any unintended consequences and how system elements' interactions generate emergent properties over time.</p> <p>Quantitative methods to measure impacts could include interrupted time series analyses, system dynamics modeling, agent-based modeling, network analysis.</p>

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## Phase 1: A static system description

In the first part of this 2-phase framework, we propose that evaluators conduct a period of research in order to gain an initial understanding of the system, including the system structure, the boundaries, the constituent elements, and the relationships between these [6,14] at a given time point [24]. This description represents a snapshot of the system at one point in time. For many evaluators, it may make sense to capture the “initial conditions” or “initial state” of the system at the time the intervention is first implemented. In these cases, the evaluation would involve a period of familiarization and the first part of data collection as the intervention is being implemented or shortly thereafter. In this stage, evaluators would also begin to hypothesize some of the ways that the intervention may lead to change within the system (which may be informed by the intervention’s theory of change, if one is articulated). If the intervention designers have not described a theory of change, evaluators at this stage should articulate one by mapping out the initial hypotheses of system change.

In Phase 1, evaluators would begin to make sense of and document the “local rules” that govern both the intervention and the system, including the rules that govern how different system elements interact and relate to each other and how the intervention operates and relates to different parts of the system. In undertaking Phase 1, evaluators would draw on concepts that are most closely aligned with systems thinking (the left-hand side of Fig 2 and first half of Table 2) and use these to structure the initial data collection and analysis. Following the identification of the system structure, elements, boundaries, and relationships, evaluators should begin to consider some of the ways in which the intervention may lead to changes within the system. Evaluators could ask how the system elements respond to the intervention, comparing different stakeholder perspectives. Evaluators could also begin to assess system coherence by analyzing the degree to which the intervention is aligned with the interests of those in the system or the instances in which the intervention may “swim against the tide” [72,73].

In Phase 1, data should be collected from a range of different actors within the system. Evaluators may find a number of different data collection methods useful, including, but not limited to, an initial documentary review, interviews, and workshops. The boundary decision and the identification of system elements will inform from whom data are collected and through which methods [14].

As part of this process and as a way of analyzing the data collected in Phase 1, it may be helpful to create a map of the system. The type of map created will depend on the role it is to play in the evaluation. For example, if a map is made to visually represent the system structure and boundaries to help depict and understand the system structure and relationships between the system elements [57], it may be created through a semi-structured brainstorming session or interviews and the analysis of the data collected in Phase 1. Alternatively, evaluators may choose to create more structured system maps, drawing on established mapping methods, such as concept mapping or group model building, in order to map out causal linkages between system variables [74]. In these instances, Phase 1 represents an opportunity for initial preparatory work for the map creation process.

The output of Phase 1 would be relatively descriptive and static: a qualitative description of the system structure, elements, boundaries, and relationships which may well be depicted on a map, as well as some hypotheses about how the intervention may lead to system change, including the ways in which the elements and the system as a whole adapt and co-evolve in response. The hypotheses of system change may be depicted as a theory of change, which maps out how the intervention could lead to impacts, with particular consideration given to the pathways and mechanisms by which that change is brought about [6]. The initial system description and possible pathways for system change would then inform Phase 2.

## Phase 2: A system undergoing change

The second phase of evaluation would examine emergent properties of the system and explore system change stemming from the intervention, drawing on a complexity perspective. In Phase 2, evaluators should be prepared to follow the pathway of emergent findings. In this sense, the evaluation needs to be adaptable, flexible, agile, incorporate multiple perspectives, and deal with uncertainty to support real-time decision-making. Evaluators would use the data collected in Phase 1 (particularly the emerging hypotheses about system change) to develop specific research questions about the intervention and the system. In defining the research questions, there is an opportunity to explicitly apply some of the complexity concepts—for example, by asking questions about the adaptive responses within different elements of the system, unintended consequences of the intervention for different population groups, or emergent system outcomes as the system co-evolves with its broader environment. It is not our suggestion that evaluators attempt to apply all complexity concepts to any one evaluation but rather focus on those that can generate useful evidence for decision-making [71]. Although the timing of Phase 2 may be determined by the theory of change, it may also be influenced by the timing of other types of data collection. For example, the process evaluation may accompany an impact evaluation that prespecifies time points for data collection [16,17].

At this stage, a more formal period of sampling and data collection would begin, to complement data collected in Phase 1 and to focus the sampling and data collection strategies to better answer the research questions. The specific sampling strategy and data collection methods will vary from evaluation to evaluation, but any process evaluation applying a complex systems perspective would sample multiple types of participants (e.g., different system elements) and use multiple methods [6,66]. As the papers in this review underscore, the careful use and reporting of different qualitative methods underpinned by complex systems theoretical principles can help an evaluator assess different perspectives across and within system levels, as well as different types of information [27]. Analyzing data generated through different qualitative methods can be used to bring a dynamic component to the evaluative research; for example, documents can be used to understand previous decisions and interviews or observations could then be used to understand the trajectory of those decisions and their impact across the system on different population groups [27]. Evaluators should consider the timing and ordering of mixed methods; a document review might, for example, provide important context in order to inform interview schedules [27]. Complexity concepts have traditionally been used within the context of quantitative and modeling methods. However, we argue that there is no reason that these concepts should not be of interest within a process evaluation using qualitative methods, particularly as many deal specifically with system changes upon which qualitative research could shed light [41,48].

During the analysis stage, the evaluators would begin to make sense of the emerging findings through the application of relevant complexity concepts. For example, an evaluation concerned with understanding the ways in which the intervention may lead to the amplification or dampening down of certain kinds of systemic change would have an explicit focus on identifying feedback loops within the system [75], or it might make sense (based on hypotheses generated in Phase 1) to focus the analysis on understanding how the system's history influences its trajectory and adaptation in response to the introduction of an intervention [76]. As the analysis is undertaken, there is likely a need to collect more data, in a kind of evaluative feedback loop. Such a process will be familiar to those who apply iterative research designs [17,77]. Throughout the analysis, evaluators would revisit, revise, and refine the theory of change and system map in light of the new data.

Generating outputs can be a challenge for public health evaluators applying a systems perspective. It is difficult to convey complex findings in a manner that is useful and timely for

decision makers and does not result in an overly reductionist account or a confusingly “complex” set of findings. This is particularly a concern for qualitative research in which large volumes of data are collected. We suggest that one way to present the findings from a complex systems process evaluation is to create a “system story,” wherein the evaluator describes and analyses how the intervention embeds and co-evolves with the system and its elements overtime [3].

A more traditional approach to process evaluation is often rooted in the intervention itself, rather than the system in which that intervention is implemented. As a result of this orientation, such an evaluation generally considers the intervention and its immediate implementation processes and mechanisms, although there may be some consideration of more distal mechanisms and impacts [17]. In addition, more traditional process evaluations tend to adhere to research protocols that may themselves be relatively inflexible. A process evaluation from a complex systems perspective takes the system as the initial starting point of the analysis and considers the ways in which the intervention may lead to immediate, as well as more distal impacts, and the ways in which that intervention may change how the system elements—and the system as a whole—behave. Doing so will inherently require a flexible, adaptive, and iterative design. The framework presented here suggests at least 2 phases of data collection, with the understanding that the second phase will likely include an iterative process of defining research questions and collecting and analyzing data. Utilizing a longitudinal design with data collected over a relatively lengthy period of time or at more than one time point in order to capture a dynamic system undergoing change [24,67,71] may be a challenge to public health evaluators because it implies longer timescales [78], a move away from more standard evaluative approaches and a degree of risk with which some funders and decision makers may be uncomfortable. In addition, it may challenge traditional public health evaluation methods that strictly follow protocols in an attempt to control for internal validity [16]. In contrast, a complex systems approach to evaluation must inherently plan to adapt and change in response to early evaluative findings, as well as in response to the changing intervention and broader system. As a result of an adaptive evaluation design, the distinction between different types of evaluation (such as formative, process, outcome, and impact) may be less clearly defined. As evaluators follow the pathways of emergent hypotheses and findings, it may well make sense to, for example, measure or predict impacts alongside process mechanisms. Finally, further work remains on the ways in which realist and mixed methods approaches can more explicitly contribute to a process evaluation from a complex systems perspective, but it is beyond the scope of this current review.

## Limitations

The nature of the review topic area required the research team to make a number of judgments throughout the review process. First, judgments were made regarding which studies to include or exclude on the basis of their public health relevance and the degree to which they featured a complex systems perspective. Although the majority of decisions were clear cut, the reviewers, in discussion with one another, had to make judgments in cases that were less obvious, and there is the possibility that other review teams would have made different decisions. In addition, there was a subjective element in deciding which concepts from systems thinking and complexity science to highlight; we sought to capture the key principles associated with each of the traditions with the goal of this list being used by those wishing to draw on systems thinking and complexity science within the context of public health evaluation. We recognize that other reviewers might have chosen to highlight other concepts. Finally, the critical appraisal of the studies again required judgments. In order to increase validity, 2 reviewers completed the process independently and reconciled their decisions, but the decisions were not always clear cut.

Another limitation of this review is the focus on studies which self-identify as taking a systems and/or complexity-informed approach. This focus has 2 possible limitations: First, it excludes studies that may be compatible with systems thinking but do not cite systems literature or draw explicitly on systems concepts, and second, it may include studies that utilize the terminology of complex systems, because it has become somewhat fashionable in the last few years, but fail to apply the concepts in such a manner that investigates complex uncertainties to generate better evidence for decision-making [71]. Taking the first concern, many rigorous qualitative studies foreground context in their research focus and analyses, considering the broader economic, social, political, cultural, environmental, and historical factors that impact interventions' trajectories and influence diverse population groups [79]. As we have contended, "system" and "context" are broadly synonymous, in that all of a system can arguably be considered "contextual." Therefore, qualitative research that actively engages with the broader context may apply a perspective that is compatible with systems thinking, without using the accompanying systems terminology. Indeed, the MRC Guidance on "Process Evaluation of Complex Interventions," had limited reference to complex systems theory and terminology but nevertheless advocated a systems-compatible approach to process evaluation, namely, an approach that explores the "dynamic relationships between implementation, mechanisms and context, the importance of understanding the temporally situated nature of process data in understanding the evolution of an intervention within its system" [17,71]. With regards to the second concern, complex systems thinking is currently in vogue in public health, which can be seen in the growth of calls for the application of a complex systems perspective to public health practice and research [1,35,80,81]. Although many researchers are grappling with how to harness insights from the systems thinking and complexity science traditions to improve public health research, there is some concern that complex systems literature and concepts have been used without researchers truly engaging with the underlying theory [71]. These limitations suggest a number of opportunities for further research in this field. In particular, future research could fruitfully explore the degree to which public health literature—on intervention development and evaluation—is compatible with a complex systems perspective, even when not explicitly described as such. Other research might identify process evaluations that do not explicitly adopt a complex systems approach and analyze the added value of an explicit engagement with the systems and complexity literature.

Finally, we limited our search to English-language publications and relied on 2 previous reviews and an expert consultation to identify qualitative process evaluations from a complex systems perspective that were published prior to 2014, which is a limitation of our search's sensitivity. The studies identified through these means may have been influenced by other researchers' interpretations and possible biases. Any papers not identified from our search may have potentially added further to our methodological synthesis and the recommendations we put forward in the Discussion.

## Conclusions

We have conducted a systematic review to identify qualitative process evaluations of public health interventions that consider themselves to be informed by systems thinking and/or complexity science, and we have analyzed the extent to which they feature key concepts from these fields. We found that this area of public health evidence generation is still in early stages of development and there is little consensus on a general approach. Informed by our evidence synthesis, we have therefore developed a framework for process evaluations that assesses change within the context of a wider complex adaptive system. We suggest that to do this, evaluations themselves need to be designed with a complex systems perspective, which requires

being agile and adaptable in order to capture the system change they seek to assess. We are currently testing out this approach in an evaluation of how a system and its elements adapt and co-evolve in response to a local alcohol intervention that raises additional revenue to police and manage the night-time economy. We intend that this 2-phase framework can be of use, and be further refined, by public health practitioners and researchers who seek to produce evidence to improve health in complex social settings.

## Supporting information

**S1 PRISMA Checklist. PRISMA, Preferred reporting items for systematic reviews and meta-analyses.**

(DOC)

**S1 Text. Example search strategy.**

(DOCX)

**S2 Text. Case study examples from the systems thinking and complexity science traditions.**

(DOCX)

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## Chapter 6: Research paper: Addressing alcohol-related harms in the night-time economy: a qualitative process evaluation from a complex systems perspective

### 6.1 Introduction

My fourth research paper is presented in this chapter and at the time this thesis was submitted, it had been submitted to *BMJ Open*. The previous chapter described the development of a framework for qualitative process evaluations from a complex systems perspective and suggested a two-phase approach to process evaluation, beginning with developing an understanding of the system before analysing the ways in which the intervention may generate change within that system (1). In this chapter, I apply the framework to conduct a process evaluation of the Late Night Levy (LNL) following its implementation in one London local authority. The evaluation had the dual aims of describing and visualising the system into which the LNL is implemented and analysing how the system, its actors and the intervention adapt and co-evolve over time. As such, it was designed to address Objective 5 of this research programme: to theorise and analyse how local alcohol interventions affect the systems within which they occur by exploring intervention pathways to impact with reference to key complex systems concepts. The topic guides and observation templates for this study are presented in Appendix F. In Chapter 7, I assess the application of the framework to the LNL and consider the implications of it for the further development of evaluative methods from a complex systems perspective (Objective 6).

The research in this thesis has been presented in the order in which I conducted the analyses to illustrate the progression of how I have applied a complex systems perspective to the evaluation of alcohol harm prevention efforts. Specifically, as will be demonstrated in this chapter, when conducting the evaluation of the LNL I began with mapping the local system, before locating the intervention within it. With the RtS evaluation in Chapter 3, I began with the intervention itself, rather than first developing an understanding of the system (2). In the LNL evaluation, I utilised the map and description of the system to identify hypotheses to focus on and then drew on a greater number (compared to the RtS evaluation) of complexity concepts in my analysis, such as co-evolution and emergence.

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## RESEARCH PAPER COVER SHEET

Please note that a cover sheet must be completed for each research paper included within a thesis.

### SECTION A – Student Details

Student ID Number	305848	Title	Ms
First Name(s)	Elizabeth Tyner		
Surname/Family Name	McGill		
Thesis Title	Evaluating local-level interventions to address alcohol-related harms in England: the development and application of a complex systems perspective to process evaluations		
Primary Supervisor	Professor Matt Egan		

If the Research Paper has previously been published please complete Section B, if not please move to Section C.

### SECTION B – Paper already published

Where was the work published?			
When was the work published?			
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Have you retained the copyright for the work?*	Choose an item.	Was the work subject to academic peer review?	Choose an item.

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### SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	BMJ Open
Please list the paper's authors in the intended authorship order:	Elizabeth McGill, Dalya Marks, Mark Petticrew, Matt Egan

Stage of publication	<b>Submitted</b>
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**SECTION D – Multi-authored work**

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	Conceived and designed the study; led on ethics application; conducted data collection; conducted data analysis (ME independently identified system variables) and interpretation; drafted the manuscript; and critically revised the manuscript (with input from all co-authors). ME, DM and MP provided supervision.
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**SECTION E**

<b>Student Signature</b>	Elizabeth McGill
<b>Date</b>	26/02/2021

<b>Supervisor Signature</b>	Matt Egan
<b>Date</b>	26.02.21

## **Addressing alcohol-related harms in the local night-time economy: a qualitative process evaluation from a complex systems perspective**

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**Word count:** 8,657 (excluding abstract, tables, figures and references)

## Abstract

**Objectives:** English local authorities (LAs) are interested in reducing alcohol-related harms and may use discretionary powers such as the Late Night Levy (LNL) to do so. This study aims to describe and visualise the system in which the LNL operates and to explore how the system, its actors and the intervention adapt and co-evolve over time.

**Design:** A process evaluation from a complex systems perspective, using qualitative methods.

**Setting:** A London LA, with a high density of residential and commercial properties, which implemented the LNL in 2014.

**Participants:** Data were generated through interviews with LNL implementers and alcohol consumers, observations in bars and during LNL patrols, and documentary review.

**Intervention:** The LNL allows LAs to charge late-night alcohol retailers to manage and police the night-time economy (NTE).

**Results:** The local system into which the LNL is introduced is characterised by many interrelated variables. Stakeholders theorised the levy to increase resources for policing and managing the NTE, thereby decreasing anti-social behaviour, crime and litter. Stakeholders also theorised that the levy could have unintended consequences by reducing support for public-private partnerships and forcing venues to vary their hours or to close, thereby undermining the levy's viability, clustering closing times, reducing NTE diversity and producing negative economic impacts. In the first two years, levy-funded patrols developed relationships with the licensed trade and the public. The LNL did not undermine public-private partnerships and while some premises varied their hours, these changes did not undermine the intervention's viability, nor significantly cluster venue closing times, nor obviously damage the area's reputation for having a diverse NTE.

**Conclusions:** This study demonstrates the application of a framework for process evaluation from a complex systems perspective. The evaluation could usefully be extended to measure alcohol-related outcomes and to further consider the interplay between the national and local systems.

**Keywords:** alcohol; complex systems; qualitative research; process evaluation

## Strengths and limitations of this study

- This study used a novel design, drawing on a complex systems perspective, to understand the mechanisms by which the intervention may generate system-wide changes.

- We generated data through a range of qualitative methods, including interviews, observations and documentary review which allowed us to collect data from a wide range of sources.
- We include data from implementers, NTE users, business owners and staff but not health service workers.
- The evaluation occurred after the intervention started, although many of the documents reviewed were produced prior to implementation.

## INTRODUCTION

In England, alcohol misuse is the largest risk factor for poor health and early mortality for adolescents and adults aged 15-49 years (1), a pattern that is mirrored globally (2). In addition to the health harms associated with alcohol consumption, alcohol contributes to broader societal harms including crime, violence, anti-social behaviour and disorder (3), many of which occur within the context of the night time economy (NTE) (4).

At the turn of the 21st century in England, there was growing public discourse and concern about the rise of the “alcohol-fuelled, consumption-driven, night-time high street” (5 p.466) which was characterised by clusters of late-night establishments and a tension between those enjoying nights out, those employed within or profiting from the NTE and those impacted by violence, anti-social behaviour and nuisance (6,7). A series of sweeping legislative and regulatory changes were made, with claims made that this would create a safer NTE, while generating economic benefits to businesses, the people they employed and to governments (6,8). These changes included the Licensing Act 2003 (enacted in 2005) which transferred responsibility for alcohol licensing from magistrates to local authorities (LAs) and removed fixed closing times for alcohol-retailing venues (8). The sale of alcohol in England is therefore overseen by LAs, also referred to as Councils, through licensing, trading standards and planning bodies (9). In this context, LAs have access to a range of discretionary powers to tackle alcohol-related harms, including Cumulative Impact Policies and Early Morning Restriction Orders, both of which were introduced in the Licensing Act 2003.(10) Another discretionary power, which will be the focus of this evaluation, is the Late Night Levy (LNL) which was introduced in the 2011 Police Reform and Social Responsibility Act. The Act allows Councils to charge alcohol-retailers who have a licence to sell alcohol between midnight and 6 am a fee; the revenue is split between the LA and the police to manage the NTE.

Public health researchers have become increasingly interested in applying a complex systems perspective to analysing the multiple interactions that lead to patterns of health behaviour, outcomes and inequalities across communities (11-13). Where LA’s choose to implement the LNL, it is introduced locally into a complex system that interacts with regional, national and international systems. A system is a group of elements, bounded in some way, that interact with each other (14,15). A complex system is one that is characterised by unpredictability and change over time (16,17). Complex systems exhibit emergent properties that cannot be reduced to the behaviour of the individual system elements (18). Elements within a system respond to internal and external system inputs; these responses may feedback on the inputs themselves, either amplifying or dampening their impacts, which may, in turn, create unanticipated or unintended effects (19,20). Analysing a complex system encompasses making sense of the system’s trajectory, considering how

it is influenced by its previous history and the interactions between its elements (17,21). Key concepts from a complex systems perspective, which we consider in this paper, are defined in Table 1.

**Table 1: Complex systems concepts**

<b>Concept</b>	<b>Definition</b>
<b>Elements</b>	Components within a system ('agents', institutions, resources, etc.) (17)
<b>Boundaries</b>	The 'limits' or 'bounds' of a given system; boundary judgements may be made by system actors (first-order) or researchers (second-order) (15,22)
<b>Levels</b>	The structure of the system; levels may operate horizontally and/or vertically depending on boundary decisions (20,23)
<b>Relationships and interactions</b>	Connections between different system elements, within and across system levels, and between elements and the broader context (24)
<b>Local rules</b>	The norms and principles that guide interactions between system elements and drive system behaviour (25)
<b>Perspectives</b>	The different ways actors within the system may view the system, their goals and actions and boundary decisions (26)
<b>Non-linearity</b>	Inputs into a system may lead to a non-correspondingly-sized impact (22)
<b>Feedback</b>	Responses that either amplify or dampen the impacts stemming from an intervention and may alter the intervention itself (19)
<b>Adaptation</b>	The ways in which system elements and the system as a whole behave in response to internal and external inputs (16)
<b>Emergent properties</b>	The emergent, collective behaviour of a system that cannot be reduced to its individual parts (27)
<b>Co-evolution</b>	The changes to a system and the broader systems in which it is located, over time (17)
<b>Unintended consequences</b>	Processes and impacts that were unanticipated at the design stage of an intervention (20)
<b>System trajectories</b>	The evolution of a system over time, which is path dependent or constrained in some ways due to its history (17,21)

Complex systems are characterised by their open boundaries and as a result, they interact with, influence, and are influenced by, other systems (28). From a geographical perspective, they can be characterised by both horizontal and vertical complexity. Horizontal complexity refers to the relationships between system elements, and between systems within the same geographical scale. Vertical complexity refers to the relationships and interactions across geographical scales, with, for example, an emphasis on how international and national systems may influence, constrain and shape local systems (29,30). A recent scoping review of complex systems perspectives applied to alcohol consumption and prevention found that much of the research in this field is conducted in sub-local (e.g. individual, families, social networks) or local (e.g. neighbourhood, town, cities) systems. Far less consideration is given to the ways that the local systems interact with the national or international systems (30).

A complex systems perspective applied to public health evaluation involves analysing the multiple ways in which a complex system and an intervention interact and influence each other to generate health impacts and health inequalities (31-34). Evaluators might consider interventions as ‘events’ within systems that have the ability to disrupt system behaviour, generating evolving and adaptive patterns of behaviour and emergent outcomes (21,35).

In public health, process evaluations have traditionally been used to understand the mechanisms by which interventions leads to impact, the influence of the broader context on observed variations in impact, as well as to assess intervention fidelity and the quality of implementation (36). Applying a complex systems perspective to a process evaluation can be used to first describe the system, understand its elements, boundaries and the ‘rules’ or norms that govern the behaviour of its elements and the ways in which they interact each other. Following the introduction of an intervention such as the LNL, a process evaluation with a complex systems perspective then aims to understand the mechanisms by which the elements within the system, and the system as a whole adapt and co-evolve in response.

This process evaluation was conducted in one London LA with the dual aims of 1) describing and visualising the system into which the LNL is introduced; and 2) exploring how the intervention acts as an event within the system, with an emphasis on understanding how the system, its actors and the intervention adapt and co-evolve over time.

## METHODS

### Study design and data generation

We applied a framework for process evaluation using a complex systems perspective to data we collected on the LNL in one LA (32). This evaluation framework consists of two phases: Phase 1 involves producing a static system description and developing theories of how the system may change in response to the intervention; Phase 2 analyses the system as it undergoes change following implementation. The evaluation approach is adaptive and theories of change (ToCs) generated in Phase 1 are intended to inform the evaluative focus of Phase 2. In Phase 2, evaluators should be open to exploring unintended processes that stem from the intervention, that may not have been considered at the design stage or in Phase 1 of the evaluation.

### Intervention and setting

The LNL was designed to “empower local areas to charge businesses that supply alcohol late into the night for the extra enforcement costs that the night-time economy generates for police and licensing authorities” (37 p.1). The intervention aims to prevent and address disturbance and crime associated

with late night drinking. The power is discretionary and LAs can choose, following a period of local consultation, to implement a levy on all establishments in the on- and off-trade that have a licence to sell alcohol between midnight and 6 am. The amount each premise pays is set out in a nationally-determined fee schedule based on the rateable value of the premise and the degree to which the premise was primarily alcohol-led (Table 2). Individual LAs may exempt certain types of premises, such as those operating within a Business Improvement District (BID), and/or offer reductions for premises engaging in schemes such as Best Bar None or PubWatch. BIDs, Best Bar None and PubWatch are business- and alcohol industry-led schemes and businesses voluntarily participate in them. These initiatives are supported by public bodies, including LAs or the Home Office. As shorthand, these schemes will be referred to as public-private partnership (PPP) schemes. The revenue from the levy, following the deduction of administrative costs, must be split with a minimum of 70% going to the police and the remainder to the LA. In 2011, The Home Office estimated that the levy would likely be viable in 94 of the 378 LAs across England and Wales and generate a total net revenue of £12.1m per year (38). The legislation was enacted in 2011 and Newcastle City Council was the first to adopt the levy in November 2013.

**Table 2: Late Night Levy charges**

<b>Rateable value</b>	A: No rateable value - £4,300	B: £4,301 - £33,000	C: £33,001 - £87,000	D: £87,001 - £125,000	E: £125,001 + above	D x 2 multiplier applied to premises in category D that are primarily / exclusively alcohol-led	E x 3 multiplier applied to premises in category E that are primarily / exclusively alcohol-led
<b>Annual levy charge</b>	£299	£768	£1,259	£1,365	£1,493	£2,730	£4,440

Source: Home Office 2015 (39)

The LA that is the subject of this process evaluation, held a local consultation on the levy at the end of 2013 and implemented the LNL in late 2014. The levy hours are set at 00:01 to 06:00 and businesses that demonstrate commitment to best practice, as defined by the LA, are eligible for a 30% reduction of the levy fee. Businesses that are a member of the local BID, which requires members to pay a levy separate to the LNL, are neither exempt from the levy nor granted an automatic reduction in the fee. The Metropolitan Police and the LA chose to pool the net amount of levy payments to deliver one broad programme consisting of two different strands: i) additional dedicated police resource to coordinate NTE policing and conduct support and enforcement activity; and ii) a visible street-based patrol service delivered by a police-accredited community safety

company four nights per week to give assistance to the licensed trade and members of the public. A Late Night Levy Board with representation from licensees oversees the use of funds raised through the levy.

### Sampling and data generation

A complex systems perspective encourages evaluators to consider the intervention as a multi-stage process that, in the instance of the LNL, began with changes in national policy, then a local consultation, and finally local implementation. Local delivery processes could continue to interact with national (or other 'non-local') developments. However, this evaluation focuses primarily on the local system: a focus on horizontal complexity. This local focus represents a 'secondary boundary judgement' (22); that is one that is made by evaluators (compared to a 'first order boundary judgement' which is made by actors operating within the system).

The sampling strategy aimed to capture a range of different actors and perspectives within the national and local systems in order to contrast how different actors perceive, respond and adapt to the introduction of the intervention. A large number of system stakeholders were participants in this study but they did not contribute to its design. Given the evaluative focus on the LNL in one LA, the sampling strategy was designed to primarily collect data from local actors through interviews, observations and a documentary analysis. However, recognising that complex systems are open systems, the sampling strategy was intentionally wider than the local system and the documentary analysis also included national data in order to analyse vertical systemic relationships.

In this process evaluation, Phase 1 focuses on the period prior to local implementation, which included the national policy change and the local consultation. Phase 2 focuses on the local implementation stage and is the stage at which we became involved in evaluation. Data collection for Phase 1 was largely retrospective, but based on primary documentary sources generated during the earlier time period. Phase 2 was based on interviews, observations and document analysis collected during the first two years of the levy's implementation.

A range of data collection methods were utilised, including: a review of national and local documents, interviews with those implementing and delivering the LNL locally (n=12), interviews with users of the NTE (n=9), observations of community safety patrols (28.5 hours) which included informal conversations with patrol officers (n=10) and observations in pubs and bars (6 hours). Table 3 shows the documents analysed and their publication dates; Table 4 provides details of the primary data collection. To preserve participant anonymity, generic job roles are presented to remove identifying information. Data collection and fieldwork was conducted by EM, a research fellow with experience of a range of qualitative methods and analysis.

**Table 3: Documents in documentary review**

	<b>Title</b>	<b>Organisation (Date)</b>
<b>National documents</b>	Police Reform and Social Responsibility Bill Research Paper 10/81	House of Commons Library (2010)
	Impact Assessment for the alcohol measures in the Police Reform and Social Responsibility Bill	Home Office (2011)
	Police Reform and Social Responsibility Act (2011)	Act of Parliament (2011)
	The Government's Alcohol Strategy	Home Office (2012)
	Next steps following the consultation on delivering the Government's Alcohol Strategy	Home Office (2013)
	Amended guidance on the late night levy	Home Office (2015)
	The late night levy	House of Commons Library (2015)
	Modern Crime Prevention Strategy	Home Office (2016)
	Policing and Crime Bill: Changes to the Late Night Levy – Impact Assessment	Home Office (2016)
	<b>Local documents</b>	Annual Public Health Reports (n=5)
Licensing Policies (n=2)		Council (2011 – 2017)
LNL Consultation		Council (2013)
LNL Consultation Responses (n=338)		Council (2014)
LNL Written Consultation Responses (n=31)		Council (2014)
LNL Council Meeting Minutes		Licensing Committee (2014)
LNL Year 1 and Year 2 Reports		Council (2016; 2017)
LNL Year 1 and Year 2 Reports		Community Safety Company
BID Annual Reports		BID Board (2015/2016; 2016/2017)

**Table 4: Primary data collection**

	<b>Participants</b>	<b>Number (details)</b>	<b>Year</b>
<b>Interviews (n=21) (10.4 hours)</b>	Local authority managers and officers relevant to licensing and public health	4 (one individual interview; three interviewed as a group)	2014
	Police officers	3 (individual interviews)	2016
	Community safety officers	5 (two individual interviews; two interviewed as a pair)	2014, 2016
	Users of the NTE	9 (interviewed in pairs or one group of three; Fridays between 20:00 – 21:30)	2016
<b>Observations and informal conversations (35.5 hours)</b>	LNL-funded, community safety patrols; 5 different officers	2 (18.5 hours; 5 officers; Friday 21:00 – 7:00 and Saturday 21:30 – 8:00)	2016
	Non-levy, community safety patrols; 5 different officers	3 (10 hours; 5 officers; Tuesday 6:00-9:00; Wednesday 13:00-20:00)	2016
	Quarterly review meeting (Local authority managers; community safety company managers)	1 (1 hour; 4 participants)	2016
	Pubs and bars (observation only)	4 (6 hours; Fridays between 19:30 – 22:00)	2016

Documents were identified through online searches which included searches of national and local government websites for documents about the LNL, alcohol and health and crime and safety. In addition, Google searches were undertaken using the term 'late night levy'. Documents were included if they shed light on the rationale and process for developing and implementing the levy, or reported on the levy following implementation. All documents are located in the public domain. Some of the documents included what might be considered 'outputs' in a process evaluation and short-term social and health impacts following intervention implementation. The analysis of these data focused on how they were presented, for what purposes, by which actors and how they suggested early indicators of change stemming from the intervention. We report some of the data from these documents in our Results section.

Interviews with professionals implementing and delivering the LA's LNL followed a topic guide and asked participants about alcohol-related challenges, their experience of the LNL and the system in which the intervention is located. Topic guides were semi-structured to allow the participant scope to guide the conversation based on their experiences and understanding of the local system and the intervention. The interviews were audio-recorded and transcribed.

Observations were conducted during five community safety patrols partly funded by the LNL in which addressing alcohol consumption and associated harms was either a primary or secondary focus of the patrol. During the patrols, the fieldworker engaged in informal conversations with patrol staff and observed their actions and engagement with individuals or groups, including staff from licensed premises, police officers, users of the NTE, street drinkers and rough sleepers. In total, ten officers conducted the patrols, two of whom were also formally interviewed prior to the patrols. Throughout each patrol, the fieldworker wrote notes when appropriate and, where possible, captured direct quotations from patrol officers. An additional observation was conducted during a LNL review meeting between managers from the LA and community safety company.

In order to better understand how users of the NTE experience the local alcohol system and the LNL, interviews were conducted in pubs and bars. Nine participants were recruited from alcohol-retailing venues; the fieldworker approached groups of 2-3 drinkers for interviews about the local area, particularly its NTE and their views on the LNL. Due to the setting, the fieldworker did not take notes during the interview or record the discussion. Notes, including any direct quotations, were written immediately following each interview.

Ethical approval for this study was obtained from the London School of Hygiene & Tropical Medicine Ethics Committee (ref: 10129) with particular attention paid to consent and safety issues around collecting data in situations where alcohol is consumed.

## Patient and public involvement

No patients or public involved.

## Analysis

### Phase 1

The framework for process evaluation from a complex systems perspective using qualitative methods suggests several questions to guide Phase 1 of the evaluation: 1) What is the system of interest and what are its boundaries? 2) What are the characteristics of the system and how does it behave at the initial timepoint? 3) In what ways could the intervention lead to changes within the system, including changes that may be unanticipated or unintended (32)? The 'Intervention and Setting' section above sets out the local system of interest and its boundaries, which for this evaluation, are the geographical boundaries of the LA.

The analysis began with an in-depth reading of all transcripts, fieldnotes and documents and a deductive approach to coding the data was undertaken, guided by a number of concepts from systems thinking which included: elements, boundaries, levels, relationships and interactions, perspectives and history (see Table 1). The coding process was used to make sense of the national and local histories that created the conditions for the development and implementation of the LNL, the goals of different actors and how their perspectives influenced their views towards the levy. The data were then utilised to develop theories of change, with a particular emphasis on stakeholder perspectives and how they aligned or contradicted each other in order to understand how the intervention may lead to changes within, and beyond, the system into which it is introduced.

A system map was developed utilising Visual Understanding Environment (VUE) software (40) (Figure 1). The choice of the geographical boundary was reflected in the map, but the analysis also sought to understand the influences on the implementation of the levy from beyond the LA geographical boundaries. A list of variables relevant to the LNL, nationally and locally, was independently generated by two researchers (EM and ME) from the coded data. The variables and the relationships between them were then represented visually on a map, noting whether variables were positively or inversely related. The map was used to visualise the system, aid understanding of the 'initial conditions' into which the LNL was introduced and to generate hypotheses on the ways in which the levy was theorised to generate change within the local system. The analysis of Phase 1 was completed before the Phase 2 analysis so that it could inform the analytical focus for Phase 2.

## Phase 2

In Phase 2 of the process evaluation framework, the evaluator seeks to understand how the system and the intervention itself change following implementation, exploring the mechanisms by which change occurs (32). The theories of change developed in Phase 1 were used to guide the analysis. In Phase 2, the focus of the evaluation was on the new actors that were introduced into the system with levy funding. There was a simultaneous focus on the system elements and the system as a whole, considering how they adapt and co-evolve over time, disrupting the local system rules and patterns of behaviour. The coding and analysis were led by EM, with analytical discussions taking place across the research team. NVivo 12 was used to aid the data analysis (41).

## RESULTS

### Phase 1: system description and theories of change

*What are the characteristics of the system and how does it behave at the initial timepoint?*

The local system structure and the relationships within it are presented in Figure 1. The system map is comprised of a range of variables that characterise the local system; each variable is represented by a bubble; the lines represent relationships to other system variables and whether the two variables are positively (solid line) or inversely (dashed line) related to each other. A description of each variable is provided in Table 5, along with the other system variables it is directly related to and/or from. The final column in the table provides an excerpt of data to illustrate each variable. The system represented in the diagram is bounded so that it contains the elements operating within the geographical area of the LA. However, the local system is a complex system and therefore these boundaries should be considered 'open'.



**Table 5: System variables and relationships within the local system**

System	Variable	Description	Connected to/from (positive or inverse relationship)	Example(s) (source)
National	National support for NTE regulation	The degree to which national policymakers support the introduction and extension of regulation in the NTE.	To: LA powers to regulate NTE and alcohol licensing (+); societal alcohol-related economic/health harms (+)  From: alcohol-industry lobbying / discourse-shaping activity (-)	“The Government intends to rebalance the licensing regime to enable local ‘Licensing Authorities’ (LAs) and the police to clamp down on alcohol-related crime and disorder, particularly late at night; to allow wider considerations and the views of local communities to be taken into account in licensing decisions; to protect children from the harm of alcohol; and introduce a late night levy to help pay for other costs caused by late-night drinking.” (Impact assessment for Police Reform and Social Responsibility Bill 2010)
	LA powers to regulate NTE and alcohol licensing	The specific powers available to LAs to regulate the NTE and control the provision of alcohol through alcohol licensing powers, such as the LNLs, CIPs, and EMROs.	To: LA support for the levy (+); alcohol outlet density (-)  From: national support for NTE regulation (+)	“The late night levy is a discretionary power enabling licensing authorities in England and Wales to raise a contribution towards policing the late-night economy from holders of premises licences or club premises certificates.” (House of Commons, Late Night Levy Briefing, 2015)
	Societal alcohol-related economic and health harms	The societal harms associated with alcohol, including the associated healthcare costs, productivity losses and population-level health harms.	To: national support for NTE regulation (+)  From: alcohol consumption (+)	“Alcohol misuse also costs the United Kingdom economy an estimated £7.3 billion a year in lost productivity and the National Health Service in England an estimated £3.5 billion a year. In England, over 15,000 people die from alcohol-related illnesses each year.” (Next steps on delivering the Government’s Alcohol Strategy, 2013)
	Alcohol industry lobbying / discourse-shaping activity	Activities the alcohol industry engages in to lobby for and frame debates in terms favourable to their corporate interests.	To: industry profitability (+) ; national support for NTE regulation (-)  From: support for PPP schemes (+)	“We believe that the Council should maintain its current voluntary best practice approach which is delivering real results and crucially is focused on eliminating the source of the problems rather than simply paying for any clean up.[...] This is in line with the National Alcohol Strategy which states that targeted action taken voluntarily by pubs and clubs themselves is most effective in curbing irresponsible drinking and associated drunken violence. The Home Secretary, Theresa May, in publishing the strategy suggested that a legislative approach, either national or local, was a 'sledgehammer' which all too often misses its target and that a partnership approach was more effective.” (Consultation response, trade organisation representing on-licence premises).

System	Variable	Description	Connected to/from (positive or inverse relationship)	Example(s) (source)
National	Industry profitability	The financial gains realised by the alcohol industry.	To: business rates/licence fees (+)  From: alcohol-industry lobbying / discourse-shaping activity (+); customer numbers (+)	"[The LNL] will impose a significant further cost burden on the hospitality industry in the [local] area when the overall costs the industry must pay whether food, drink, labour and taxes contribute to rise and customers' real incomes shrink impacting on profitability". (Consultation response, operator of managed pubs).
	Alcohol outlet density	Concentration of premises selling alcohol for consumption on or off the premises.	To: alcohol consumption (+)  From: LA powers to regulate the NTE and alcohol licensing (-); mixed land use (+)	"The number of licenced premises continues to grow rapidly so that [LA] has one of the highest densities of pubs, bars, clubs and off licences in the country and second highest in London after the City of Westminster." (Licensing Policy 2013-2017)  "I: So from your perspective, what would you say are the major kind of alcohol related challenges in [LA]? R: <i>There are too many licensed premises.</i> " (Interview, Police licensing officer)
Local	Alcohol consumption	The amount of alcohol an individual consumes. Can be measured in the context of a single drinking event, or to describe patterns of consumption.	To: crime / ASB / disturbance (+); alcohol-related health harms (+)  From: alcohol outlet density (+) ; alcohol availability (+)	"Drinking above recommended maximum limits has become much more common over the past two decades, particularly among younger and middle aged men and women of all social groups. This trend is mirrored in [LA]. [...] The effects of the increase in alcohol consumption seen over the past two decades are now being seen in the significant increases in alcohol-related attendances and admissions in the NHS." (Licensing Policy 2011-2014)  "Alcohol consumption is increasingly identified as a major factor behind violent crime and disorder in the borough with serious consequences to victims, businesses and local communities." (Licensing Policy 2013-2017)
	Alcohol-related health harms	Individual health harms experienced as a result of alcohol consumption.	To: LA support for the levy (+); emergency service usage (+)  From: alcohol consumption (+); crime / ASB / disturbance (+); police and community safety presence (-)	"In reviewing our Licensing Policy we have been mindful that [LA's] residents suffer from high levels of alcohol-related ill health and early deaths." (Licensing Policy 2013-2017)  "Studies assessing the effectiveness of limiting the density of alcohol outlets showed greater alcohol outlet density to be associated with increased alcohol consumption and harms including injury, violence, crime and medical harm. Small numbers of concentrated problematic nightlife venues often cause a large proportion of alcohol-related harm, violence and injuries in city centres." (Public Health Report 2012)

System	Variable	Description	Connected to/from (positive or inverse relationship)	Example(s) (source)
Local	Mixed land use	The degree to which areas within the LA are mixed residential and commercial.	To: residential reputation (-); alcohol outlet density (+)  From: population change (+)	"[LA name] is a densely occupied area, with no clear delineation between residential and commercial premises and the Licensing Authority will need to carefully balance the conflicting needs of residents, patrons and businesses in relation to the introduction of flexible opening hours for the sale and supply of alcohol and late night refreshments." (Licensing Policy 2011-2014)
	Population change	The demographic characteristics of the local population and its rate of change.	To: mixed land use (+)  From: residential reputation (+)	"[LA], however, is undergoing a process of rapid change and this is likely to continue. The number of people living here has grown from 178,000 in 2001 to an estimated 199,130 in 2010. One of the reasons for this is the increase in the number of young adults who are moving into inner London, and starting families. [...] This has turned many parts of the borough, which were previously exclusively commercial, into mixed-use hubs incorporating commercial and residential premises in very close proximity." (Licensing Policy 2011-2014)
	Residential reputation	The extent to which the local area is viewed as a desirable place to live.	To: population change (+); council tax (+)  From: perceptions of safety (+); mixed land use (-); nightlife reputation (+/-); strength of the local economy (+)	"I spoke to the public health lead for alcohol in [neighbouring LA] last week and he was saying this, exactly. [...] Having all those bars, having all those people drinking, that's what they call regeneration, whereas in [this LA], my impression what they call regeneration is a good place to live, not a good place to party." (Interview, Public Health specialist)  "[LA name's] nightlife is marvellous and one of the reasons I love being a resident here." (Consultation response, resident)
	Nightlife reputation	The extent to which a local area is viewed as a desirable place to go out.	To: residential reputation (+/-); customer numbers (+)  From: perceptions of safety (+); diversity of NTE offer(+)	[Participant] almost always goes out in [LA] when he goes out. He likes the variety of places and that you can get fairly cheap drinks and still be in Zone 1. (Excerpt from fieldnotes)  "[LA] has a reputation for its vibrant nightlife and the council, along with its partners the Metropolitan Police and London Fire Brigade recognise that many people are working hard to ensure that [LA]'s clubs, pubs and bars provide a safe and attractive venue for customers." (Licensing Policy 2011-2014)
	Cost of policing and managing the NTE	The resources required to manage and regulate the NTE; includes police, community safety, street cleaning, licensing and trading standards.	To: LA support for the levy (+)  From: emergency service usage (+); crime / ASB / disturbance (+)	"[LA] has a well established night-time economy that has continued to grow since the introduction of the Licensing Act in 2005. The number of late-night and 24 hours premises is high and they are spread across the borough. The costs of policing the late night economy are substantial." (Consultation response, Executive Member for Community Safety).

System	Variable	Description	Connected to/from (positive or inverse relationship)	Example(s) (source)
Local	LA support for the levy	The degree to which key stakeholders responsible for local area, support the need to introduce the levy; includes elected members and responsible authorities.	To: Late Night Levy  From: LA powers to regulate NTE and alcohol licensing (+); cost of policing and managing the NTE (+); alcohol-related health harms (+); strength of the local economy (-); litter / vomit / urine / graffiti (+); support for PPP schemes (-)	"The supporting statement for the consultation at Appendix A sets out why the Council, supported by the police, believes the levy is necessary and this is still felt to be strong and compelling." (Consultation response, Executive Member for Community Safety).
	Perceptions of safety	The extent to which individuals feel safe in their local environment; includes both residents and visitors perceptions.	To: residential reputation (+); nightlife reputation (+)  From: police and community safety presence (+)	"[LA] is a safe place to socialise, this is my perception and common among my going out friends" (Consultation response)  "I've lived in a lot of places – [LA] and, in particular, [popular NTE area] are hardly a war zone!" (Consultation response)
	Emergency service use	The use of emergency services, including ambulances, A&E and police.	To: cost of policing and managing the NTE (+)  From: police and community safety presence (-); alcohol-related health harms (+)	"Generally, as density of licensed premises in LA increases so does the number of ambulance callouts (shown on map) and also levels of alcohol-related crime." (Public Health Report, 2012)
	Crime / ASB/ Disturbance	The prevalence of crime, anti-social behaviour, disturbance and nuisance that is fuelled by alcohol consumption.	To: alcohol-related health harms (+); cost of policing and managing the NTE (+)  From: alcohol consumption (+); police and community safety presence (-); numbers of intoxicated individuals on the street (+)	"A comparison of alcohol related violence prior to deregulating licensing hours in 2004 with 2011 shows that in 2004 alcohol related crime peaked between the hours of 11pm and midnight. By 2011 the peak hours for alcohol related crime had expanded and shifted to midnight to 5am with a corresponding 600% increase in alcohol related crime." (Licensing Policy 2013-2017)  "I'm very pleased to see [name] council taking this initiative. I live in [area] which has more than enough pubs and clubs and where noisy customers in the street are a problem in the small hours." (Consultation response, resident)

System	Variable	Description	Connected to/from (positive or inverse relationship)	Example(s) (source)
Local	Police and community safety presence	The visible presence of police and community safety officers on the streets and in and around licensed premises.	To: emergency service usage (-); alcohol-related health harms (-); crime / ASB / disturbance (-); perceptions of safety (+); litter / vomit / urine / graffiti (-)  From: resources for managing / policing the NTE (+)	“From October 2012, a new late night levy will empower local areas to make those businesses that sell alcohol late into the night contribute towards the cost of policing and wider local authority action. This will help enable visible and proactive policing at targeted locations where there are local needs.” (The Government’s Alcohol Strategy, 2012)  “The proposals we have for spending the levy are to: • have a uniformed presence patrolling at weekends to deal with enforcement issues, drunkenness, street urination, rowdy and nuisance behaviour and assistant to vulnerable individuals identified. • Provide additional policing to support operations targeting crime and disorder. [...]” (LNL Consultation, 2013)
	Resources for managing / policing the NTE	The funds, staff and equipment needed to police and manage the NTE.	To: police and community safety presence (+) ; street cleaning services (+)  From: Late Night Levy; business rates / licence fees (+); council tax (+); failure of PPP schemes (-)	“The fees set for licensed premises have not increased since their introduction in 2005. During the intervening eight years, the demands for services have increased along with the number of premises opening late and it is now necessary to look to alternative ways of financing the services needed to manage the impacts.” (LNL Consultation, 2013)  “[The Late Night Levy] could potentially curb some of the more dangerous behaviour and sales of alcohol, as well as provide the Council and Police with additional resources in recognition of the extra costs involved in policing, monitoring and cleaning the areas around premises with late alcohol licences.” (Consultation response, political party)
	Business rates / license fees	The fees that premises pay to the LA; the business rate is based on the rateable value of the premise and the license fee is applicable for all premises with a license to sell alcohol for on- or off-premise consumption.	To: resources for managing / policing the NTE (+)  From: premise closures (-); industry profitability (+)	“Like I said, I don’t want boarded up buildings. I can’t have a whole area of [LA]. Because I live here, it’s not good for the economy, it’s not good for crime and disorder, you know. It’s, it’s not good, you know, it’s not good for the Council, you know, we don’t get business rates if premises are empty.” (Interview, Licensing officer)  “The council and police should already be budgeting for such a problem. Bars and pubs already pay a licence fee to the council – what’s that currently paying for?” (Consultation response, licence holder)
	Council tax	Tax paid by households to LA based on the value of the property to fund LA services.	To: resources for managing / policing the NTE (+)  From: residential reputation (+)	“Business rates/council tax is already astronomically high so I don’t see why this shouldn’t already be covered?” (Consultation response)

System	Variable	Description	Connected to/from (positive or inverse relationship)	Example(s) (source)
Local	Support for PPP schemes	The degree to which alcohol retailers and the alcohol industry support voluntary partnerships with the police and local authority, as well as other businesses, including the BIDs, PubWatch, Best Bar None, etc.	To: failure of PPP schemes (+); alcohol-industry lobbying / discourse-shaping activity (+); LA support for the levy (-)  From: Late Night Levy	“It penalises the hard work that many operators have undertaken in partnerships with the local authority and the police.” (Consultation response, licence holder)  “[LA] has engaged in active partnership working with its licensed premises so as to ensure high standards of management that will prevent nuisance and crime. It has participated in Central Government initiatives, held training events and developed a number of best practice schemes, including the Community Alcohol Partnership programme [...] There are six Pubwatches operating throughout the borough though this still sees only a small percentage of businesses actively engaging with the Council and police. Despite this engagement and the standards achieved within premises, [LA] continues to have a high level of alcohol related crime.” (Consultation response, Executive Member for Community Safety).
	Failure of PPP schemes	The number of PPP schemes that licensees choose to no longer support.	To: street cleaning services (-); resources for managing / policing the NTE (-); customer numbers (-)  From: support for PPP schemes (-)	“It is also unrealistic in the current economic climate to expect operators to have funds available to support involvement in voluntary initiatives AND pay the late night levy. Where no discount is available to encourage participation in such schemes and to provide some financial relief for doing so, such schemes will wither on the vine as membership falls away.” (Consultation response, Pub company)
	Opening hours	The hours until which a premise is licensed to sell alcohol.	To: alcohol availability (+); clustering of closing times (-); Late Night Levy  From: Late Night Levy	“[...] we understand that a large number of our members’ business will choose to voluntarily restrict their hours. Generally, it is only dedicated late night businesses which will generate sufficient revenues after midnight to justify retaining licensing hours within the levy period. Many traditional pubs or restaurants will have later closing times but will not regularly use them and, as the levy is based on permission not use, will therefore voluntarily relinquish them rather than face an additional cost.” (Consultation response, trade association representing on-licence trade)
	Clustering of closing times	The degree to which premises close at the same time.	To: numbers of intoxicated individual on streets (+); diversity of NTE offer (-)  From: opening hours (-)	“One consequence of the levy is likely to be that a significant number of premises will reduce their hours to 12 midnight resulting in a return to a non staggered closing time culture, contrary to government policy.” (Consultation response, supermarket chain).

System	Variable	Description	Connected to/from (positive or inverse relationship)	Example(s) (source)
Local	Number of intoxicated individuals on the street	The number of people out on the street who have been drinking.	To: crime / ASB / disturbance (+); litter / vomit / urine / graffiti (+)  From: clustering of closing times (+)	“The Council should also consider the risk of a defacto uniform terminal hour for premises arising as operators cut back their premises licences to cease at whenever the levy starts to bite. We have highlighted the actual experience of [LA with a levy] above. This will mean more customers on the street at the same time with resultant pressure on resources such as taxis, fast food outlets and policing.” (Consultation response, Pub company)
	Alcohol availability	The ease and convenience of purchasing availability; availability is comprised of the density of licensed premises (physical availability), the hours in which alcohol is sold (temporal availability), and the cost of alcoholic beverages (economic availability).	To: diversity of NTE offer (+); customer numbers (+); alcohol consumption (+)  From: opening hours (+); premise closures (-)	“Availability of and access to alcohol has an important influence on levels of alcohol consumption. Generally speaking, changes in the availability of alcohol tend to be reflected sooner or later in changes in levels of alcohol consumption and alcohol-related harm.” (Public Health Report, 2012)
	Premise closures	The number of alcohol-retailing premises who cease operating.	To: alcohol availability (-); business rates / licence fees (-); Late Night Levy  From: Late Night Levy	“There is a very real risk that [LA] Council will be responsible for premises closures, loss of jobs and income from rates (with higher outgoings in dealing with those people put out of work) from over-taxing those premises already struggling to cope with the burden they currently have.” (Consultation response, Pub and bar operator)
	Street cleaning services	The services to keep streets clean, including clearing rubbish and recycling, washing away vomit and urine, and removing graffiti.	To: litter / vomit / urine / graffiti (-)  From: resources for managing / policing the NTE (+)	“The proposals we have for spending the levy are to: [...] provide additional cleaning and service such as litter removal, graffiti removal and cleaning.” (LNL Consultation, 2013)
	Litter/vomit/urine/graffiti	Quality of the physical environment; physical manifestations of incivility.	To: LA support for the levy (+)  From: street cleaning services (-); police and community safety presence (-); number of intoxicated individuals on the street (+)	“the Licensing Authority has seen an increase in concerns raised by local residents, Councillors and local businesses about the impact that the night time economy is having on the local environment in this area. Typical issues of concern include: • Public urination • Litter • Noise nuisance from patrons of licensed premises • Drug dealing • Thefts • Damage to property and vehicles • Obstruction of the public highway” (Licensing Policy, 2011-2014)  “For instance, a significant majority [of] litter on the streets at night comes from premises not licensed to sell alcohol at that time, such as takeaways and shops with late opening hours. It is illogical and unfair to make payment for cleaning up the sole responsibility of premises selling alcohol.” (Consultation response, Pub company and brewer).

System	Variable	Description	Connected to/from (positive or inverse relationship)	Example(s) (source)
Local	Customer numbers	Number of patrons frequenting licensed premises.	To: footfall (+); industry profitability (+)  From: alcohol availability (+), nightlife reputation (+); failure of PPP schemes (-)	"Any reduction to its licensed hours made by venue operators will unquestionably have a detrimental impact on other local businesses in the area, including [LA's] many eateries, as there are likely to be fewer customers in the area for a shorter period of time, thus further affecting the financially lucrative late night economy." (Consultation response, licensee).
	Footfall	The number of individuals in the LA on a given night.	To: attractive area for businesses (+)  From: customer numbers (+)	"We are bound to ask whether the Council has considered the consequences of closures not just to the licence holders in [LA] but the migration of customers into the neighbouring boroughs which will not only affect the earlier evening trade but will also have the effect of damaging other businesses through lower footfall in that earlier evening." (Consultation response, Hospitality company)
	Attractive area for business	The degree to which an area is perceived as attractive for a business, includes number of residents and visitors, other types of establishments and 'friendliness' of Council to businesses.	To: local jobs (+); diversity of NTE offer (+)  From: footfall (+)	"The Council should consider its decision very carefully before [LA] becomes a place that becomes unattractive as a place to trade. [Pub company] will decide its future expansion and growth plans within London on the basis of how business friendly the incumbent Council is in any particular area." (Consultation response, pub company)
	Local jobs	The number of jobs in a local area, some of which are in the alcohol-retailing and hospitality sector.	To: strength of the local economy (+)  From: attractive area for businesses (+)	"This is an unfair tax on vulnerable businesses who provide wealth and jobs for the borough." (Consultation response, licence holder)  "But we're a poorer borough, we need people to have jobs, we don't want boarded up or empty premises". (Interview, Licensing officer)
	Strength of the local economy	The degree to which there are wealth generating activities in the LA. The NTE is one contributor to the local economy.	To: LA support for the levy (-); residential reputation (+)  From: local jobs (+)	"The council recognises that the entertainment and alcohol industry contributes to the borough by providing a variety of opportunities for entertainment as well as employment and career opportunities." (Licensing Policy 2011-2014)  "This is a significant additional cost for businesses to bear and it will affect profitability and viability for many. Some will choose to close earlier to avoid paying this, with knock on effects on turnover, GVA to the local economy and employment patterns." (Consultation response, trade association representing on-licence trade)

System	Variable	Description	Connected to/from (positive or inverse relationship)	Example(s) (source)
Local	Diversity of NTE offer	Different types of premises operating in the NTE, including: pubs, bars, clubs, restaurants, live music venues, off-licences, supermarkets, clubs, hotels and the characteristics of those premises (e.g. catering to different types of clientele).	To: nightlife reputation (+)  From: alcohol availability (+); clustering of closing times (-); attractive area for businesses (+)	“The council is keen to preserve a diverse mix of premises through the borough and wants to work with businesses, residents and partners through its Licensing Policy to resist the saturation of licensable premises of similar types within identified local areas.” (Licensing Policy 2011-2014)  “We feel that there has not been enough research carried out into the benefits of a mixed and diverse night time economy in [LA] which could stagnate on the introduction of a levy. Premises where alcohol does not contribute significantly to profit but is offered after midnight may well close early. This will harm the diversity of offer, leaving only larger pubs and nightclubs willing to pay the levy.” (Consultation response, pub company and brewer)

Abbreviations: A&E: Accident and Emergency; BID: Business Improvement District; CIP: Cumulative Impact Policy; EMRO: Early Morning Restriction Order; LA: Local Authority; LNL: Late Night Levy; NTE: night time economy; PPP: public-private partnership



*they're making so if there was a police presence I don't think they'd be as boisterous.*  
(Consultation response, resident)

It was theorised that a safer NTE would enhance the overall reputation of the area, driving up visitor numbers and encouraging individuals to spend more money in local establishments. Implicit in this argument was that the levy fee would be easily offset by increased customer numbers, thereby making the levy beneficial for both commercial actors and the LA:

*the money's going to pay for more policing, and [licensees] get more policing and that is beneficial for them because the safer an area is, the more people that come to the area and the more money that gets spent and the more money they make.* (Interview, Community safety officer)

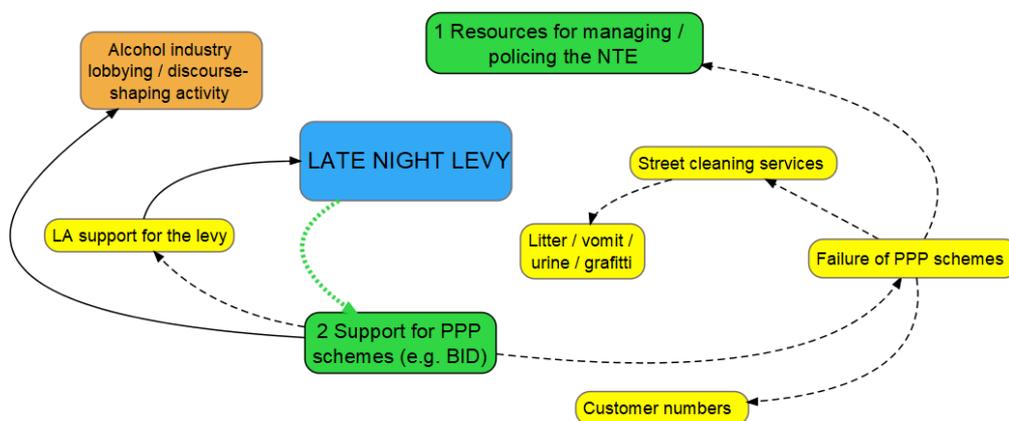
### ToC 2: Reduced support for PPP schemes

A second theory of change, articulated by businesses, was that licensees would be disinclined to continue to support PPP schemes because the resources do so would be re-directed to paying the levy:

*If operators do choose to pay the levy then it will impact on funding they can provide for partnership initiatives such as BIDs, Pubwatch and Best Bar None which the Council should look to support and promote in preference to a levy.* (Consultation response, Pub company)

Many licensees in particular expressed concern about the LNL's impact on the BID, which funds dedicated police officers and cleaning services. In consultation responses, licensees agreed they would vote against the BID when it came up for renewal, which in turn, would cause the BID to fail: (Figure 3): "As a BID payer if the levy were to come into force I would be voting no the next time the bid comes up for tender" (Consultation response, licensee).

**Figure 3: Theory of change 2**



Orange bubble = national variable; Yellow bubbles = local variables; Green bubbles = immediate theorised impacts stemming from levy introduction  
Solid line: positive relationship between variables; Dashed line: inverse relationship between variables; Dotted green lines: theorised impacts stemming from the levy introduction

If the BID were to fail as a result of the LNL, it was theorised that there would be a range of unintended consequences in the local system. These included reducing the overall resources available to manage and police the local area and damaging economic impacts because the BID is intended to work to create an environment that encourages residents and visitors to the area:

*It is a possibility that nearly 40 licensed premises in the [local area] BID area will not vote for the BID again if this means that they pay two levies instead of only one. A BID needs a majority by numbers and also rateable value to succeed. A failure to achieve either one of these would therefore, jeopardise the provision the BID makes for policing and cleaning as well as what we do to ensure a good shopping environment for local people, Christmas lights, hanging baskets, support for community events and much more. (Consultation response, Pub manager)*

Any negative impact of the levy on the BID was theorised to also have impacts beyond the boundary of the local system. The BID Board argued that this should be considered within the Mayor of London's goal to increase the number of BIDs throughout London:

*BIDs are burgeoning in London and the Mayor has set a target for a number of additional BIDs by 2015. It would be a loss, not just to [LA] but to London as a whole should [BID name] not get re-elected and become the first BID in London to fail. (Consultation response, BID Board)*

*ToC 3 and 4: Premises will (3) vary hours or (4) close due to unwillingness or inability to pay the Levy*  
In response to the Council's consultation, 42% of businesses reported they would voluntarily change their permitted licensing hours in response to the introduction of the levy. A smaller number argued that the levy would force some businesses to close as they became economically unviable. These possible responses were theorised to lead to a range of unintended consequences, including undermining the levy, re-introducing a 'terminal hour,' reducing the diversity of late-night provision and ultimately generating negative economic consequences to the local area in the form of reduced employment and local investment.

Only two consultation responses, submitted by Public Health and the Clinical Commissioning Group, considered the LNL in terms of its ability to reduce alcohol consumption and associated harms by restricting the availability of alcohol. In contrast, all other system actors discussed the levy in terms of addressing the harms associated with acute intoxication, focusing primarily on disturbance, anti-social behaviour, crime, and to a far lesser degree on health-related indicators such as ambulance call-outs or hospital admissions. In this sense, discourses around reducing or preventing alcohol consumption (primary prevention) were largely absent, with a focus instead on making the NTE a safer space for consumption and the possible economic and cultural impacts of the levy.



*Many operators will have to curtail their hours irrespective of the economic consequences, thereby reducing the number of post-midnight premises in the borough. [...] visitors to the Borough's late night economy [would be] choosing other areas of London where no such restrictions apply with obvious economic consequences for [LA]'s late night economy and the businesses that rely on it. (Consultation response, Operator of managed pubs)*

In underscoring how elements of the system are interconnected, a number of businesses suggested that the LNL would have negative economic impacts that affect more than just late-night alcohol retailers, making the LA a less appealing area to operate a business:

*I am currently looking at sites in the borough; I run a high end food and drink offer, if this levy is introduced I would have to look if the operation could still be viable. My venues do not run beyond midnight but I understand that early evening venues are intrinsically linked to the later venues and if these were to close or relocate it would reduce footfall in the areas affected. (Consultation response, prospective licensee)*

Ultimately many businesses argued that the LNL, through changes to opening hours, lower profit margins, premise closures and lack of investment in the local area, would result in negative economic consequences and job losses for the LA as a whole:

*The council will further kill off the high street if they implement this levy. Pubs and bars will re-locate to other nearby locations where the levy is not in place and lose a number of job opportunities for local people. I thought the council's major objective as to increase employment opportunities for local people, not decrease it. (consultation response)*

## Phase 2: early implementation and mechanisms of system change

The levy began on November 1, 2014 and in the first year, fees were collected from 338 licence holders.

### ToC 1: Increased resources

The key theory of change as described by those who designed and implemented the levy, was that it would bring in additional resources to manage and police the NTE (Figure 2). In the first year the levy raised £397,278 and in the second year £377,122 (Council LNL Year 1 and 2 Reports). While these figures were lower than the Council's projected £450,000, the Council described these as sufficient to plug an "an identified gap" in managing and policing the NTE (Council, LNL Year 1 and 2 Reports). The additional resources were utilised to fund an NTE-specific police team and a four-person community safety patrol, delivered by a police-accredited, private company, that worked Thursday – Sunday nights from approximately 8 pm – 8 am.. The new community safety service is the primary focus of Phase 2 of this process evaluation; an overview of the structure of the new service is provided in Table 6, along with output data from the service provider's annual reports.

**Table 6: Community safety service**

<b>Patrol description:</b> The patrol met at 8 pm and conducted a ‘scan’ of the borough, driving down main roads and stopping to address any issues they identified, such as visible pre-loading. At 10 pm the officers attended a briefing at the police station which included: 1) a police briefing for all officers on duty and 2) a NTE briefing for the NTE police patrol and the community safety officers. Following the briefing, the community safety officers patrolled the borough throughout the night, conducting a number of ‘taskings’ (which came from the Police, the Licensing Team or were self-generated), responding to calls from venues, identifying and responding to individuals and groups and patrolling areas where there were hyper-local ‘kick-out times’. The patrol concluded around 8 am.		
<b>Strands of the service</b>	<b>Year 1</b>	<b>Year 2</b>
Welfare	316 checks	724 checks
Medical	161 individuals	97 individuals
Addressing anti-social behaviour, aggression, urination, pre-loading	365 incidents of violent or aggressive behaviour, 451 dispersals, 738 warnings about conduct	784 incidents of violent or aggressive behaviour, 675 dispersals, 1,235 warnings about conduct
Support to the licensed trade	2,295 liaisons with licensed trade; 226 responses to calls	2,482 liaisons with licensed trade; 125 responses to calls
Intelligence gathering	620,459 words	620,292 words

Source: Fieldnotes; Community Safety Company, LNL Year 1 and Year 2 Reports

A key component of the new patrol service, which significantly increased from Year 1 to Year 2, was engagement with users of the NTE to ensure their welfare and to intervene early in anti-social behaviour, disturbance and nuisance to prevent its escalation:

*So not only are they there to deal with the response side of it, but it's to try and prevent that happening in the first place, so to deal with those people who potentially would go on and commit further offences because they've started shouting and swearing and causing problems with someone up this end of the street. By the time you get down the other end, they've stopped in five other pubs on the other way, not been challenged, not been highlighted to anybody on the way down, although their behaviour's getting more and more rowdy. Then they go in, have a fight or cause a disturbance and need for police action further down the road. (Interview, Police officer)*

The welfare aspect of the service, which included community-safety officers helping members of the public, was also considered a critical component of the service and as shown in Table 6, increased significantly from Year 1 to 2. The officers also provided medical care and the medical service represented an evolution of the service. While it was always within their remit to have a first-aid trained officer, they expanded this provision shortly after starting the service and purchased additional medical equipment. In addition to supporting members of the public, the medical side of the service was seen as a low-cost mechanism to reduce the burden on the London Ambulance Service and NHS. In the first two years the service reported preventing or cancelling the dispatch of 54 and 57 ambulances, respectively, which they calculated as savings of £16,200 and £14,478.

The Council reported a 17% reduction in alcohol-related crime between midnight and 8 am and a 14.4% reduction in alcohol-associated violence compared to the previous 12 months, although they

assumed that this was not all attributable to the levy. They also reported a large increase (29-30%) in calls to the police and anti-social behaviour line about alcohol-related incidents which they further argued justified the need for the levy funding (Council, LNL Year 1 Report). In Year 2 the Council reported a 21% reduction in alcohol-related crimes compared to the previous 12 months, and a 24% decrease in anti-social behaviour calls (Council, LNL Year 2 Report).

#### *Engagement with the licensed trade*

Whilst ToC 1 emphasised the resources to police and manage NTE users in the area, the new patrol service also sought to develop relationships with local actors. Notably, they tried to develop relationships directly with the licensed trade – to monitor and support licensed operators to encourage safer business practices aimed at minimising anti-social behaviour within and outside the premises. In the first year of the levy funding, the patrol provided an introductory visit to 251 of the venues on the levy, which they argued was as an important mechanism to overcome hostility towards the levy and its funded patrols.

Outside of the initial visits, the patrol worked to develop relationships and trust with venue staff through the repeated interactions; a key element of this, which they contrasted with the police, was the deployment of the same officers every night, particularly in the first year of the service:

*One of the things you absolutely have when you're any form of policing, really, you've got to have that consistency. You've got to have the relationships. That comes from, you know, repetition. It's from meeting the DPSs [designated premise supervisors] on a regular basis, building up a trust and an understanding of what you're there to do [...]. Well if you're on rotation you can't possibly know. You wouldn't even know who that person is and you certainly wouldn't be able to kind of build a balanced intelligence picture. (Interview, Community safety officer)*

When probed, community safety and police officers described an evolution of the relationships such that many licensees began to engage with the service, overcoming their initial resistance:

*We came up initially against a lot of unhappiness because it's another tax effectively, a levy on these premises. They don't want to pay it. They're already paying ridiculously high rates and other business taxes and stuff. So, but, you know, I get that. But we're seeing a change now, you know. A year, 18 months down the road, they can see a benefit to it, so [...], if they need help they'll get help. You know, they'll prevent stuff happening and hopefully make their business more attractive. (Interview, Police officer)*

Others licensees, however, remained what the officers referred to as 'hostile venues,' continuing to oppose the levy and its associated services. Officers put this down to a misunderstanding of the service's remit: "they [the licensees] see it as an enforcement role instead of a support role."

(Excerpt from fieldnotes)

The community safety service was tasked with collecting intelligence to help the police or inform licensing decisions. Key to this intelligence-gather strategy was developing cooperative, rather than adversarial relationships with venue managers and staff, as described above. Information gathering and sharing amongst police, patrol and licensed venue operators was reciprocal, or in system terms, represented a positive feedback loop. Closer relationships amongst these three groups of actors appeared to emerge as a consequence, along with an ‘othering’ of certain venues who remained outside of this information sharing sub-system. Furthermore, the information gained was used to inform licensing decisions that affected alcohol availability (although as stated earlier, participants tended not discuss the LNL in terms of its impacts on alcohol availability). This intelligence was considered key to ensuring that managing and supporting the NTE was achieved across agencies and showed the ways in which new system actors developed and extended relationships with others to manage the local NTE:

*And [the community safety officers] assist us as well. Not just us as licensing officers, but the police on the whole, because within our briefings we can say to them, just little things that have happened, that you wouldn't normally get a chance to deal with, can you go and check on this and this, this, this, and just have a look and even in terms of where new applications are coming in and people are asking to do various different things in their licence, and we're thinking, not sure you could do that, but we need to check the place out. [...]. And they report back to us, and then that assists us in saying whether someone can or can't have a licence. It's invaluable, really.” (Interview, Police licensing officer)*

Through the mechanisms described above, the Council, the police and the community safety officers reported that more venues were operating in a ‘responsible manner’ following the implementation of the levy. Hence, while the initial theory of change around extra resourcing focused on policing and management of NTE-users, by the second year of LNL’s implementation a new mechanism for impact had emerged through information sharing and relationship building between NTE operators and the agents that patrolled and policed the NTE:

Interviewer: do you think it (LNL and other licensing policies) has changed kind of how people consume alcohol in the borough?  
Respondent (Police licensing officer): *I don't think it's changed how people consume their alcohol in the borough. I think it's changed how operators operate.*

Taken holistically, the new service was perceived to have changed how actors within the system behaved and interacted with one another, disrupting previous patterns of behaviour as system elements responded and adapted to the new services. The service could also be conceptualised as having a non-linear effect on the broader system: the four-person patrol represented a fairly small system input which had the ability to affect, for example,

perceptions of safety, emergency service usage, anti-social behaviour and alcohol retailing practices.

#### ToC 2: Reduced support for PPP schemes

The second key theory of change was that if businesses were liable to pay the levy, they would no longer support PPP schemes, particularly the local BID (Figure 3). This initial ToC did not accurately theorise how the system would adapt in the first two years of the intervention. Instead, in October 2016 members of the BID “again voted resoundingly for us to continue” (BID website) and the BID expanded to cover a larger geographical area. Following the introduction of the levy, the BID reported a key priority for safety in their area was: “achieving 24-hour security at [BID area] through co-ordinated working with street patrol [LNL-funded service]” (BID Annual Report, 2015/2016) and a licensee described a reliance on both BID- and LNL-funded patrols:

*The night time economy is a major contributor to the wealth of the [BID area]. Making sure the environment is fun yet safe is a huge undertaking, not only for us licensees but also for the police and [LA] Council. [BID name] makes sure we are all working together. Not only do we have the [BID-funded] Police Team at our disposal but can also rely on [LNL-funded service]. (BID Annual Report, 2016/17, Bar Owner)*

Prior to the levy’s implementation, members of the licensed trade argued that the BID-funded services addressed their policing and safety needs. However, as the LNL-funded community safety patrol became embedded in the local system, some members of the BID came to see the community safety patrols as a complement to their own funded services and promoted collaboration between the two services, leading to greater resources for managing the local environment.

#### ToC 3 and 4: Premises will (3) vary hours or (4) close due to unwillingness or inability to pay the Levy

The final theories of change were that a large number of premises would vary their hours in response to the introduction of the LNL, or in some cases close completely, which would lead to unanticipated consequences (Figure 4). The data reported by the Council showed that approximately one quarter of all premises who were initially liable to pay the levy either varied their licence hours or closed prior to the implementation date, which was lower than the 42% who indicated they would during the consultation period. The majority of these businesses varied their hours, rather than permanently closing their doors.

The majority of premises that were identified as being liable to pay the levy continued to operate after midnight and the LA did not see a re-introduction of a ‘defacto terminal hour’. However, there remained clusters of bars and pubs that closed at similar time, which the community safety officers would refer to informally as ‘kick-out times’.

Members of the licensed trade and some residents and visitors theorised the levy would create an NTE that lacked diversity, which in turn would drive down visitor numbers. During the course of fieldwork, we observed a busy NTE with bustling streets and busy venues. All the users of the NTE we spoke with during the course of fieldwork in the second year of the levy described numerous and diverse places to go out in the LA:

*[Name] was talking about how there used to be only one place really to go (The Name – which she says is a great pub), but now there are so many options. The places to go out don't just include alcohol: "It used to be that there were just three places to eat ... [she lists their names] and now there are so many to choose from. (Excerpt from fieldnotes)*

Cumulatively, these data show that some premises did vary their hours in response to the introduction of the levy, but the levy remained viable and that an insufficient number of premises closed at midnight to re-introduce a 'terminal hour'. The LA maintained a reputation for providing a diverse and busy NTE following the implementation of the intervention.

## DISCUSSION AND CONCLUSION

This two-phased process evaluation sought to describe the local system into which the LNL is introduced and explore how the intervention may lead to changes as the system, its actors and the intervention adapt and co-evolve over time. We identified four main theories of change that describe the multiple processes by which the intervention might generate system change, including those that were unanticipated at the intervention design stage.

The first theory of change articulated how the intervention was designed to increase the resources available to police and manage the NTE. The evaluation shed light on the mechanisms by which those resources might lead to change; specifically, by introducing new actors into the local system, who through consistent, visible and prolonged relationship building with the licensed trade and the public, sought to disrupt local system rules and develop new practices. Findings from the first two years of the levy suggest that these efforts led to an evolution in the way that many, although not all, licensees viewed the levy and a change in how some venues are managed. Information sharing practices provided emergent opportunities for mutually-supportive relationships between those who operate licensed premises and those who manage or police the NTE – although some premises were 'othered': i.e. positioned outside of these relationships.

Contrary to expectations, the introduction of the LNL did not undermine PPP schemes during the study period, particularly the BID, as expressed in the second theory of change. The reason that the LNL's implementation co-occurred with an increase in voluntary industry initiatives and partnerships is unclear. Commercial actors had originally showed a clear preference for voluntary and partnership

initiatives (such as the BID) over regulation (such as LNL), and there may have been a desire amongst commercial interests to maintain support and claim success for local PPP schemes during a period when the LA was adopting discretionary regulatory powers – in order to avoid regulation themselves. Whatever their reasons, some commercial actors appeared to believe that both regulatory and voluntary activities had adapted to complement each other and confer their own benefits on the NTE. The mechanisms by which increased regulation of the sale of harmful commodities might lead to increased voluntary and partnership activity warrants further investigation across different types of interventions and harmful commodities.

With regards to the third and fourth theories of change, there was some evidence that premises varied their hours in response to the levy, but these changes did not ultimately undermine the viability of the levy, lead to the re-introduction of a terminal hour, or obviously damage the NTE's reputation as being diverse and vibrant. Taken together, those in charge of developing and implementing the levy at the local level, viewed these early indications of system change as successful. This suggests a reinforcing feedback loop, whereby the perceived success of the levy ensured its continuation.

Almost all actors in the system deprioritised discourses of reduced alcohol harm through reduced availability – even though we know that some degree of temporal (earlier 'kick out' times) and physical (premise closures) reductions in availability did occur. The discourse around LNL's impacts on harm focused almost exclusively on secondary prevention of harms through improved community safety services and policing of anti-social behaviour linked to intoxicated NTE users. Discourses around primary prevention (reducing or preventing alcohol consumption) were deprioritised in favour of economic and cultural impacts. Although these findings focus on the local system, they occur within a wider system in which industry actors frame discourse and lobby policymakers to encourage voluntary partnership approaches to regulation (42). The focus on secondary, rather than primary, prevention suits commercial interests in that action to prevent harm is taken after the point of sale. The nature of the framing of harm prevention, and when preventive action should be taken, is a point that could be explored through further research.

This evaluation represents the first application of our complex systems framework for process evaluations (32). While many in public health have argued that complex system approaches can produce better evidence for decision making that account for real-world complexities (13), there have been relatively few prominent examples of this perspective applied to public health process evaluation to date (43). In addition, many process evaluations in this field have focused largely on describing static systems with limited attention paid to dynamic processes of system change (32).

This work attempts to address some of these limitations. The use of the framework and explicit application of systems and complexity concepts was utilised to make sense of the broader system into which the levy is introduced, the many processes through which the levy may lead to impacts, many of which might be unanticipated, and the dynamic responses to the intervention that lead to an evolution of the system's actors, their relationships with each other, the intervention, and the system as a whole.

This process evaluation is also the first known evaluation of the LNL (44,45). An Institute of Alcohol Studies (IAS) report reviewed the impact of the Licensing Act (2003) ten-years post-implementation and reported that the LNL had the potential to reduce alcohol availability by encouraging premises to shorten their opening hours, could help foster a cleaner environment through the provision of additional street cleaning resources and could be used to promote diversity in the NTE. The report also highlighted other possible impacts of the levy, including that the levy might prevent or damage partnership working between LAs and the alcohol industry, impact the industry's profitability, and be too inflexible a tool to be well suited to many LA's NTEs (44). The findings from our process evaluation shed light on the mechanism by which these impacts may or may not occur within a local system. Despite acknowledging that there has been no evaluation of the LNL's impact on crime and disorder, a subsequent joint IAS and Foundation for Alcohol Research and Education report argues: "Attempts have been made to limit closing times in areas with acute problems, through the late night levy and early morning restriction order, although these policies have also proven largely ineffective" (45 p.10). Few LAs have tried to implement the LNL, so in that sense the impacts of this discretionary intervention have been highly localised. However, in light of the findings from this process evaluation that suggests some of the mechanisms by which the LNL may reduce crime and disorder, as well as other problems in the NTE, we would recommend further evaluation of the LNL, and of alcohol and health impacts within local systems.

### Strengths and limitations

As evaluators, we made two crucial boundary decisions in this process evaluation: to focus on the local level and to include and exclude certain local system variables from our analysis. Together, these represent an emphasis on horizontal complexity. The first decision was made a-priori and was influenced by the nature of the intervention (i.e. a locally-delivered intervention) and our interest in the delivery processes within one LA system. However, there are also vertical complexities that affect, influence and interact with the local system; the local system is embedded within broader regional, national and international systems and the boundaries between them are open (15). We included some consideration of the national system in order to make sense of the context in which the LNL was introduced as a discretionary power available to LAs, but other stakeholders within the

national and local systems, or other evaluation teams might have chosen to broaden their boundaries. Given limited evaluation resources, there may be a trade-off of breadth versus depth. Some evaluators have suggested conducting Qualitative Comparison Analyses (QCAs) to address this challenge (46,47). In addition, as evaluators, we made decisions about the variables of interest within the local system (46). This was informed by the data generated through the evaluation and our aim was to focus on the variables we found to be most relevant to the LNL. Examples of this exist within the systems literature, for example, with researchers utilising data generated through documentary review and interviews to develop causal loop diagrams (48). However, this raises important considerations around power dynamics and who ultimately decides where boundaries are drawn (49). This work could fruitfully be extended by engaging in processes that invite system stakeholders to participate in the boundary decisions and critique (20,50).

A limitation of this evaluation is that we did not collect primary data from residents or those working within the healthcare system. In addition, no data were generated or analysed about the broader economic impacts on the local economy. Conducting systems research often involves collecting data from a wide range of different actors across a given system (16), which is resource-intensive and challenging when conducting smaller, local evaluations. Conducting a documentary analysis is one possible way to include data from a wider range of participants than might be possible through interviews and observations alone. In this evaluation, for example, we collected limited primary data from members of the licensed trade and relied on their extensive consultation responses which provided insight into the ways in which they theorised the levy might lead to a range of unanticipated impacts across the local system.

We collected data for Phases 1 and 2 concurrently in the post-implementation period (although many documents included in our documentary review were produced prior to the levy's implementation). As a result, Phase 1 informed the Phase 2 analysis, but not the Phase 2 data collection. While this approach underscores the flexibility of the process evaluation from a complex systems perspective framework, it also limited our ability to follow all emergent findings. For example, the consultation responses underscored how the levy might affect employment patterns in the local area, with premises having to vary their employees' shift patterns or make some employees redundant. We did not collect data from premises or from the LA that could then speak to these possible impacts.

### **Future direction and conclusions**

The process evaluation from a complex systems perspective is intended to be adaptive, drawing on early findings to inform subsequent data collection and analysis. A logical next step for this

evaluative process is to measure alcohol-related outcomes and to understand the processes beyond the immediate local system of interest, to consider the vertical dimensions of complexity. The evaluation shed light on the possible spillover effects to neighbouring local authorities, and these processes and outcomes could be explored. In addition, in the Modern Crime Prevention Strategy (2016) the Government proposed changing the structure of the levy to apply to specific types of premises or specific hotspots within the NTE, rather than entire LAs. At the end of the same year, the Home Office concluded that the levy had been implemented in fewer LAs than anticipated (n=7) because of criticisms “that LAs consider the levy to be inflexible and the licensed trade has highlighted issues of unfairness in terms of which businesses pay the levy” (51 p.1). While the changes were to come into effect in 2020, by which 11 LAs had a LNL (52,53), at the time of writing, they have yet to do so. Finally, the Covid-19 pandemic represents a large system shock that has had significant financial impacts on LAs and the licensed trade (54). This process evaluation could usefully be extended to explore these interacting local, regional, national and international processes and systems.

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**Author contributions:** EM designed the methodology, conducted data collection, led on the analysis and drafted this manuscript. ME contributed to the analysis. EM, DM, MP and ME provided input into data interpretation, critically revised the manuscript and approved the final version.

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## Chapter 7: Discussion and Conclusion

### 7.1 Introduction

This thesis aimed to develop and apply a methodological framework for the application of a complex systems perspective to public health process evaluations of interventions to reduce alcohol-associated harms. In order to achieve this aim, I had six objectives:

- 1) To understand how complex systems are defined and conceptualised in public health.
- 2) To describe the scale and scope of research on alcohol consumption and associated harms from a complex systems perspective and to identify evidentiary gaps in this literature base.
- 3) To identify and appraise process evaluations of public health interventions that utilise qualitative methods and apply a complex systems perspective.
- 4) To develop a methodological framework for process evaluation from a complex systems perspective.
- 5) To theorise and analyse how local alcohol interventions affect the systems within which they occur by exploring intervention pathways to impact with reference to key complex systems concepts.
- 6) To identify implications of this research for further development of evaluative methods from a complex systems perspective.

The following sub-sections briefly summarise how the components of the thesis fit together to meet each of the objectives of the research and how they have contributed to the literature on efforts to utilise a complex systems perspective to address wicked public health challenges, such as alcohol misuse.

#### 7.1.1 Objective 1: definitions and conceptualisations of complex systems in public health:

To understand the roots of systems thinking and complexity science, and to make sense of how complex systems are defined and conceptualised within public health, I began this PhD research by conducting an unstructured literature review which is presented in Chapter 2. I began with a number of key texts and then utilised a snowball search strategy to continue to identify relevant papers, focussing on specific concepts from systems thinking and complexity science (e.g. boundaries, feedback, etc.) to guide my search. This initial literature review was designed to bring clarity to the concepts utilised in systems thinking and complexity science in public health and to begin to consider the ways in which these concepts could be used to inform the conduct of process evaluations from a complex systems perspective.

7.1.2 Objective 2: scale and scope of research on alcohol consumption and associated harms from a complex systems perspective:

Some alcohol researchers, alongside other public health researchers, have argued that alcohol research would benefit from the explicit adoption of a complex systems perspective to develop and evaluate alcohol harm prevention efforts across multi-level systems (1,2). I therefore used the PhD opportunity to explore and contribute to gaps in this knowledge. As part of this, I conducted a scoping review (Chapter 4) to determine the scale and scope of complex systems research on alcohol and to identify evidentiary gaps in this body of literature. Through database searching, hand searching and reference screening, I identified 87 primary studies and three systematic reviews that I categorised into three main methodological approaches: theory-led approaches, dynamic simulation models and social network analyses. The studies focused on patterns of alcohol consumption and environments where alcohol is consumed, and predominately focused on individual or local-level systems, with fewer examples considering the interplay between these and regional, national and international systems.

Conducting this review provided an important contribution to the literature on efforts to reduce the harms associated with alcohol consumption and it allowed me to better situate the research done for this PhD within the broader context of alcohol research that takes a complex systems perspective. It also helped inform the analytical focus on the Late Night Levy (LNL) process evaluation (Chapter 6).

7.1.3 Objective 3: qualitative process evaluations that apply a complex systems perspective:

Concurrent to conducting the scoping review to address Objective 2, I planned and conducted a systematic literature review to identify qualitative process evaluations of public health interventions that utilise a complex systems perspective. While there are many examples of using mathematical simulation methodologies, such as agent-based modelling or system dynamics modelling (3-5), to conduct complex systems research, there is no clear methodological approach for conducting process evaluations from a complex systems perspective. Through my ongoing familiarisation with the public health complex systems literature and my own work (Chapter 3), I identified some process evaluations drawing on systems thinking and complexity. In order to appraise and synthesise their methodological approaches, I therefore conducted a review to systematically identify public health process evaluations that utilise qualitative methods and a complex systems perspective (Chapter 5) (6). Through database searching, citation searching and expert consultation, I identified 21 unique process evaluations, including the RtS study (Chapter 3), that explicitly applied a complex systems perspective. The evaluations primarily used systems concepts to describe a system at a static point

in time, whereas fewer used concepts from complexity science to dynamically evaluate system change stemming from intervention implementation. I found the studies lacked a coherent methodological approach to process evaluation from a complex systems perspective, and I therefore developed a framework to address this gap (Chapter 5).

#### 7.1.4 Objective 4: methodological framework for process evaluation from a complex systems perspective:

The process evaluations identified in the systematic review (Objective 3), my early attempt to apply a complex systems perspective to a process evaluation of an alcohol intervention (Chapter 3) and my understanding of complex systems (Chapter 2) were utilised to develop a methodological framework for qualitative process evaluations from a complex systems perspective (Chapter 5). The framework was developed to utilise the conceptual and methodological tools associated with systems thinking and complexity science to provide a clear rationale and process for conducting process evaluations that extend beyond immediate implementation. The framework was designed to be flexible to suit different evaluative foci and varying levels of resource available for evaluation.

#### 7.1.5 Objective 5: evaluation of local alcohol interventions with a complex systems perspective:

I conducted two different process evaluations of local-level alcohol interventions: RtS and the LNL (Chapters 3 and 6). The evaluations were designed and conducted at different points within my research degree programme and I was therefore able to use the first evaluation as an opportunity to learn and extend my application of complex systems thinking in the second evaluation. For the LNL evaluation, I retrospectively applied the framework detailed above (Objective 4). Applying the evaluation framework allowed me to theorise and analyse the mechanisms by which the intervention and the multiple responses to it impact the broader system into which it is implemented (Objective 5). Both evaluations contribute to the empirical literature on local-level alcohol policymaking and interventions and progress the methods on applying a complex systems perspective to public health evaluation.

#### 7.1.6 Objective 6: implications of this research for future methodological development:

Cumulatively, the research presented in this thesis was undertaken to both advance complex systems methodology for public health evaluators and to use these advances to generate empirical evidence on local-level alcohol interventions implemented in England. Taken together, this

programme of research demonstrates opportunities for public health evaluators to develop and advance their methodological approaches to addressing wicked public health issues. These implications are discussed in this chapter.

## 7.2 Empirical findings: summary and comparison with existing literature

Each of the chapters presenting empirical findings on efforts to reduce alcohol-associated harms (Chapters 3 and 6) has its own discussion section. To avoid excessive duplication, the following sections will provide an overview of the main results from each process evaluation before turning to a broader discussion that situates the findings within the literature on English alcohol policymaking and interventions and draws out some of the wider implications for public health research.

### 7.2.1 Reducing the Strength

The analysis of RtS presented in Chapter 3 utilised a systems framing and drew on concepts from complexity theory to understand the mechanisms by which the intervention may lead to intended and unintended consequences within the system into which it is implemented. The intervention entailed police and licensing officers asking retailers to voluntarily stop selling ‘super-strength’ beers and ciders in order to reduce street drinking, begging, alcohol-specific hospital admissions and to underscore the dangers of super-strengths to local residents. I collected data from homeless drinkers and service providers relevant to that population through interviews and a focus group in order to understand responses (hypothetical and actual) to the intervention at different levels within the system.

At the individual (or sub-local) level, drinkers engaged, or were assumed to engage, in a wide range of substitution behaviours, including finding shops that still sell super-strengths, switching to different drinks within compliant shops or substituting substances, which may undermine the goals of the intervention and lead to unintended consequences including consuming the same or more units of alcohol and engagement in criminal activity. At the service level, service providers viewed the intervention as too limited to address excessive alcohol consumption, although recognised it as an opportunity to engage with drinkers who were already seeking help. Service providers portrayed the intervention as a missed opportunity for collaborative working between public and private sector interests. While the intervention was viewed as having limited local impact, participants argued that within the broader sociocultural environment the intervention could be part of a longer process by which the accumulation of small, local initiatives increase public awareness of the harms associated with alcohol and spur social and political change. The evaluation of RtS led by local

authority (LA) practitioners and presented in Appendix C, focused on another aspect of the local system, the retail environment, and found that while there were high rates of participation from retailers, the low rates of non-compliance could easily undermine the intervention. Some retailers therefore suggested a regulatory scheme would be more effective in achieving the intervention's goals (7).

The RtS evaluations underscored the value of applying a systems perspective: both studies highlighted how individual and/or local foci risk missing important social, political and economic processes that intersect sub-local (individual), local, regional, national and international systems. For example, retailer decisions about participation in a voluntary scheme like RtS need to be considered within their broader corporate structures and the financial and political interests of alcohol producers. Making sense of RtS's ability "to highlight the dangers of alcohol, particularly super-strength alcohol, to residents" (8 p.3) requires conceptualising the intervention as an event within a system that can contribute to longer-term social and cultural processes, something a more conventional evaluative timeframe might miss.

### 7.2.2 Late Night Levy

The process evaluation of the LNL (Chapter 6) was designed to describe the system into which the LNL is introduced and analyse how the intervention affects resource allocation, changes individual and organisational relationships and displaces certain activities (9,10), as well as how such adaptations to the intervention create feedback loops that may amplify or dampen system changes (11,12).

The LNL was designed to generate additional resources to police and manage the night time economy (NTE) in order to address crime, anti-social behaviour, nuisance and litter associated with late-night drinking. Prior to the levy's implementation, stakeholders in one inner-London LA theorised the levy could also generate a number of unintended consequences, including leading to the failure of public-private partnerships, such as the Business Improvement District (BID) or forcing venues to close early or shut entirely. These responses might, in turn, jeopardise the viability of the levy, increase anti-social behaviour associated with many venues closing at the same time, reduce diversity within the NTE and lead to negative economic consequences across the LA. The evaluation found that the levy did increase resources for policing and managing the NTE. The newly-funded community safety patrol developed new information sharing practices across the LA and appeared to change the ways in which some venues were managed. The levy did not undermine the BID and further research into the co-occurrence of an increase in regulatory and voluntary partnerships initiatives would be beneficial in this area. Some licensed premises did vary their hours to avoid the

levy although these changes did not lead to a significant clustering of closing times or obviously damage the LA's reputation for having a diverse NTE.

The LNL evaluation explicitly adopted a complex systems framing, through the application of the framework developed in Chapter 5, which informed the research questions, sampling strategy, data collection methods, analysis and interpretation of findings. The value of this framing came in the ability to identify and collect data on multiple theories of change, rather than focussing solely on those as articulated by the intervention designers or implementers. The development of the initial system map and the location of the intervention within that map were key to identifying those theories and is a major difference between the LNL evaluation and the preceding RtS evaluation. The system mapping process focused the evaluation on issues that clearly concerned system actors, such as the impact of the levy on public-private partnerships and attempts to make the streets safer for drinkers. It also allowed me to identify causal chains within the system that could potentially influence the system but were not widely discussed by participants, such as the potential for the intervention to affect alcohol availability. The adaptive evaluation approach then allowed me to draw further conclusions about how these specific hypothesised causal chains played out over time. It also allowed me to consider system-level properties that emerged such as the reinforcement of a broader policy discourse that focused on prevention after the point of alcohol sale, rather than on prevention or reduction of those sales. This discourse itself is situated within a wider system that includes commercial interests and their interactions with government policy at local and national levels. With further resources, a third stage of this evaluation could explore these wider system-level interactions in greater detail and analyse how they interact with efforts to support or discourage regulatory and voluntary approaches to tackling harms associated with the NTE and with harmful commodities in general.

### 7.2.3 Local alcohol research in England

The research presented in this thesis can be situated within a growing body of literature exploring policymaking processes for alcohol policy locally and evaluating local-level intervention (13). As described in Chapter 2, the impetus for growth in this type of research comes from a number of factors, including the localism agenda in England, the relative failure of action on alcohol at the national level, the move of public health into local government in 2013 and the growing evidence that licensing processes can play an important role in preventing alcohol harms (14-17). The following sections will situate the findings from this PhD within this broader body of literature. I will begin by comparing my results with other literature on RtS and the LNL, before considering how the findings relate to a key licensing intervention in England – the Cumulative Impact Policy (CIP).

### *Evaluations of RtS and the LNL*

There is a relative paucity of literature on RtS and the LNL. While RtS has been implemented in at least 30 areas (18) (although some estimates are as high as 100) (19), there are only three academic evaluations of RtS, all of which have been conducted or co-produced by academics associated with the NIHR SPHR. The first one is presented in Chapter 3; the second is a mixed-methods evaluation presented in Appendix C (7). As described in the introduction to Chapter 3, I contributed to the mixed-methods evaluation of RtS in two neighbouring London LAs. The evaluation focused on the retail environment and we found a reduction in shops selling super-strengths, as well as an increase in the median price of the cheapest unit of alcohol for sale across all retailers, with a greater increase in the median price in shops participating in the scheme (7). Some retailers supported the scheme suggesting it helped deter anti-social behaviour in their shops and neighbourhoods and could be a mechanism to create or maintain a good relationship with licensing officers and the police. Other retailers described a negative financial impact of participation or cited a potential loss of income as a reason for non-participation. Some participants preferred a compulsory approach to reduce the financial impact of customers going to non-participating shops and as a more effective means to prevent street drinking (7). Taken together, these first two evaluations of RtS focus on multiple levels of the system in which the intervention is implemented (i.e. individual, service provision, retailer, broader sociocultural environment) and unpack the mechanisms by which RtS contributed to observed impacts in the local area following implementation.

The third academic evaluation of RtS was a time series analysis which evaluated the impact of the scheme in three English counties where a supermarket chain removed super-strength products from sale (18). That evaluation reported no impact on the total units of alcohol sold or the sales value for beer and cider. In addition, the authors found no substitution effects between different alcohol products within the supermarket chain (18). That evaluation provided valuable data on the impacts of the intervention in these counties, but it may be hard to generalise these findings to more urban areas. The RtS evaluation described in this thesis was conducted in a London LAs where super-strengths are predominately purchased from off-licences, rather than supermarket chains and there are greater opportunities for substitution between retailers, a finding that emerges from situating the intervention within its wider system. Evidence on impacts on units purchased and sales value in this context would therefore be valuable.

RtS schemes have also been evaluated by individual LAs and local police departments (20). Two schemes in particular have received significant publicity: Suffolk and Portsmouth (20,21). Suffolk pioneered the RtS scheme and launched it in 2012, utilising an approach which included i) asking

retailers to voluntarily stop selling super-strengths, ii) police action against street drinkers and iii) outreach workers funded by public health to help street drinkers engage with treatment services (21). Following the first year of implementation, the Suffolk Constabulary reported a 73% reduction in reports of street drinking and a 31% reduction in crime in a part of Ipswich which had previously had high levels of anti-social behaviour (22). In addition, the number of individuals engaged in street drinking fell “from a total of 70 individuals before the campaign was launched to just over 20” (21 p.16). The Portsmouth campaign reported that over half of all 180 off-licences signed up to the scheme in the first 6 months of implementation (21), which was associated with an 80% reduction in incidents of street drinking in parts of the city (20).

One challenge with comparing RtS schemes is that they have tended to vary significantly between LAs (21) and as Gavens and colleagues note, alcohol policies are often not transferred exactly as they were originally designed (23). For example, the definition of a ‘super-strength’ beer or cider varies across areas (18). In addition, the aims of the intervention may differ, which is reflected in which components of the intervention are implemented locally. The Local Government Association (LGA) and Institute for Alcohol Studies (IAS) have both raised concerns that many RtS schemes do not use the approach that was developed in Suffolk, which the LGA has referred to as an “evidence-based, holistic approach” (21 p.4), which entailed joint working across several agencies and explicitly aimed to help dependent drinkers into treatment (20). Participants in the evaluation of RtS described in this thesis also described this concern and suggested the impact of the intervention would be undermined by the lack of a joint approach that brings together the council, police, alcohol treatment services and the licensed trade. Based on these considerations, it is challenging to generalise findings from one area to another, particularly when the intervention and its constituent components are often poorly articulated. Nevertheless, the RtS study included in this thesis did identify some clear mechanisms for dampening intervention effectiveness that may be applicable to other contexts. Even though participating shops did reduce availability of these products, the target consumers generally found it easy to adapt by buying these products at shops that were not participating in this voluntary intervention, or by utilising other intoxicants. The question of whether this adaptive behaviour could be discouraged if specialist services for homeless and street-drinkers interacted more with the intervention remains an open one because in the area I evaluated, such interaction was minimal.

The LNL evaluation presented in this thesis is, to my knowledge, the only academic evaluation of the intervention in England. As described in Chapter 6, a joint IAS and Foundation for Alcohol Research and Education report appears to have adopted contradictory positions on the LNL. It states that LNLs have “proven largely ineffective,” but also recognised that there have been no evaluations on the

impact of the policy on crime and disorder (20 p.10). Mooney and colleagues conducted a study comparing two LAs with different approaches to regulating the NTE. The study included a LA that had a levy in operation, although the aim of the research was to explore drivers of alcohol policy, rather than evaluate any specific interventions (24). Participants described support for the levy amongst some licensees who welcomed the additional police presence and the visible use of levy funding. This mirrors findings from my LNL evaluation where licensees wanted transparent use of levy funds and a clear community safety presence to support alcohol-retailing establishments. Mooney et al's study also described how the LA provided a discount on the levy for retailers who were engaged in industry-sponsored best practice schemes (24). The authors suggest this is indicative of the LA's approach of developing good working relationships with the licensed trade (24). While the LA in my LNL evaluation did not offer an automatic reduction for those engaged in such schemes, a similar process was evident where the council and levy-funded community safety officers wished to continue to have or to develop relationships with alcohol retailers. These relationships were viewed as a mechanism for both improved information sharing between local system actors and a means to improve venue management in a non-adversarial manner.

The lack of evaluation of a range of alcohol initiatives has been portrayed as a barrier to addressing public harms: "[...] a general absence of piloting and post-hoc evaluations are, we believe, creating significant obstacles to the pursuit of statutory intentions and ultimately the public good" (25 p.529). The evaluations that I have led and present in this thesis therefore provide some understanding – within the context of a relative paucity of evidence – of the systemic mechanisms by which RtS and the LNL may affect alcohol consumption and associated harms in England. Such evidence is important because LAs transfer policies between each other and studies have reported that local practitioners find evidence from local case studies particularly helpful in determining whether a specific intervention is likely to suit the context of their own locality (16,23,26).

#### *Comparison to Cumulative Impact Policies (CIPs)*

One licensing policy that has attracted considerable attention from public health researchers is CIPs. CIPs have been conceptualised as a policy that can be used to address the spatial and temporal availability of alcohol and have been implemented in over 100 LAs (17). Similar to the LNL, the CIP is a discretionary policy that LAs may choose to implement. The policy allows LAs to designate sub-areas of the LA as Cumulative Impact Zones (CIZs) where the density of alcohol-retailing outlets has resulted in negative social impacts (27). This differs from the LNL that currently must be applied across an entire LA's geographical area. Within a CIP, a licence to sell alcohol will normally be

refused unless the applicant is able to demonstrate that the new premise, or changes to the existing premise, will not undermine the licensing objectives (Box 1) (27,28).

**Box 1: Licensing objectives in England and Wales**

- |   |
|---|
| <ul style="list-style-type: none"><li>a) the prevention of crime and disorder;</li><li>b) public safety;</li><li>c) the prevention of public nuisance; and</li><li>d) the protection of children from harm.</li></ul> |
|---|

Source: Licensing Act (2003) (28)

The following section will explore some of the key findings from the literature on CIPs and compare them to the findings from the RtS and LNL evaluations, interventions which can also be described as licensing initiatives that can theoretically reduce alcohol availability to affect population-level alcohol consumption and associated harms.

Licensing data from the Home Office (29) and two evaluations of the impact of the policy on applications in London boroughs (14,15) found no significant decline in the number of licences being granted within CIZs which suggests that they are not being used to reduce the density of alcohol-retailing outlets. One of the studies in London involved a time-series analysis and assessed the impact of the policy on the content of applications, alcohol sales in bars, crime and ambulance call outs (14). The authors found a decrease in trading hours in applications following the intervention, a small reduction in alcohol sales, large declines in crime which were only partially reversed over a longer timeframe and no changes to the rates of ambulance call outs (14). Another study that measured the impact of ‘licensing intensity’ (a measure that included the adoption of a CIP) found that LAs with more intense licensing policies were associated with greater reductions in alcohol-associated hospital admissions, as well alcohol-related violent and sexual crimes and public order offences compared to LAs with more passive policies (30,31), but not anti-social behaviour (32).

Several studies have considered the ways in which CIPs may be used as a mechanism to shape local alcohol environments (15-17,24). These studies have found that locally, CIPs tend not to be portrayed as an intervention that will either reduce or limit the number of alcohol outlets in a given area (16,17). Rather, the policy has been described in terms of its ability to reduce social harms and the evidence used to object to applications in CIZs is usually based on social harms data, although sometimes area-level health data is considered relevant (17). These findings echo many of those from the evaluations of RtS and the LNL. While these interventions could reduce economic and physical availability (for RtS), and physical and temporal availability (for the LNL), actors within the local system described them almost exclusively as a means to reduce the social harms associated with either street or night-time drinking.

Findings from studies of CIPs suggest that the policy can be used to subtly shape the alcohol environment through a range of mechanisms, including changing managerial practices in alcohol-retailing establishments and working with licence applicants to shape applications to better reflect LA's vision of the alcohol environment (15-17,33). The evaluation of the LNL found community safety, police and licensing officers sought to engage with the licensed trade, using the levy as a mechanism to develop relationships with premises. The aim was to develop supportive rather than enforcement-oriented relationships. These professionals believed that the introduction of the levy led to an evolution in the ways in which premises were managed, which helped prevent social harms such as nuisance and anti-social behaviour. Such mechanisms are not exclusive to areas with discretionary policies such as the LNL or CIPs. Mooney et al, for example, found that in a LA that applied a 'lighter touch' to regulating the alcohol environment, the police developed close relationships with the licensed trade and used these relationships to address problems stemming from specific premises, rather than apply a more blanket regulatory approach (24).

CIPs are used to focus on specific areas in which the saturation of the alcohol environment has led to adverse social and health outcomes (27). One study comparing CIPs in five LAs found licensing practitioners use tacit knowledge about their area, in addition to density, crime and health data, to inform these boundary decisions (16). This reliance on tacit knowledge accumulated over time was also reflected in how the levy-funded community safety patrols operated. While the levy applies to an entire LA, in practice, community safety officers used their knowledge about the 'flow' of the NTE to focus their patrols on specific areas, particularly where many premises closed at the same time. As described in the preceding chapter, changes to the levy so that it would apply only to specific premises or parts of the LA were meant to come into force in 2020, but have yet to be implemented.

Finally, the study of CIPs across five LAs found that CIPs differ significantly in their goals and focus. As described above, RtS schemes are similarly diverse; they have different explicit and implicit aims, vary in the degree to which they focus on preventing anti-social behaviour associated with street drinking or working to help dependent drinkers into treatment and target different drinks as measured by alcohol-by-volume (ABV) (20,21).

#### 7.2.4 Framings of prevention

##### *Population vs individual*

As described in Chapter 2, public health academics and practitioners have argued that alcohol-related harms should be considered at a population level and have therefore advocated strategies to address upstream influences on alcohol consumption (34-36) and target drinkers who suffer disproportionately high levels of alcohol-associated harms (37). This stands in contrast to alcohol

industry framings who have emphasised individual responsibility and argued that harmful alcohol consumption occurs amongst only a minority of the population, thereby negating the need for population-level prevention measures (38,39). The industry has used these framings to argue for highly targeted interventions for specific groups of drinkers and to argue against regulatory interventions (40-42). Such a framing may help explain many retailers' willingness to participate in schemes such as RtS, which are highly targeted and focus on a minority population who engage in visible drinking practices. In a similar vein, while the LNL targets a broader population than street drinkers, it still targets a relatively small minority (individuals and retailers within the NTE) and has a specific emphasis on the visible impacts of excessive alcohol consumption, such as anti-social behaviour and unclean streets. While the LNL has been repeatedly critiqued by commercial actors, the evaluation of the LNL described in Chapter 6 showed an evolution in the ways licensees perceived the intervention, with many licensees willing to ultimately engage with the intervention and recognise its potential for challenging the behaviour of certain types of drinkers in the NTE.

#### *Primary vs. secondary*

As described in Chapter 6, while the LNL has the ability to reduce the temporal – and to a lesser degree the physical – availability of alcohol, it is very rarely portrayed in these terms. Rather, discourses about primary prevention, or attempting to reduce alcohol consumption, are largely absent from theories of how the intervention may address alcohol-associated harms. Instead, the focus is on secondary prevention, or the ability of the intervention to reduce the harms associated with alcohol once it is sold or already consumed. This framing of primary versus secondary prevention is, as described above, also prevalent in commercial actors' views of prevention (41).

The RtS scheme emphasised both primary and secondary aspects of prevention, although the aim of reducing anti-social behaviour associated with street drinking has often been prioritised. One reason for the emphasis on secondary prevention evident across these two interventions may be that both have been primarily led and developed by licensing and police teams, rather than public health practitioners within LAs. RtS was originally developed in Suffolk with involvement from public health which may account for the partial primary prevention framing. The following section will explore the role of public health in licensing which may help make sense of the framings around secondary prevention evident in these two interventions.

Within local government, public health practitioners have two main routes to influencing alcohol policy and decisions to grant licences to premises: 1) they may provide input into the development of alcohol licensing policy, primarily through contributions to a LA's Statement of Licensing Policy; and 2) they can assess individual licensing applications and make representations on licence

applications if the proposed or existing premise will undermine one or more of the licensing objectives (Box 1) (43,44). While the opportunities therefore exist for public health framings of alcohol harm prevention to influence local alcohol licensing policy, challenges exist to this in practice and several studies have underscored the variability across different LAs with regards to the extent to which public health plays an active role in licensing processes (43,45,46). These studies have described a number of factors that contribute to these challenges, including different ‘cultures of evidence’ between health and non-health sectors (47), competing priorities, the lack of a public health licensing objective in England and the relatively new location of public health teams within councils (43-46,48).

Nicholls (2015) argued that there are “epistemological tensions between the perspectives adopted by licensing practitioners and those adopted by public health professionals. These tensions have concrete implications for both the development and the implementation of alcohol licensing policies [...]” (46 p.2). Others have described these potential conflicts between public health and licensing, with particular reference to the value of different types of knowledge and evidence, as well as professional priorities (43,49). A study on public health and licensing in England described how licensing processes tend to be dominated by local police and crime evidence, which is informed by both local data and anecdotes (46). Such evidence is often counterbalanced with evidence about the local economic benefits generated by licensed premises, a finding echoed in Scotland (46,48). Other studies exploring public health practitioners’ views of their roles addressing alcohol-associated harms through licensing processes have described a perception that their data is often not viewed as persuasive within these contexts (43,44,48). Challenges include using broader epidemiological data on alcohol consumption and harms which may be perceived as being insufficiently specific to develop measures to address harms within a specific locality (43,44), as well as the limited transferability of evidence generated in other contexts (13,48). However, within the licensing process, as with other areas of policymaking, decision makers consider evidence alongside their own beliefs, knowledge of the locality and anecdotes (23,48). There may also be competing political priorities, with other council strategies and priorities focused on economic development or regeneration which may be at odds with public health priorities of reducing alcohol availability (13,24,43,50). A challenge to public health practitioners as relative newcomers in this space is how to make public health evidence relevant and applicable within these broader decision-making cultures.

Another challenge facing public health practitioners in England is that public health is not a licensing objective. While Scotland implemented a fifth licensing objective of “protecting and improving public health” in 2009 (46), England has not followed suit. While this does not prevent public health

practitioners or other responsible authorities from using public health evidence, it does make it more challenging to bring public health considerations into licensing processes (51). Some public health practitioners have described the lack of a public health licensing objective as resulting in them having “lack of status within the licensing process” (44 p.e1). In particular, without a public health objective, practitioners described challenges communicating public health evidence within these structures (44). A study on the implementation of Scotland’s public health licensing objective found these challenges persisted even with this objective in place. For example, the authors found that public health data was often not valued by other licensing actors, some of whom maintained the promotion of public health was not a goal of licensing and that economic goals should take priority (48).

Public health practitioners are also relatively new within LAs, having moved to local government in 2013. Some practitioners have reported having insufficient capacity to engage with licensing (43). Others have actively sought to engage with licensing processes, seeing it as a means to promote and position public health within the council and shape policy making (43). However, as studies on these processes in both England and Scotland show, developing relationships and embedding public health across different statutory functions, such as licensing, takes significant time and will not be immediately realised, even with the inclusion of a public health licensing objective (43,48).

The challenges and considerations described above may go some way in explaining why the LNL has primarily been framed within secondary prevention terms, a framing which is more consistent with licensing than public health. Both the LNL and RtS were implemented at a time when public health had only just moved into local government (late 2013 and late 2014 for RtS and the LNL, respectively) and the seeds for each intervention were planted before those dates. For example, in the LA that was the subject of the LNL evaluation, their Statement of Licensing Policy, which was published in 2013, included a commitment to investigating the option of introducing the LNL. Evident within the 2013 Licensing Policy are tensions within the Council, with a desire to promote economic regeneration locally while balancing the harms associated with alcohol. This echoes the tensions identified in many of the studies described above and may help explain the choice and framing of interventions like the LNL and RtS. Further research to test out these hypotheses with specific consideration to the LNL and RtS is warranted. A complex systems approach that considers the drivers of interventions, conflicts and tensions between different sectors and situates these within vertical structures of national policy would be helpful.

## 7.2.5 Approaches to prevention

### *Voluntary vs. regulatory*

RtS and the LNL represent different approaches to addressing the harms associated with alcohol; RtS is a voluntary scheme in which retailers can choose to participate, whereas the LNL is a discretionary, but regulatory measure applying to all late-night alcohol retailers within an LA. There is a breadth of literature, from the UK and internationally, about different approaches to preventing alcohol harms, whose interests are served by these measures and their effectiveness. The alcohol industry prefers voluntary, partnership or self-regulatory approaches over regulatory ones (25,39,52) – something evident in retailers’ and trade organisations’ responses to the LNL consultation – and has argued that the former are just as effective as the latter, despite evidence to the contrary (40). Indeed, there is limited evidence that self-regulatory approaches are effective at meeting their intended outcomes, including reducing alcohol-associated harms (53,54). For example, a recent review that examined self-regulation of alcohol marketing found that violations of the regulatory codes were “highly prevalent”, particularly in media to which youth are exposed (55 p.28). Despite this lack of evidence, the national government has exhibited a willingness to encourage and promote industry self-regulation and partnership approaches, at the expense of regulatory interventions (25).

There is, however, more evidence for regulatory interventions that address different facets of availability: economic (affordability), temporal and physical (spatial) (53,56-58) and as described in Chapter 2, there is consistent evidence that there is an association between the dimensions of availability and alcohol consumption and associated harms (45). RtS is an intervention designed to primarily reduce the economic availability of alcohol, whereas the LNL can affect the temporal and physical availability of alcohol, although, as discussed above, the intervention is rarely framed in these terms. While interventions such as RtS can increase the cost of alcohol per unit (as shown in the evaluation of RtS in Appendix C), they cannot, due to the processes described in Chapter 3 (e.g. substitution behaviours, limited geographical scale) have the impacts on consumption and associated harms of a policy like minimum unit pricing (MUP). As shown in the process evaluation of the LNL (Chapter 6), the LNL can reduce the temporal availability of alcohol, as premises cease alcohol retailing before midnight to avoid the levy. Although not the primary mechanism of change, the LNL may have impacts on physical availability if premises close or new premises choose not to open in an area with a levy, thereby affecting an area’s alcohol outlet density.

In addition to showing a clear preference for voluntary approaches over regulatory measures, recent studies examining alcohol policymaking processes in England have shown that the alcohol industry utilises their engagement in voluntary and partnership approaches with national and local

governments to divert from regulation (52,59), a tactic Savell and colleagues have referred to as 'policy substitution' (38). Hawkins and McCambridge explored the political consequences of the UK's Public Health Responsibility Deal (52,59), a public-private partnership active between 2011 and 2015, in which companies voluntarily committed to pledges to improve public health (60,61). They found that through engagement with the Responsibility Deal, the alcohol industry was able to exert significant influence over the process and content of alcohol policy (52). By developing relationships with key policymakers and making a show of commitment to reducing alcohol-associated harms through the Responsibility Deal, the alcohol industry dominated the policymaking space effectively shutting down discourse on regulatory approaches with a clear evidence base for effectiveness (52). In particular, MUP, which the Coalition Government originally committed to in The Government's Alcohol Strategy (2012) (62), was shelved in 2013 in order to allow the alcohol industry to continue to self-regulate through partnership and voluntary approaches such as the Responsibility Deal (52,59):

*Our decision not to proceed with the introduction of minimum unit pricing at this stage gives the alcohol industry an opportunity to demonstrate what more it can do to reduce the harms associated with problem drinking. Our challenge to the industry is to increase its efforts, building on what has already been achieved through the public health responsibility deal. (Jeremy Browne, Liberal Democrat Home Office Minister, quoted in Hawkins and McCambridge 2020) (59 p.326)*

In one study of CIPs in one London LA, Grace and colleagues found some licensees would promote their planned participation in the RtS scheme, arguing it demonstrated their "responsibility to the community" and that their application to open a premise within a CIZ should therefore be granted (17 p.80). Engagement with initiatives like RtS may therefore be used as a form of leverage by the alcohol industry to further perpetuate the use of voluntary approaches over regulatory measures and to justify the granting of new licenses to alcohol outlets, thereby increasing outlet density. The RtS evaluation described in this thesis found that drinkers and service providers noted a reduction in the availability of super-strengths in the local area as a result of shops participating in the scheme. In Sumpter et al.'s paper (Appendix C) some retailers described their willingness to participate as being rooted in their desire to maintain a good relationship with the LA and police (7). The Association of Convenience Stores, a trade organisation representing off-licences, has issued guidance for its members on participating in RtS. While it cautions retailers to ensure that their participation does not violate competition law, it also suggests there may be benefits to the initiative and the guidance is intended to "help convenience stores manage their relationship with local authorities [...]" (63 p.1). In responding to the consultation on the LNL, retailers and the trade organisations that represent them described a desire to continue with voluntary and partnership approaches with the

LA, arguing that pursuing a regulatory intervention like the LNL risked damaging the relationships that had been built between the Council and the licensed trade. Cumulatively, engagement in voluntary initiatives or partnerships might be seen as show of 'good faith' in addressing alcohol harms, but at the expense of interventions that have a stronger evidence base for effectiveness.

The alcohol industry has also demonstrated a willingness to take some action towards addressing drinking that could result in what Petticrew and colleagues have referred to as 'reputational risk' (40). In their review of the effectiveness of Community Alcohol Partnerships (CAPs), they argue the alcohol industry may sign up to or promote initiatives which are targeted at addressing alcohol harms that could damage the reputation of the industry, including, in the case of CAPs, visible and public underage drinking and anti-social behaviour associated with it (40). Initiatives such as CAPs align closely with industry-promoted action on alcohol, including, for example the "Beer, Wine and Spirits Producers' Commitments" (a set of non-enforceable pledges) rather than necessarily reflecting the needs of local communities (64). Petticrew's findings align with those from the RtS evaluations that showed a willingness on behalf of many retailers to participate, which may be motivated by addressing visible harms associated with drinking (e.g. street drinking) that can damage the reputation of individual retailers, certain alcohol brands and overall consumption of alcohol (41). While the LNL is a regulatory, rather than voluntary measure, the findings presented in Chapter 6 suggest that there was a sort of 'softening' overtime in terms of licensees' views towards the intervention, with many licensees coming to value the levy-funded services as a means to address anti-social behaviour and nuisance associated with night-time drinking. Engagement with the levy-funded community safety patrol was therefore a mechanism to improve or secure both the reputation of individual premises, as well as the reputation of the local NTE as a whole, both of which were theorised to increase customer numbers, with positive economic benefits accruing to retailers.

#### *Implications for a complex systems perspective*

Cumulatively, many of these findings point to the need to apply a complex systems perspective to understanding alcohol policymaking processes, as well as the evaluation of specific alcohol interventions, something other studies have concluded as well (2,24). Haydock, for example, argues the UK's emphasis on local over national approaches may better suit commercial interests who are opposed to "national red tape" (65 p.154). While local licensing processes may be a key opportunity to shape local alcohol environments, findings from the RtS and LNL evaluations show how local interventions, particularly in a large urban area such as London, can be undermined by the geography of the local system. Consumers of super-strength beer and cider, for example, may still be

able to purchase their drinks of choice from non-participating shops, including shops in neighbouring LAs where the scheme is not promoted (or not promoted with the same intensity). Similarly, if late-night drinkers find a diminished NTE due to the implementation of an LNL, they may be able to easily visit other vibrant NTE locations in the same city. Such findings, which are substantiated by the results of the scoping review in Chapter 4, point both to the need to consider regional and national approaches to addressing alcohol consumption and associated harms, as well as the need to widen evaluative lenses to contextualise local interventions within the regional, national and international systems in which they are located. A systems approach provides a means for evaluators to consider these mechanisms across different levels. However, as my review of alcohol systems research demonstrated, it still requires researchers to make use of this feature of systems evaluation. Many of the studies identified in that review focused exclusively on sub-local and local systems, which somewhat counterintuitively represent the use of a systems approach to focus on a 'smaller picture' rather than a 'bigger picture'. Ignoring the interactions between systems operating in different geographical areas or across different geographical scales risks missing the processes by which interventions may or may not achieve their intended outcomes, and the mechanisms by which they may generate unintended outcomes.

In a similar vein, evaluations that focus on a specific, public-health relevant outcome (such as alcohol outlet density) risk missing broader mechanisms of change occurring within local systems (15,16). As the studies on CIPs show and the process evaluation of the LNL suggested, even when interventions do not reduce the spatial or temporal availability of alcohol, they may generate system-level changes that can prevent alcohol consumption and associated harms by subtly re-shaping alcohol environments and the ways in which system actors perceive and address alcohol harms. Linear theories of change that measure only how interventions operate through indicators such as outlet density (14) may be too narrow to capture system-level change processes. This suggests a need for evaluators to develop multi-level, non-linear theories of change, taking into account different perspectives across the system and considering the impact of systems beyond the boundary of the specific evaluation.

Finally, interventions on alcohol do not operate in isolation, but rather co-occur within a broader system that includes other interventions and activities (18). The combination of interventions may lead to processes and impacts not envisaged within the intervention design (16). Evaluations utilising a complex systems perspective offer an opportunity to explore how interventions interact and affect each other within a system, which include dampening or amplifying the impacts on the interventions or changing their foci. A systems perspective can help make sense of these processes as they dynamically unfold within the system. The LNL evaluation pointed to these interactions, with the LNL

co-occurring with an increase in public-private partnerships in the form of the BID. While the evaluation did not capture the reasons for this co-occurrence, an extension of the evaluation using a systems perspective could usefully explore these processes.

The following section now turns to a discussion of the methodological dimension of this thesis, considering the development of a framework for process evaluation from a complex systems perspective and its implications for future public health research.

### 7.3 Methodological discussion

#### 7.3.1 An early application of complex systems thinking in public health evaluation

In 2016, Walton argued “[...] while a steadily growing interest in systems and complexity theories within evaluation is evident from available literature, they remain somewhat peripheral in evaluation practice” (66 p.412). The RtS evaluation therefore represented one these early attempts to apply systems and complexity theories to an evaluation. RtS was conceptualised as an event within a system (9) and I sought to draw out the ways in which the intervention may generate both intended and unintended consequences. The sampling strategy aimed to collect data at two different system levels: the individual- and the service provision-level. The analysis focussed on possible mechanisms for change at these two levels, as well as within the broader sociocultural environment; the third level (sociocultural) emerged from the data, rather than being explicitly built into the sampling strategy.

In 2018, White and Adams argued that public health evaluators should embrace new approaches to evaluation in order to produce stronger evidence for the improvement of population health (67). Drawing on Hawe and colleagues’ arguments (9), they advocated for a complex systems approach to evaluation: one that conceptualises interventions as ‘events’ within systems and focuses on the continuous, adaptive responses to an intervention, across system actors and levels. In their article, they described the research on RtS as ‘valuable examples’ of how a complex systems perspective has been applied to public health evaluation:

*While such approaches to evaluation remain in their infancy, some valuable examples are emerging, such as a recent study evaluating the impacts of a voluntary scheme in which retailers were challenged to reduce availability of low cost, high strength beers and ciders. In this study, the researchers engaged with the complexity of the context and the potential for wide-ranging consequences of the intervention, assessing these through multiple methods and diverse sampling strategies, as well as through analyses informed by complexity theory and systems thinking. (67 p.3-4)*

Recognising that the RtS study was an early attempt at applying a complex systems perspective to public health evaluation, I reflected on the experience of conducting that evaluation and continued

to compare it with the growing literature on complex systems and public health. As with most qualitative researchers, I was attuned to the broader context in which the intervention is implemented, but I primarily used the intervention as an entry point into the system, rather than starting with the system itself. This is reflected in my multi-level theories of change; while they show different system levels, they are presented almost as if they exist in isolation from one another (Figures 1 and 2, Chapter 3). A more sophisticated application of systems thinking would have better integrated them into the system by, for example, portraying them on one system map and analysing the interactions between different levels. Given the opportunity to 're-do' the RtS evaluation, I would begin by more critically determining the boundaries of the system and developing a better understanding of the local system, its trajectory and the influences that informed the 'rules' or patterns of behaviour at the time the intervention was designed and implemented, before considering how the intervention might disrupt those local rules. In analysing the intervention, I would more explicitly consider how the intervention and system adapt and co-evolve dynamically, considering more interactions across system elements and between system levels. This would have generated a more pluralistic understanding of intervention processes and the findings could have better spoken to the interaction between local alcohol policymaking and the actions of corporate actors.

Based on these reflections and informed by the growing literature on complex systems thinking in public health, I designed the LNL evaluation and collected data with the aim of understanding how the levy has the potential to disrupt the local system in which it is implemented. A complex systems perspective informed my overarching research question, the sampling strategy and data generation methods. I sampled from a range of system actors, and while the primary focus was on the local system (a focus on horizontal complexity), I also collected data from elements within the national system in which the local system is embedded (an example of vertical complexity). As I described in my Chapter 1, I then paused this research and returned to analyse the data a few years after it was generated. The following section will briefly summarise how I developed a framework for qualitative process evaluations using a complex systems perspective and applied it to the data I generated on the LNL in one London LA.

### 7.3.2 A framework for qualitative process evaluation from a complex systems perspective

In the intervening years between my initial LNL data collection and my subsequent work on the evaluation, the calls for applying a complex systems approach to public health intervention development and evaluation continued to grow. An increasing number of researchers argued that systems thinking and complexity had the potential to generate better evidence for decision making

in real-world contexts (68). However, alongside these calls, there was also a realisation that there was limited understanding and development of methodologies for applying a complex systems perspective to public health issues, particularly for evaluation (69-73). These arguments corroborated my own experience of the RtS evaluation: I saw the value of applying a complex systems perspective to the data, but found it challenging to operationalise in practice, with limited guidance to draw on. Given the calls for public health evaluations to take a complex systems perspective, I therefore decided that prior to analysing the LNL data, I should systematically review how others had applied this perspective to public health process evaluations in practice. From 21 unique process evaluations, I found most evaluators drew on ad-hoc frameworks to analyse data and tended to utilise concepts from systems thinking to describe a system at a single time point. This body of literature was characterised by fewer attempts to understand dynamic change following intervention implementation. Drawing on these examples, as well as my understanding of complex systems, I then developed a framework for qualitative process evaluation from a complex systems perspective.

The framework suggests two sequential phases for evaluation (Chapter 5, Figure 3). The focus of Phase 1 is to describe the system at a single time point (usually at baseline). Data is collected from a range of system actors and analysed to generate a qualitative description of the system, including its structure, boundaries, constituent elements and to make sense of the 'local rules' or patterns of behaviour that govern the interactions between system elements. Evaluators should then begin to consider the ways in which the intervention may generate system changes, which includes considering how different actors will respond to the intervention and how these responses interact with and influence the response of other system actors. The output of Phase 1 will be a qualitative description of the system, which may be visualised on a map, as well as a description of possible changes stemming from the intervention, which may be depicted as multiple theories of change. This phase is intended to inform Phase 2, in which the focus is analysing the system as it undergoes change stemming from, or co-occurring with, the intervention. Using data and the theories developed in Phase 1, evaluators would develop research questions and engage in a more structured period of data collection, typically drawing on a range of methods. In the analysis stage, the evaluators make sense of emergent findings, utilising complexity concepts to help structure their analyses. As additional findings emerge, including unanticipated processes and impacts, evaluators should be prepared to conduct additional data collection. The output of Phase 2 will be an account of how the intervention embeds in the system and the processes by which the system and its elements respond to the intervention. There could also be subsequent phases if the intervention was considered consequential enough to warrant them. In the case of my LNL evaluation, there

were not the resources available to conduct further evaluation, but further investigation about the impacts of the intervention is warranted.

#### *Reflections on the application of the framework to the evaluation of an alcohol intervention*

As described previously, I applied this framework retrospectively to data collected on the LNL in one London LA. I also drew on findings from the scoping review presented in Chapter 4, where a key finding was that much of the complex systems literature on alcohol consumption and the prevention of alcohol-related harms focuses on the sub-local (individual) and local levels, with relatively little analysis of the broader systems which shape, influence and interact with these more micro-systems. Although my focus in the LNL remained on the local system in which the levy is implemented, I aimed to bring in more of a vertical dimension than was included in the RtS study, through, for example, the inclusion of national-level levy documents.

In Chapter 6, I provided some brief reflections on the application of the framework to data generated in the LNL evaluation. Here I will provide a more in-depth discussion of this process, considering some possible shortcomings in my application, before I turn to considering how the framework might be further developed and utilised in conjunction with the growing body of literature on a complex systems perspective applied to evaluation.

In the framework, I suggest that data in Phase 1 should be collected through a range of methods, including, for example, documentary analysis, interviews and workshops. In the LNL evaluation, I relied extensively on documents to develop an understanding of the system, its structure and behaviour at the time the intervention was implemented, as well as to develop theories of how the intervention may disrupt local system rules. I also interviewed a number of actors involved with different aspects of the intervention delivery, but the majority of these interviews took place two-years post implementation. While the interviews were designed to allow for retrospective accounts which spoke to the changes that stemmed from the intervention, it may also have been beneficial to have collected data for Phase 1 through additional methods. In particular, it would have been helpful to conduct a series of workshops at the beginning of the evaluation with a range of system stakeholders in order to develop a more participatory understanding of the local system, with specific reference to the boundaries of the system and the evaluation. These initial workshops would have been valuable in developing research questions and further structuring the rest of the evaluation. Such a process would have gone some way to addressing the uneven power dynamics in this evaluation, where I made decisions about which questions to pursue and where to draw system boundaries based on my own analyses. However, my approach does demonstrate how a systems perspective can be brought to intervention evaluations that lack resources for more intensive forms

of data collection. This is particularly important if we want to embed systems thinking within local evaluation, including evaluations commissioned by local authorities or other local organisations.

The framework was also designed so that evaluators would take an adaptive evaluative approach, with the hypotheses developed in Phase 1 guiding the data collection and analytical focus on Phase 2. In Phase 2, it was assumed that data collection would be an iterative process; as findings emerged, evaluators could further explore them in subsequent rounds of data collection. I collected the majority of the data in 2016, although some documents, including the consultation responses, were identified when I returned to this work after my interruption of studies and before I began the analysis. Because I applied the framework retrospectively it was not possible to follow the evaluation process exactly as designed. I conducted the analysis of the data from Phase 1 prior to Phase 2 and so the hypotheses informed the analytical focus of Phase 2, but I was unable to fully follow up on emergent findings; for example, the findings in Phase 2 suggest that the levy co-occurred with an increase in public-private partnerships in the form of the BID. As described in Chapter 6 and earlier in this chapter, the reasons for this co-occurrence were unclear and I was unable to conduct subsequent rounds of data collection which would have allowed me to further examine this finding. While the retrospective application of the framework is a limitation to this work, it is not without precedent (70) and underscores the utility of the framework in being sufficiently flexible to apply to many evaluation contexts. Due to pragmatics, including time and resource constraints, evaluations are often not conducted in complete adherence to 'best-practice' guidance. While ideally evaluations are designed before intervention implementation, knowing that this cannot always be achieved, it is important to have evaluation guidance that can account for and accommodate a range of evaluative contexts. The use of documents, such as those included in the LNL evaluation, is one way of collecting data that was generated prior to intervention implementation and before researchers become involved in its evaluation.

#### *Situating the framework within the broader complex systems literature*

The framework for process evaluation was developed in response to concerns that while there are many calls to utilise a complex systems perspective in public health evaluation, the methodologies for doing so are underdeveloped. In a study exploring experts' views on applying complexity theory to evaluation, Walton found that there was a lack of practical tools for evaluation from a complexity perspective and a key challenge was operationalising 'academic' concepts within the context of an evaluation (66). Therefore, my aim was to create a practical tool that depicted how a process evaluation could be conducted from a complex systems perspective through operationalising concepts from systems thinking and complexity sciences. The framework was designed to detail the

entire evaluation process, which inherently meant that no single stage was covered in great depth. The following section will consider a few specific steps within the framework and consider how they align, and can be extended, using insights from other complex systems literature.

In both Phase 1 and 2 of the framework, the first step is to decide on the evaluation questions and scope. Key elements within this step involve deciding on the research questions and delineating the boundaries of the system under inquiry, two aspects which go hand-in-hand with one another. For Phase 1, I suggested a number of evaluation questions that could guide the evaluation (Box 2), although this is not an exhaustive list of questions that may be asked within this phase. Other systems thinkers have grappled explicitly with how to operationalise complex systems concepts into questions to guide evaluators and teams conducting evidence syntheses (74-76). For example Booth et al proposes a list of ‘complexity-related questions’ that can be answered utilising qualitative methods (74). Knai and colleagues developed a list of questions that are pertinent to understanding interconnections within a system (75), a group of questions that are particularly relevant for Phase 1 of the framework when trying to make sense of the system structure and how elements of the system relate and interact with one another. Petticrew and colleagues also outline how different aspects of complexity map onto possible systematic review questions, although many of the questions will also be relevant to single evaluations (76). These papers provide clear operationalisation of key concepts from systems thinking and complexity science. They are therefore particularly useful for evaluators seeking more guidance on how to develop complex systems-consistent evaluation questions within the context of applying the process evaluation framework.

**Box 2: Possible research questions to guide Phase 1 of a process evaluation from a complex systems perspective**

- |   |
|---|
| <ol style="list-style-type: none"><li>1) What is the system of interest?</li><li>2) How does it behave at the initial timepoint?</li><li>3) How is the intervention theorised to change the system?</li></ol> |
|---|

Source: McGill et al. 2020 (6)

As described above, generating research questions is inextricably linked with making boundary decisions, including decisions about the boundaries of the system under inquiry, as well as the evaluation’s scope. The framework I developed for process evaluations from a complex systems perspective provided little guidance on how to make boundary decisions and the implications of those decisions. The application of the framework to the LNL evaluation described the boundary judgements with an explanation for the focus on the local system, which mirrored the system level in which the intervention is implemented, an approach suggested by Blackman and colleagues (77,78). Chapter 6 further explored the implications of these judgements, including briefly

considering the power dynamics involved in the evaluator making decisions based on data generated through the documentary review, interviews and observations, but without direct input from system stakeholders.

Boundary decisions are crucial in a systems-level evaluation and therefore warrant some further discussion. As described in Chapter 2 and illustrated in the RtS and LNL evaluations, as well as the studies identified in the scoping review in Chapter 4, complex systems have open boundaries (79), and even systems with seemingly obvious boundaries, such as a schools, are characterised by interactions well beyond the immediate system (80). Decisions must be made about where to bound a system; indeed, as Moore and colleagues have argued, it is not possible to investigate all aspects of complexity and follow all uncertainties that may arise from the introduction of an intervention within a complex system (69). To do so would be, in their words “unattainable; it is never possible, nor perhaps even desirable” (69 p.25). I agree; attempting to analyse the way an intervention may lead to system changes, across all possible systems by following all uncertainties and emergent findings would lead to an unfocused, resource-intensive and unwieldy evaluation unlikely to generate usable findings (81). Public health advocates of using a complex systems perspective have suggested using decision makers’ key uncertainties (81), theories of change (77,82) and the systemic level of the intervention (78) to guide the evaluative focus, thereby informing the boundary decisions. One possibly underexplored methodology in public health evaluation to guide boundary decisions and explore the implications of these judgements is critical system heuristics (83,84). Critical systems heuristics is a tool that utilises a 12-step questioning process to conduct a ‘boundary critique’ in order to consider who and what are being excluded by certain boundary judgements and to consider ways of reconciling conflicting boundary dynamics (83-85). Evaluators have suggested applying critical systems heuristics to evaluations (85,86), but a recent review that I co-led which identified complex systems methods applied to public health evaluation found no examples of the methodology, suggesting this is an area for further exploration and application by public health researchers and evaluators (87).

The framework developed in Chapter 5 suggested that system mapping may be an integral part of a complex systems process evaluation, but it provided relatively limited guidance on how to conduct it, something that has been noted about many forms of systems guidance (88). This was intentional; within the complex systems literature there are a range of different mapping techniques (ranging from relatively unstructured applications of mind mapping to more structured methods including group model building), each of which is best suited to different purposes. The framework was designed to have some flexibility in it so that it could be used by those conducting process evaluations with different foci. When applying the framework to the LNL evaluation in Chapter 6, I

drew on elements from many systems mapping traditions to create a bespoke system map which represented system variables and how they relate to each other, with a focus on showing how these variables may be influenced through multiple pathways with the introduction of the levy. These multiple pathways to change were depicted as theories of change on the map. Then, when exploring each theory of change in detail, I was able to 'explode' the relevant section of the map to further explore the interactions between those variables. As those engaged in complex systems approaches have acknowledged, these mapping processes can be somewhat ad hoc (87) and the methodology is often developed throughout the course of the evaluation (73), rather than being pre-specified, both of which observations reflect my own experience. The benefits of this are that they can be flexible and adapted to the specific needs of the evaluation. However, this can lead to issues with validity (89) and the methods are also often hard to replicate, particularly when not well described by evaluators (71,88).

As described above, I combined the system mapping process with developing and depicting theories of change, an integration that has been recently advocated by evaluators from The Centre for the Evaluation of Complexity Across the Nexus (CECAN) in a paper published early in 2021 (88). Theories of change have been used extensively in the evaluation of complex interventions (71). While they vary significantly in their form and application, they have also been criticised for being too simplistic and linear, while failing to account for the broader context in which interventions are implemented (88,89). However, they can be generated and depicted in ways that are less linear and are situated within the complex system in which the intervention occurs (71). Researchers in CECAN have therefore published a practical guide on how to integrate participatory systems mapping with theories of change; a process which involves first conducting workshops with system stakeholders to develop a map of system variables and their interactions, before re-working the map to explicitly depict theories of change (88). They have illustrated the application of this process using an example from energy policymaking (88). Their suggested process has many similarities with the process reported in my LNL evaluation (notwithstanding the lack of a participatory process). The process developed by CECAN may hold some promise for public health evaluators grappling with how to use systems mapping to inform their evaluations. Further examples and evaluation of its application in public health are warranted.

This section has been devoted to fleshing out some aspects of the framework for process evaluation from a complex systems perspective, considering how it compares with other complex systems literature and where other literature may be able to further expand on ideas within the framework. The following section will now turn to some reflections on future directions and some of the challenges facing public health process evaluation from a complex systems perspective.

### 7.3.3 Future directions

While there continues to be both an increase in calls for public health evaluation to apply a complex systems perspective and examples of this in practice, two key challenges relate to the transparency of reporting systems methods and the presentation of systems-level findings.

In an article analysing multiple case studies of systems approaches in evaluation, Gates argued: “A final area of needed research focuses more specifically on refining and advancing the use of systems approaches by describing and evaluating the use and added value of specific methodologies.” (90 p.168). This argument corroborates a key finding from the systematic review of public health process evaluations in Chapter 5: evaluation methods and findings are often reported in such a manner that it is unclear why specific methods were chosen and to what extent complex systems thinking influenced different stages within the evaluation. This, in turn makes it challenging to evaluate the evaluation. A key recommendation stemming from the research in this thesis, therefore, is that evaluators applying complex systems methods should become more transparent in their reporting, particularly about methodological decisions and trade-offs. This includes making explicit how complex systems thinking informs different evaluation stages, documenting evaluation processes, justifying choices and describing and reflecting on evaluation challenges (71,89). Doing so will go some way in assessing the quality of these evaluations, as well as their ‘added value’ compared to other evaluative approaches (90). As an extension of this, public health researchers might compare the findings of systems- and non-systems-informed evaluations, making explicit what, if any, added value the former brings. Further work could also be done to re-imagine or re-work systematic reviews or evaluations that did not originally take a complex systems perspective and exploring with users or policymakers what the added value of a complex systems perspective is for decision-making. Some limited examples of this exist (2,91), but this is an area for future research.

One challenge to this approach could be that some process evaluations that do not explicitly state an intention to apply a systems perspective may still consider issues that a ‘systems evaluation’ would also focus on. My assumption is that process evaluations that consider how dynamic, multi-level contexts interact with an intervention’s delivery and impacts could indeed be said to apply a systems perspective even if the evaluators do not explicitly use systems language. However, systems thinking and complexity science offer a new, at least new for public health, set of conceptual and methodological tools to conduct such evaluations and a clear rationale for process evaluations that include theories of change that extend beyond the immediate implementation, acceptability and uptake of an intervention.

Another challenge facing evaluators, particularly those conducting qualitative process evaluations is how to present often large amounts of data generated with a complex systems framing in a manner

that is useful for decision-making and strikes the balance between being ‘reductionist’ and ‘too complex’. This is particularly important given that taking a complex systems approach is often predicated on the assumption that it generates better evidence for decision-making (68). Some evaluators have also highlighted this challenge; for example one study found: “Messages about unpredictability or uncertainty can be particularly difficult to convey to those working in organisations, or sectors, where a high value is placed on simplicity and certainty, and less value accorded to exploration and learning.” (92 p.28). In another study, Walton described a complexity-consistent evaluation of a fruit provision programme in schools in New Zealand in which the Executive Summary failed to include some of the key findings informed by complexity theory, in particular the importance of initial conditions and the ways in which these influenced schools’ divergent trajectories (91). These two studies highlight the challenge of conveying complex findings in a manner that is useful to decision makers.

The complex systems literature is relatively sparse on possible ways forward. Some have suggested creating a ‘system story’ or narrative that describes the ways in which the system evolves over time in response to an intervention, describing the mechanisms by which the impacts stemming from the intervention may be amplified or dampened depending on different system responses (81). In describing the framework in Chapter 5, I suggested this as one possibility; this sort of system story may be able to convey complex findings in a way that is accessible to a range of different audiences and allows a more holistic representation of the findings. However, a system story may also be long and include many findings making it unwieldy. As a result, it may be a challenge to draw a single, or indeed even just a few, ‘take-home’ messages from the evaluation.

When analysing the data from the LNL evaluation, I grappled with how to best present the large amount of data I had generated in a way that succinctly conveyed the findings without removing them from their systemic context. Ultimately, I chose to provide a relatively brief account of the system structure, its elements and the relationship between them. I used a system map to convey these visually and a lengthy table that described each variable, showed which other variables each related to (and the direction of influence) and gave an excerpt of data as illustration. This approach was chosen to both succinctly describe the system structure and also provide transparency about the system mapping process, a process which can sometimes be clouded in mystery. I then described the key theories of change and explored the extent to which these were or were not realised within the local system, focusing on the processes by which change occurred within the system. This approach allowed me to provide a clear focus for the analysis and a clear structure to report multiple findings. I was also able to show the dynamic nature of system and the intervention as they co-evolved, although this would perhaps have been portrayed more clearly through a system

story. Given these challenges, a second key recommendation for future research is to consider different ways of presenting the findings from complex systems evaluations and further explore how to make findings usable to decision makers.

#### 7.4 Knowledge exchange and co-production

One feature of the research described within this PhD is that it has been conducted with several different audiences in mind. Throughout my PhD registration period I have conducted a number of knowledge exchange activities to engage these audiences with my research and to utilise their feedback in further developing it (Table 1). Some of these have been rather traditional dissemination routes where I have presented my findings at academic conferences. However, I have also engaged with a mix of policy, practitioner and academic audiences about complex systems approaches to evaluation, utilising my work on alcohol interventions as illustrative case studies. My early engagement efforts focussed on describing the rationale for applying a complex systems perspective to evaluation and engaging in conversations about the extent to which these reasons resonated in different contexts. A key theme arising from these early discussions was that many different types of evaluators saw the value of applying a complex systems perspective, but lacked the knowledge and skills to apply it practically (a point mirrored in the complex systems literature and raised earlier in this chapter). My more recent engagement efforts therefore emphasised the practicalities of applying a complex systems perspective to evaluation and I have sought to underscore that this perspective could be applied in different evaluative contexts, including lower-resource settings.

**Table 1: Knowledge exchange activities**

<b>Title</b>	<b>Activity description</b>	<b>Audience(s)</b>	<b>Date</b>
Evaluation of public health interventions from a complex systems perspective	Invited talk at the Danish Centre for Clinical Research and Prevention’s webinar: <i>Developing and evaluating complex interventions using systems approaches</i> (co-presenter with Dr Vanessa Er)	Academic; Policy and Practice	March 2021
Systems approaches to public health evaluation	Invited talk at the Public Health Research Applications and Design Assistance (PHRADA) Workshop for NIHR PHR commissioned calls	Academic; Policy and Practice	September 2020
Tackling local alcohol-related harms in the night time economy: a process evaluation with a complex systems perspective	Poster presentation at Society for Social Medicine & Population Health’s Annual Scientific Meeting 2020	Academic	September 2020

<b>Title</b>	<b>Activity description</b>	<b>Audience(s)</b>	<b>Date</b>
What can a complex systems approach to local area intelligence do for you? Developing new guidance for local authority practitioners and other local professionals	Keynote talk at the Local Area Research + Intelligence Association's Annual Conference: <i>Shaping the place - the role of local area intelligence</i> (co-presenter with Dr Tarra Penney)	Policy and Practice	May 2018
How evidence-informed decision making can take a systems perspective: the implications of systems thinking for public health evaluation	Invited talk at the Department of Health Seminar Series (co-presenter with Professor Mark Petticrew)	Policy and Practice	October 2017
How evidence informed decision-making can take a systems perspective: review and guidance for local practitioners	Invited talk at the Centre for Global Non-Communicable Diseases & ECOHOST The Centre for Health and Social Change's Annual Symposium: <i>Complex systems thinking and NCD prevention</i>	Academic; Policy and Practice	September 2017
Addressing alcohol harms through voluntary action? A complex systems perspective	Invited talk to the UCL Alcohol Research Interest Group	Academic	January 2016
Addressing alcohol harms by removing cheap, super-strength beer and cider: a qualitative study of a local alcohol availability intervention	Oral presentation at the Lancet's <i>Public Health Science</i> Conference	Academic	November 2015
A local alcohol availability intervention to reduce 'problem drinking' by removing a 'problem drink': a qualitative study	Poster presentation at the Global Alcohol Policy Alliance Conference: <i>Momentum for Change: Research and Advocacy Reducing Alcohol Harm Conference</i>	Academic; Policy and Practice	October 2015
A qualitative study of 'Reducing the Strength': a local alcohol availability intervention	Poster presentation at the European Alcohol Conference: <i>Comparing and Contrasting Practice Across Europe</i>	Academic	April 2015

Gavens and colleagues report that academics are often disengaged from or outside of the networks in which policies and ideas are transferred between those working in local government (23). While my knowledge exchange efforts were rather limited, they represent an attempt to move beyond traditional spheres of academic dissemination and engage with local practitioners working in a range of settings.

As described in the Chapter 1, this research was conducted alongside my role as a researcher with the NIHR SPHR. SPHR has emphasised co-production and the RtS evaluation is an example of this. One of the research team members was a public health strategist involved in supporting and evaluating the intervention in the local area. His involvement in the intervention was valuable for helping shape the research questions, as well as interpreting the data generated through the interviews and focus group that I conducted. In turn, I contributed to the analysis of the mixed-

methods evaluation (Appendix C) which he led. The findings of the evaluations, collectively, provided valuable evidence on the mechanisms by which RtS contributed to observed impacts in the local area following implementation, as well as theories about longer term processes that may contribute to social change. These findings have been considered useful by the Council and have provided evidence more broadly about RtS schemes. The LNL evaluation did not have a co-production element, a limitation which is explored in the following section.

## 7.5 Strengths and limitations

In the following section, I briefly summarise the limitations of my research papers (Chapter 3-6) and consider some strengths and limitations of this cumulative body of work.

The RtS evaluation (Chapter 3) was conducted in a single case study site which was a trade-off chosen to prioritise breadth over depth. The sample was relatively small and did not include all possible types of super-strength consumers, including for example, the street homeless or those with more stable forms of housing. However, the sample did include drinkers and different types of service providers which allowed me to explore intervention processes at different levels within the local system. The data was generated through interviews and a focus group which could have been subjected to social desirability bias. Participants' responses were grounded in their personal experience of the intervention, as well as hypothetical responses about behaviours if the intervention had been implemented more fully (i.e. full retailer participation). The former is stronger evidence about the processes that played out following intervention implementation, but both provide data on how participants perceived the intervention and how it may generate system change. Finally, the study represented an early attempt to utilise a systems framing to conceptualise the intervention as an event within a system and apply a relatively small number of concepts from complexity science to inform the analysis.

The scoping review of studies applying a complex systems perspective to alcohol consumption and the prevention of alcohol-associated harms (Chapter 4) and the systematic review of complex systems process evaluations (Chapter 5) were reported according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Both were conducted in a manner to minimise bias and included a protocol, some element of independent dual screening and a transparent data extraction process to ensure the links between the data and the findings and interpretations were explicit. The search strategies of both reviews had some limitations: they may have missed studies that are compatible with a complex systems perspective but not do use the associated terminology or those that use the language but do not operationalise the concepts. Only

English-language studies were eligible for inclusion and the alcohol scoping review excluded studies published prior to 2000, whereas the systematic review relied on two previous reviews to identify papers published prior to 2014; both strategies may have resulted in missing some relevant papers. The alcohol scoping review identified a large number of studies and it was a challenge to group studies that are so diverse with respect to their aims, methodological approach and data sources. In the systematic review, we coded the degree to which each included study applies concepts from systems thinking and complexity science; this was challenging and decisions were not always clear-cut. Two reviewers undertook this process independently to minimise bias. Limitations of the qualitative process evaluation framework from a complex systems perspective and possible areas where it could be expanded have already been discussed in this chapter and will therefore not be repeated here.

The LNL process evaluation (Chapter 6) involved making a boundary decision to focus on the local system in which the levy is implemented; this decision was informed by the nature of the intervention, but was made without input from system actors. As a result of this focus, there was only a limited consideration of vertical complexity, although the local system was situated within its broader systemic context and data was included from beyond the local system, including national-level documents on the levy and national trade organisations' responses to the local consultation. The sampling strategy focused on primary data collection from a number of different intervention designers and implementers, as well as a small number of users of the NTE. Documentary sources were used to collect data on the views of the licensed trade and residents. Interviews with these system actors would have allowed for more probing of these responses and the possibility of following more emergent findings. The system mapping process was reported in a transparent manner; the table accompanying the map illustrates how I utilised the data to identify and define the variables and relationships between them. Finally, as already discussed, the complex systems process evaluation framework was applied retrospectively. Originally, I had planned to conduct a second wave of Phase 2 data collection, based on the analysis of the Phase 1 and early Phase 2 data. However, due to competing priorities and the Covid-19 pandemic and resulting lockdown, this additional phase of data collection was not possible. As a result, I was not able to fully apply the framework in its intended form and this curtailed my ability to further explore findings such as the co-occurrence of regulatory and voluntary alcohol interventions.

The PhD research described in this thesis was conducted and ordered in such a way to allow me to build incrementally on my own research and advances in the literature complex systems thinking applied to public health. The culmination of this was the development of the qualitative process evaluation framework from a complex systems perspective and its first application to a public health

evaluation. As I argued earlier in this chapter, if public health evaluators are to progress methodological innovation and assess the value added of these methodologies, it is imperative that we are transparent and reflect on our evaluative choices and processes. In this thesis I was able to do so and my intention is that this work can be further utilised to move forward to the field of complex systems thinking in public health evaluation.

A key finding from the scoping review described in Chapter 4 was that research on alcohol consumption and alcohol-related harms from a complex systems perspective has largely focused on sub-local (i.e. individual) and local level systems. This tendency reflects the dominance of individual-level theories of behaviour change in much of the alcohol epidemiology field and reflects the fact that many alcohol interventions are delivered locally (93,94). For simulation models, local systems are also seen as achieving the right balance between a simple and complex system that can be modelled (93). The empirical research presented in this thesis also had a local focus; a choice which was justified based on the geographical nature of the interventions. Both evaluations included some vertical dimensions and this was evident to a greater extent in the LNL study compared to the RtS analysis. Complex systems evaluations must be bounded in some way and it is not possible to investigate the processes and mechanisms by which the intervention affects and is affected by all systemic levels (69). However, there is scope within both evaluations to analyse more of these vertical influences, particularly a greater exploration of alcohol industry corporate interests and tactics and how they may affect and be affected by these types of interventions.

This RtS study described in this thesis had a co-production element but a limitation of the LNL evaluation was that it did not incorporate a participatory approach. A more participatory process could have encouraged system actor input into designating the system boundaries, generating research questions and interpretation of the data. Such an approach would have gone some way to addressing power imbalances in the research, as well as possibly producing findings that better suit decision-makers' needs.

This PhD research focused on visible alcohol consumption outside the home, specifically street drinking and drinking in on-trade establishments. However, changes in English alcohol consumption patterns mean that it is now more common for drinkers to purchase alcohol at supermarkets and off-licences and consume it at home (58). This is a trend that pre-dates Covid-19 lockdown restrictions and the resulting restrictions on drinking in on-trade establishments. While RtS and the LNL can affect home consumption (RtS targets off-trade sales and the levy is applied to the off-trade in addition to the on-trade), evaluations which focus on interventions that are primarily designed to address the visible impacts of excessive alcohol consumption miss the key location of alcohol

consumption and an important driver of alcohol-associated harms in England. A limitation of these evaluations therefore is that they did not delve significantly into the processes by which the interventions may influence consumption at home, thereby influencing alcohol-related harms associated with home drinking, such as domestic violence.

Finally, much like an evaluation of an intervention introduced into a complex system, the research in this thesis had to be bounded in some way. The field of complex systems thinking in public health is rapidly growing, with researchers and practitioners advancing the associated methodologies by exploring – to name a couple – the implications of the “conceptual muddle” of complex systems terminology (95 p.167) or the role of theories, including layering theories, in the context of a complex systems evaluation (77,96). While Chapter 2 does attempt to bring some clarity to the terminology associated with complex systems thinking, overall, I could have chosen to engage more explicitly with this literature and considered the implications of it for my own framework development and application, but ultimately my own boundary judgements excluded it.

## 7.6 Conclusion

This thesis has contributed to the rapidly expanding literature on applying a complex systems perspective to addressing key public health problems, including alcohol consumption and associated harms. In response to criticism that this literature base is characterised by advocacy for this perspective, with little accompanying practical guidance, this thesis presents a programme of research that has ultimately developed and tested a framework for process evaluation from a complex systems perspective. It is the intention that public health evaluators further utilise, critique and refine this framework in order to produce evidence that better reflects and seeks to solve public health challenges.

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## Appendix A: Ethics approvals



Observational / Interventions Research Ethics Committee

Karen Lock  
Senior Lecturer in Public Health  
HSRP / PHP  
LSHTM

24 June 2013

Dear Dr. Lock,

**Study Title:** How is local government alcohol policy implemented and evaluated?  
**LSHTM ethics ref:** 6452

Thank you for your application of 31 May 2013 for the above research, which has now been considered by the Observational Committee.

**Confirmation of ethical opinion**

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation, subject to the conditions specified below.

**Conditions of the favourable opinion**

Approval is dependent on local ethical approval having been received, where relevant.

Please note the following recommendation from the committee:

The committee assumes that the 'informal interviews' are the conversations that take place during the 'work-shadowing' element of the data-gathering. If so, would it be sensible to specify in Information Sheet 2, in the 'what is involved' section, that the 'talk', as well as the 'activities' and 'events' will be recorded in the notebook?

**Approved documents**

The final list of documents reviewed and approved by the Committee is as follows:

Document	Version	Date
LSHTM ethics application	n/a	
Protocol		
Information Sheet - Understanding alcohol policies in English Local Government to improve approaches to tackling alcohol-related harms		
Information Sheet & Consent form - Understanding policy decision making in UK Local Government to improving action for citizen health and wellbeing - <i>Work shadowing</i>		
Information Sheet & Consent form - Understanding policy decision making in UK Local Government to improving action for citizen health and wellbeing - <i>Interviews</i>		

**After ethical review**

Any subsequent changes to the application must be submitted to the Committee via an E2 amendment form. All studies are also required to notify the ethics committee of any serious adverse events which occur during the project via form E4. At the end of the study, please notify the committee via form E5.

Yours sincerely,



**Professor John DH Porter**

**Chair**

[ethics@lshtm.ac.uk](mailto:ethics@lshtm.ac.uk)

<http://intra.lshtm.ac.uk/management/committees/ethics/>



**Observational / Interventions Research Ethics Committee**

Dr Matt Egan  
SEHR / PHP  
LSHTM

4 August 2014

Dear Dr. Egan,

**Study Title: How is local government alcohol policy implemented and evaluated?**

**LSHTM Ethics Ref: 6452-02**

Thank you for your application of 14 July 2014 for the above amendment to the existing ethically approved study and submitting revised documentation. The amendment application has been considered by the Observational Committee.

**Confirmation of ethical opinion**

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above amendment to research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

**Conditions of the favourable opinion**

Approval is dependent on local ethical approval for the amendment having been received, where relevant.

**Approved documents**

The final list of documents reviewed and approved by the Committee is as follows:

Document Type	File Name	Date	Version
Other	Drinkers_Info_Consent_Amendment.docx	14/07/2014	1

**After ethical review**

Any further changes to the application must be submitted to the Committee via an Amendment form on the ethics online applications website. The Principal Investigator is reminded that all studies are also required to notify the ethics committee of any serious adverse events which occur during the project via an Adverse Event form on the ethics online applications website. At the end of the study, please notify the committee via an End of Study form on the ethics online applications website. Ethics online applications website link: <http://leo.lshtm.ac.uk>

Yours sincerely,

  
**Professor John DH Porter**  
Chair

[ethics@lshtm.ac.uk](mailto:ethics@lshtm.ac.uk)  
<http://www.lshtm.ac.uk/ethics/>

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**Improving health worldwide**

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MEDICINE



### Observational / Interventions Research Ethics Committee

LSHTM

24 August 2015

Dear

**Study Title:** Alcohol accessibility and alcohol consumers in an inner-London Borough

**LSHTM Ethics Ref:** 10129

Thank you for responding to the Observational Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

#### Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

#### Conditions of the favourable opinion

Approval is dependent on local ethical approval having been received, where relevant.

#### Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document Type	File Name	Date	Version
Protocol / Proposal	Protocol_4082	24/06/2015	1
Protocol / Proposal	Interview Topic Guides_4082	24/06/2015	1
Protocol / Proposal	Fieldnote Templates_4082	24/06/2015	1
Investigator CV	Investigators CVs_4082	24/06/2015	1
Information Sheet	Study Information Sheets and Consent Forms_4082	24/06/2015	1
Covering Letter	Response to ethics committee_4082	13/08/2015	1
Protocol / Proposal	Protocol_4082_v2	13/08/2015	2
Information Sheet	Study Information Sheets and Consent Forms_4082_v2	13/08/2015	2

#### After ethical review

The Chief Investigator (CI) or delegate is responsible for informing the ethics committee of any subsequent changes to the application. These must be submitted to the Committee for review using an Amendment form. Amendments must not be initiated before receipt of written favourable opinion from the committee.

The CI or delegate is also required to notify the ethics committee of any protocol violations and/or Suspected Unexpected Serious Adverse Reactions (SUSARs) which occur during the project by submitting a Serious Adverse Event form.

At the end of the study, the CI or delegate must notify the committee using an End of Study form.

All aforementioned forms are available on the ethics online applications website and can only be submitted to the committee via the website at: <http://leo.lshtm.ac.uk>

Additional information is available at: [www.lshtm.ac.uk/ethics](http://www.lshtm.ac.uk/ethics)

Yours sincerely,



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## Appendix B: Research paper 1: topic guides

### Reducing the Strength interview topic guide: drinkers

#### 1. Introduction:

- Introduce study, confidentiality, audio recording
- Any questions?

#### 2. To start off, can you tell me how long you have been living here at **XXX**?

*Probe around:* housing history; plans to leave hostel system (if any)

#### 3. Can you walk me through what you do on a typical day?

*Probe around:* who they interact with; leaving the hostel; engagement with any services

#### 4. I now want to ask you some more specific questions about your alcohol consumption.

- How frequently do you drink?
  - Does it differ day-to-day? Or week-to-week? If so, why?
- What do you currently drink?
  - Is there a specific brand? Why that brand?
  - Do you ever drink anything else? If so, what? And why?
- How much of [chosen drink] do you drink on a typical day?
- Where do you usually drink?
- Do you usually drink with other people?
- Where do you buy your drink?
  - *Probe around:* location, shop characteristics and retail practices, quantities available
- If you want to buy alcohol after most the shops have closed, where do you go?
- Have you ever been moved on whilst drinking? By whom?
- Are you trying to cut down on how much you drink? If so, why? If so, how?

#### 5. Have you noticed if any shops around here have stopped selling super-strength beer or cider?

- **What do you think about this?**
- **Have you changed your routines because of this?**
  - *Probe around:* buying other products, purchasing less, going to other shops, traveling a distance, switching to something else seeking treatment/help to drink less
- **Have your friends changed their routines because of this?**

#### 6. If they have not noticed: **What would happen if the brand you like were no longer sold in your normal shop?**

*Probe around:* buying other products, purchasing less, going to other shops, traveling a distance, switching to something else seeking treatment/help to drink less

#### 7. Wrap up, thank you and give voucher for participation.

## Reducing the Strength interview topic guide: service providers

### 1. Introduction:

- Introduce study, confidentiality, audio recording
- Any questions?

### 2. To start off, can you tell me a bit about the [service name], and the services you provide?

*Probe around:* services provided, types of clients, accessing client groups, interaction with other services, specific alcohol-related services

### 3. As an [X role], what does your role entail?

### 4. Can you tell me a bit more about the clients/residents that you work with?

*For those who consume alcohol, probe around:* what they drink, purchasing patterns, co-occurrence of substance misuse

- **Have there been any particular changes that you have noticed in your clients' drinking habits recently (last 6 months or so) – either large or small?**

### 5. Can you describe what a typical day might look like for your residents/clients who consume alcohol?

### 6. Can you tell me about the 'Reducing the Strength' initiative?

*Probe around:* initiative aims, type of drinker it is targeting, etc.

- **Thinking about the people you work with, do you think 'Reducing the Strength' has had any impacts on them?**
  - *Probe around:* purchasing habits (drink type, shops they visit), drinking habits (amount consumed, where they drink), interaction with treatment
- **Have you seen any other impacts of the initiative, either health or non-health related? Can 'Reducing the Strength' have broad impacts (medium and short term?)**
  - *Probe around:* perceptions of safety, drinkers' long-term health, crime, anti-social behaviour/public nuisance

### 7. If participant hasn't heard of the initiative explain what it is: **Have you heard of this happening in your area?**

- **What do you think about an initiative like this?**
  - *Probe around:* how drinkers would respond, impact on services, possible broader impacts

### 8. Over the past 6 months or so, have there been any other initiatives or service changes that have affected you?

- Have any services been deliberately linked with 'Reducing the Strength'?

### 9. What are the challenges associated with working in [LA]?

*Probe around:* certain population groups, service structure

### 10. Wrap up and thank you

## Reducing the Strength focus group topic guide: service providers

### 1. Introduction:

- Introduce study, confidentiality, audio recording
- Any questions?

### 2. To start off, could we please go around the table and have you all introduce yourselves, say your job title and just a few sentences about what your role entails?

### 3. What types of alcohol services do you provide?

*Probe around:* types of clients, how clients access the service, linkages with other services, differences between specific roles at the alcohol services

### 4. Can you tell me about your clients drinking habits?

*Probe around:* what they drink, purchasing patterns, co-occurrence of substance misuse

- **Have there been any particular changes that you have noticed in your clients' drinking habits recently (last 6 months or so) – either large or small?**

### 5. Now I would like to talk about the 'Reducing the Strength' initiative. Does anyone recognise that name? Can you tell me about the initiative?

- If not, explain: It is an initiative where off-licensed shops voluntarily remove cheap, high strength beer and cider from their shelves
  - *Probe around:* initiative aims, type of drinker it is targeting, etc.

### 6. Thinking about the people you work with, do you think 'Reducing the Strength' has had any impacts on them?

*Probe around:* purchasing habits (drink type, shops they visit), drinking habits (amount consumed, where they drink), interaction with treatment, different views amongst different roles in the alcohol service?

### 7. Have you seen any other impacts of the initiative, either health or non-health related? Can 'Reducing the Strength' have broad impacts (medium and short term?)

*Probe around:* perceptions of safety, drinkers' long-term health, crime, anti-social behaviour/public nuisance

### 8. Over the past 6 months or so, have there been any other initiatives or service changes that have affected you?

- Have any services been deliberately linked with 'Reducing the Strength'?

### 9. What are the challenges associated with working in [LA]?

*Probe around:* certain population groups, service structure

### 10. Wrap up and thank you

## Appendix C: Reducing the Strength mixed methods evaluation

## RESEARCH PAPER COVER SHEET

Please note that a cover sheet must be completed for each research paper included within a thesis.

### SECTION A – Student Details

Student ID Number	305848	Title	Ms
First Name(s)	Elizabeth Tyner		
Surname/Family Name	McGill		
Thesis Title	Evaluating local-level interventions to address alcohol-related harms in England: the development and application of a complex systems perspective to process evaluations		
Primary Supervisor	Professor Matt Egan		

If the Research Paper has previously been published please complete Section B, if not please move to Section C.

### SECTION B – Paper already published

Where was the work published?	BMC Public Health		
When was the work published?	May 2016		
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion			
Have you retained the copyright for the work?*	No	Was the work subject to academic peer review?	Yes

\*If yes, please attach evidence of retention. If no, or if the work is being included in its published format, please attach evidence of permission from the copyright holder (publisher or other author) to include this work.

### SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	
Please list the paper's authors in the intended authorship order:	

Stage of publication	Choose an item.
----------------------	-----------------

### **SECTION D – Multi-authored work**

<p>For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)</p>	<p>Contributed to data analysis and interpretation; contributed to drafting the manuscript; critically revised the manuscript</p> <p>Note this paper is included in the appendix for information. It should be considered as supplemental to the thesis rather than a core part of the thesis.</p>
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### **SECTION E**

<b>Student Signature</b>	Elizabeth McGill
<b>Date</b>	26/02/2021

<b>Supervisor Signature</b>	Matt Egan
<b>Date</b>	26.02.21

RESEARCH ARTICLE

Open Access



# Reducing the Strength: a mixed methods evaluation of alcohol retailers' willingness to voluntarily reduce the availability of low cost, high strength beers and ciders in two UK local authorities

Colin Sumpter<sup>1</sup>, Elizabeth McGill<sup>2\*</sup>, Esther Dickie<sup>1</sup>, Enes Champo<sup>1</sup>, Ester Romeri<sup>1</sup> and Matt Egan<sup>2</sup>

## Abstract

**Background:** Reducing the Strength is an increasingly popular intervention in which local authorities ask retailers to stop selling 'super-strength' beers and ciders. The intervention cannot affect alcohol availability, nor consumption, unless retailers participate. In this paper, we ask whether and why retailers choose or refuse to self-impose restrictions on alcohol sales in this way.

**Methods:** Mixed method assessment of retailers' participation in Reducing the Strength in two London (UK) local authorities. Compliance rates and the cheapest available unit of alcohol at each store were assessed. Qualitative interviews with retailer managers and staff ( $n = 39$ ) explored attitudes towards the intervention and perceptions of its impacts.

**Results:** Shops selling super-strength across both areas fell from 78 to 25 (18 % of all off-licences). The median price of the cheapest unit of alcohol available across all retailers increased from £0.29 to £0.33 and in shops that participated in Reducing the Strength it rose from £0.33 to £0.43. The project received a mixed response from retailers. Retailers said they participated to deter disruptive customers, reduce neighbourhood disruptions and to maintain a good relationship with the local authority. Reducing the Strength participants and non-participants expressed concern about its perceived financial impact due to customers shopping elsewhere for super-strength. Some felt that customers' ability to circumvent the intervention would limit its effectiveness and that a larger scale compulsory approach would be more effective.

**Conclusions:** Reducing the Strength can achieve high rates of voluntary compliance, reduce availability of super-strength and raise the price of the cheapest available unit of alcohol in participating shops. Questions remain over the extent to which voluntary interventions of this type can achieve wider social or health goals if non-participating shops attract customers from those who participate.

**Keywords:** Evaluation, Mixed methods, Alcohol, Availability, Local policy

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Full list of author information is available at the end of the article



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## Background

In an effort to tackle the perceived negative impact of super-strength alcohol in the United Kingdom (UK), a number of local licensing authorities have encouraged 'Reducing the Strength' (RtS) schemes [1–4]. According to guidance issued by the Local Government Association, "the definition of high strength varies, but for the purposes of Reducing the Strength schemes has tended to refer to products from around 6.5 per cent ABV [alcohol-by-volume] upwards" ([5] p.6). These products are usually classified as strong beers and ciders sold at low prices. Super-strength lager is often sold as single 500 ml cans and well-known brands include Carlsberg's Special Brew, Tennent's Super, Kestrel Super and Skol Super. White cider is primarily sold in 500 ml cans, 1 litre or 3 litre plastic bottles and most available brands are 7.5 % ABV. Well-known brands include White Ace, Frosty Jacks and White Star.

At the time of the intervention described in the paper (2013–2014) a single 500 ml can of 9 % ABV beer contained more than the maximum daily alcohol intake for men (3–4 units) and women (2–3 units) recommended by UK health guidance [6]. A single 3 litre bottle of white cider also exceeded the recommended weekly alcohol intake (21 and 14 units for men and women, respectively) [6]. The UK Chief Medical Officer recently updated the alcohol guidelines, recommending that men and women consume no more than 14 units of alcohol per week, spread over at least three drinking days [7]. Super-strength products continue to be sold in quantities that exceed these recommendations.

Alcohol consumed in large quantities for prolonged periods is causally associated with both acute and long-term health problems [8–10]. Wider societal problems associated with super-strength alcohol include street drinking and homelessness, anti-social behaviour, underage drinking and family breakdown [11]. There is no evidence that super-strength alcohol has a unique or 'special' type of harm that would not be experienced from consuming the same units of alcohol in another form [12], rather it is the availability (convenience and branding) and low unit cost of these drinks that raise them as an issue of interest to public health practitioners [13]. One Australian study demonstrates a positive association between high-strength beer and cask wine consumption at a population level and alcohol-related criminal activity and alcohol-related morbidity [14]. There is evidence linking the price of alcoholic beverages and the volume consumed at a population level [15].

RtS schemes have become increasingly popular as a method to address the negative impact of super-strength products, and since 2012, approximately 80 schemes have been launched across England [16]. The intervention was originally launched in Ipswich, Suffolk, although Thames

Reach, a large homeless charity, has been campaigning against super-strengths since 2005 [11]. RtS schemes vary in nature with regards to the specific drinks or populations targeted, but in general, local authorities ask local retailers licenced to sell alcohol for consumption off premise (such shops are called 'off-licences') in specific areas to voluntarily remove super-strength alcohol from sale [5].

RtS speaks to both the physical and economic aspects of availability [17]. If compliance is widespread, the intervention removes an entire group of products from an area, thereby reducing the quantity and variety of different types of alcohol available. Where super-strength beers and ciders represent the cheapest products on sale, the intervention will also raise the price of the cheapest available unit of alcohol in participating shops. Due to the relatively lower rate of alcohol levied on still ciders, white cider is almost universally the cheapest unit of alcohol available in shops. A study of heavy drinkers' habits identified those who drank white cider as the population group consuming the most alcohol [18]. An organisation working with homeless and street drinkers identified super-strength lager as a preferred drink, and a cause of harm, amongst these groups [11].

Both UK and international health agencies recommend increasing the cost of alcohol to address alcohol-related harms, and evidence suggests that higher alcohol prices will most affect those who drink at harmful levels [19–21]. Off-licences, primarily small independent retailers, as opposed to supermarkets, have been found to sell 95 % of all alcohol consumed by heavy drinkers in Scotland. White cider was found to be exclusively available at these outlets [13]. Voluntary bans on super-strength products in Portsmouth have reported high levels of shop compliance with the intervention [5] and Ipswich, Suffolk has reported a reduction in crime and anti-social behaviour [22], although to date no robust evaluations have been published.

In this paper, we address the question of whether a targeted, voluntary approach to reducing alcohol availability can achieve the prerequisite of successfully enlisting retailers to volunteer. We also present early data on the effect an RtS scheme may have on the cheapest available alcohol. This is directly relevant to national and international debates over the relative merits of voluntary and compulsory approaches for reducing alcohol availability, as well as debates over local versus national level interventions [23–25]. It also has parallels with other interventions aimed at restricting particular alcohol products, such as restrictions on the sale of cask wine in parts of Australia [26, 27].

In 2013–2014 RtS schemes were implemented in the London Boroughs of Islington and Camden. In a related paper (currently submitted) we explore responses to RtS from the perspective of target populations of drinkers and

front line staff who work with them. We have also conducted a separate quantitative study of RtS's impact on alcohol sales using retail data (also currently submitted). The aim of this study is to evaluate the Islington and Camden schemes by assessing the effect on the cheapest available unit of alcohol in off-licences and retailers' willingness to participate. Using quantitative and qualitative process data, it explores whether a voluntary reduction in alcohol availability through this intervention is feasible, what influences retailers' choice to participate or not, and how retailers believe their participation will influence alcohol purchasing amongst the targeted population.

## Methods

As part of a mixed methods evaluation we present data from local authority audits of off-licences and qualitative findings from interviews with retailers. The evaluation was conducted by members of Islington and Camden's joint public health team in collaboration with independently funded researchers from London School of Hygiene & Tropical Medicine (LSHTM). Local authority auditing processes did not require ethical approval. The LSHTM team obtained ethical approval through the London School of Hygiene & Tropical Medicine Ethics Committee.

## Intervention

In 2013–2014, voluntary RtS projects were introduced in areas considered to have street drinking and alcohol-related anti-social behaviour problems within two neighbouring London local authorities, Islington and Camden. The Islington and Camden intervention areas contained 63 and 78 off-licences, respectively. Each local authority implemented RtS independently by recruiting alcohol retailers to voluntarily remove super-strength beers and ciders (defined as cheaply sold drinks with  $\geq 6.5$  ABV) from sale in their shops with a view to reducing health and social harms associated with street drinking, but also recognising potential benefits to wider populations.

The projects were designed and implemented by licensing teams in partnership with police and public health practitioners. Repeated visits were made to local premises to advocate for voluntary participation on grounds of social responsibility. Letters and visits to off-licences by the licensing and licensing police teams were used to raise the profile of the scheme. In addition, in Camden a launch event was organised by the council, which was attended by public health, the business improvement district and the local media.

## Sampling

The local authorities held data on all local off-licences; all stores in the intervention areas were included in the audit to provide data on compliance with RtS. Shops known to be selling super-strength alcohol pre-intervention were

included in the qualitative fieldwork. Stores were sampled for qualitative fieldwork based on the assumption that around 40 of the 78 stores selling super-strength would be sufficient to provide a purposive sample that covered different geographical areas, shop types and shops that participated or declined to participate in RtS.

Sampled stores were visited to obtain consent to participate in the study from licence holders, managers or staff (which we refer to collectively as 'retailers'). Retailers that did not participate in RtS were over-sampled to ensure this group was well represented. Visits took place between 3 and 6 months after intervention implementation commenced. Two researchers conducted each visit from a pool of five researchers. All interviewers were professionals with experience of conducting qualitative research.

## Data collection

Data on sign-up and adherence was provided by local licensing teams who made regular visits to off-licences to record the prices of alcoholic beverages and to audit whether  $\geq 6.5$  ABV beers and ciders were on sale. Where possible, public health practitioners objectively assessed the unit cost of alcohol in RtS participating shops. Pre-intervention prices were obtained from shop managers or shop staff and relied on their recall of the product prices. The price, container size and brand of the cheapest beer, cider wine and spirits available in both individual and multi-buy deals was recorded on a pro-forma during visit. Where a drink type was not available this section was left blank. Where the cheapest unit of any drink type was not clear, data on several cheap products was collected for later calculation and comparison.

A topic guide was developed to enable interviews to explore retailers' views on the scheme, reasons for (not) participating in RtS, and views on how the scheme impacts on purchasing amongst the target population as well as broader impacts on the retailer and community. This guide was developed in collaboration with the licensing team who implemented the schemes and was designed to elucidate the motivations for participation, as well as the barriers. The guide provided a starting point for discussion but there was also sufficient scope within the interview for the participants to guide the discussion. The main themes in the topic guide were: knowledge of RtS, rationale for (non-) participation, impact on alcohol availability, challenges of participating in the scheme, impact on the shop, response from super-strength drinkers, intervention sustainability and suggestions to improve the intervention. Participant responses were recorded in writing during the interviews on a pro-forma with space for verbatim quotes. To aid recruitment, interviews were conducted in the shops as this was convenient for participants. However, we did not regard shops as a suitable location to audio-record the interviews due to the presence of customers.

Due to the short time span between implementation and evaluation no efforts were made to assess the wider impact of the scheme on levels of drinking, health harms or anti-social behaviour.

**Analysis**

The cheapest unit of alcohol available, regardless of drink type, was calculated for each individual off-licence using the price, container size and ABV data. The median cheapest unit was then calculated across the entire intervention area and this data was plotted in terms of median and inter-quartile range pre- and post-RtS. A sub-analysis was conducted on only those shops that participated in RtS in order to understand the potential effect if the intervention achieved universal sign-up.

Post-visit interview notes were written up and reviewed by two researchers to draw out common themes. These were reviewed by a third author and through discussion amongst the research team, we drew out the shopkeepers' prevalent and divergent opinions about RtS.

**Results**

Forty-three off-licences were approached for interview and 39 (91 %) agreed to take part; 20 out of 24 Islington shops and all 19 Camden shops approached participated in the interviews. Nine interviews were from shops that did not agree to participate in the RtS scheme. Interviews were held with staff in managerial and sales positions as Licencees or Designated Premise Supervisors were often not available.

**Impact on the availability of super-strength**

Prior to the intervention, 74 % (*n* = 47) and 39 % (*n* = 31) off-licences sold super-strength in Islington and Camden, respectively (Table 1). During the 3-6 month period following the intervention launch, 33 % (*n* = 21) of off-licences in Islington and 5 % (*n* = 4) of off-licences in Camden continued to stock these products. There remained variation within boroughs with sign-up tending to cluster geographically. There was an observed positive

**Table 1** Availability of super-strength alcohol in the intervention areas (Pre- and Post-RtS)

	Number of off-licences in area	Super-strength available pre-intervention	Super-strength available post-intervention <sup>a</sup>	Relative reduction <sup>b</sup>
Islington	63	47 (74 %)	21 (33 %)	41 %
Camden	78	31 (39 %)	4 (5 %)	34 %
Total	141	78 (55 %)	25 (18 %)	37 %

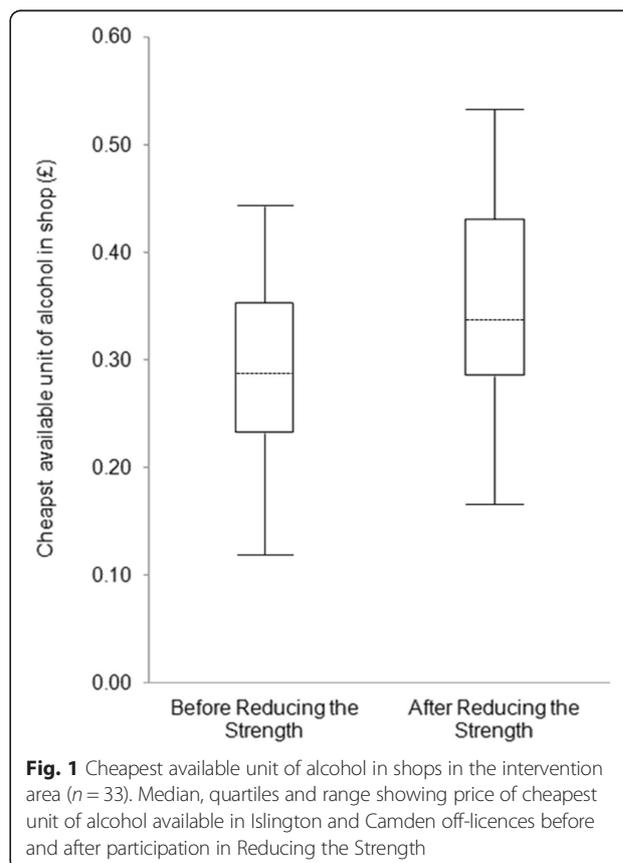
<sup>a</sup>Visits conducted between 3 and 6 months after initial retailer sign-up to RtS scheme

<sup>b</sup>Relative reduction in the proportion of off-licences selling super-strength in each area

effect of neighbouring off-licences signing up and vice-versa.

**Impact on the affordability of alcohol**

Price data was included for 33 of 39 shops visited. White cider, where available, was found to be the cheapest unit of alcohol available pre-intervention with prices as low as £0.12 per unit. Super-strength lager was found to be more expensive with the cheapest available unit across all shops costing £0.22 in a multi-buy offer. In a minority of cases the cheapest unit of alcohol identified was not classified as super-strength. In particular, multi-buy offers of cider with < 6.5 % ABV were found that provided the cheapest available unit of alcohol. Despite this there was an overall rise in the median price of the cheapest unit of alcohol from £0.29 to £0.33 (Fig. 1) available across the entire intervention area. The absolute cheapest available unit rose only slightly due to non-participation of some shops selling white cider. There was an increase in the cheapest alcohol unit available in 17 of the 33 shops surveyed (52 %). Of the shops that took part in RtS (*n* = 22), 85 % saw an increase in the cheapest available unit and the median cheapest available unit across all participating shops rose from £0.33 to £0.43.



**Fig. 1** Cheapest available unit of alcohol in shops in the intervention area (*n* = 33). Median, quartiles and range showing price of cheapest unit of alcohol available in Islington and Camden off-licences before and after participation in Reducing the Strength

### Views of shop managers and staff

#### Rationale for participation in RtS scheme

Overall, interviewees demonstrated a reasonable level of understanding of the immediate aim of the projects – to remove from sale cheap alcohol of ABV 6.5 % or above – and the further aim of reducing street drinking. Addressing health concerns associated with excessive alcohol consumption was recognised to a lesser extent. Some participants identified closely with the aims of the project, recognising street drinking as a problem in the area and at times considering their own perceived responsibility in enabling such activities:

*A lot of anti-social behaviour to reduce it which affects us...we had a lot of trouble and the neighbourhood was not happy* [Pilot participant, Camden]

Concern about the “neighbourhood” being unhappy illustrates how retailers could see attempts to reduce street drinking as a way of appeasing a wider customer base of local residents. Other retailers hoped participation in RtS would reduce anti-social behaviour within their own shops, linking street drinkers with problems such as shoplifting, verbal abuse and at times physical abuse of staff:

*It seemed like a good thing to do. They [street drinkers] were causing me problems... getting abusive* [Pilot participant, Islington]

More typically, reasons for joining RtS centred on a desire to co-operate with the licensing authorities. Interviewees mentioned wanting to “keep the council happy” by participating. There were differences in understanding with regard to the voluntary nature of the intervention, even though non-participating stores continued to operate in their area. Some retailers described a decision to participate taking the form of a voluntary agreement to new licensing conditions which would then be enforceable. Across the sample, different perspectives of what constituted ‘voluntary’ emerged, with some believing that the intervention was not voluntary:

*We thought if we don't do it, we'll lose our licence – this is our bread and butter* [Pilot participant, Islington]

#### Rationale for non-participation in RtS scheme

From the shops that had not participated in RtS, interviewees consistently justified non-participation in terms of perceived financial impact. These interviewees explained that they were concerned not only by the loss of trade from the removed super-strength

items, but also by additional items that some customers buying these products also purchased:

*At first, I thought, 'why not?' I like to be good with the council [but] as a small business I have to look out for my cost.... You realise that people don't just buy one thing, it's a package... beer, cigarettes, paper, and so you lose out on that money too* [Non-participant, Islington]

The voluntary nature of the approach – and the knowledge that other retailers in close proximity had not signed up to the pilot – reinforced the view among these interviewees that participation was not a financially viable option within the difficult financial climate they described operating within. The increase in the number of local supermarkets and raising business rates and fees were frequently referred to. These issues were compounded by the prospect of competition from shops that were not participating in RtS:

*It's not just about us doing it. If I sign up and next door doesn't they are just going to go there.* [Non-participant, Islington]

Interviewees described the need for an even playing field, with super-strength products removed from sale from all retailers – at a pan-London or national level – before they could further consider participation in the pilot. In particular, there was a perception that supermarkets had not been included within the pilot with interviewees from smaller, independent shops citing their participation as vital before they could consider signing up themselves. However, these interviewees questioned the likelihood that this degree of sign-up could be achieved on a voluntary basis and reported that they believed nothing short of a ban would be successful in achieving this aim:

*They should just ban the drinks ... That way, they wouldn't go to other shops. Those who drink will always find a way anyway. The only way to stop street drinking is to ban alcohol.* [Non-participant, Islington]

Interviews with non-participants in the scheme included representatives from two national supermarkets. Despite the fact that one of these stores had initially signed up to the scheme, both reported that at an individual store level, managers had little to no discretion over the product lines stocked. The researchers were informed that in order to remove super-strength beers and ciders, this would need to be sanctioned by their respective head offices and rolled out on a national basis. One interviewee gave the rationale for this as the importance of

consistency; that customers could walk into any store around the country and be able to purchase a similar range of items. The other offered a more multi-faceted explanation, elaborating on the potentially damaging impact that such a move could have on the relationships with the major breweries, even though the manager claimed that sales of super-strength were low:

*It can be part of the deal with the breweries. So in order for us to stock the standard Carlsberg lager we have to carry Special Brew, even if we don't sell much of it.* [Non-participant, Islington]

#### **Perceived impacts since joining scheme**

A few participants felt that there had been a reduction in levels of street drinking, violence and litter in the area surrounding their premises. They attributed this to anti-social customers going elsewhere to shop for their super-strength. Some described ambivalent feelings trading the benefits of reduced anti-social behaviour within their shop against loss of sales:

*In one way it's good because you get more decent customers but you also lose trade* [Pilot participant, Islington]

There was a widely held belief among interviewees that the majority of customers were now going elsewhere to buy super-strength beers and ciders. Interviewees highlighted that the voluntary, and targeted approach of the pilot meant that customers looking for super-strength rarely had to walk more than a few minutes before being able to purchase this: either to a shop within the pilot area that had opted not to participate, or to one which falls just outside the boundaries of that particular pilot area. Some independent shopkeepers spoke of witnessing regular customers who consumed super-strength switching to nearby rival independent stores that were not participating in RtS:

*We've lost business – we see people buying them [super-strength beers and ciders] from other shops* [Pilot participant, Islington]

*Other customers are going elsewhere. I see them.* [Pilot participant, Islington]

Some participants gave rough estimates of the percentage of their alcohol trade affected by RtS, ranging from 5 – 20 %. In other cases, participants reported customers substituting alcohol products, sometimes by stealing more expensive drinks, but more typically by buying

lower ABV products. Shops tried to encourage this form of substitution through promotion of lower ABV beers and ciders:

*We're trying to push lower [ABV] beers and we're getting close to making up sales.* [Pilot participant, Islington]

#### **Discussion**

This study is one part of a multi-methods and multi-site evaluation of RtS. It has been designed to produce early evidence on the feasibility of an intervention that relies on voluntary participation from shops. We found relatively high rates of participation by off-licences in the intervention areas and evidence that across the intervention area the median price of the cheapest unit of alcohol available increased. The rise was relatively small, although the target population of homeless and street drinkers have few financial resources making them susceptible to relatively small changes in economic availability [28]. The qualitative findings suggest that even a relatively small minority of non-participating shops can potentially deter voluntary compliance with the intervention and undermine its impacts if customers find it easy to access shops where they can still buy super-strength products. The relatively small geographical implementation area and voluntary nature of the intervention make this substitution of shops viable. The localised and voluntary nature of the intervention also presents other challenges for implementers. For instance, our findings suggest that larger retail chains make decisions to participate at a regional or national level, which means that local authorities wanting to implement RtS may be obliged to negotiate with the head offices of multiple national supermarket chains to ensure their participation.

The fact that RtS is a local-level intervention, generally delivered on a small scale, also has implications on the kinds of research approaches that are feasible and useful in this context. The local-level delivery means that the number of shops involved and the drinking population targeted were small, making sufficiently powered quantitative analysis difficult. In this paper we have included some basic quantitative data on shop uptake and minimum prices but rely on qualitative findings based on a purposive sample of half the total 'population' of off-licences known to have sold super-strength prior to the intervention.

The research also represents collaboration between local practitioners and academic researchers intended to maximise the utility of the study as a resource for informing practice. One requirement to achieve this was that the study provided timely findings about outcomes that local practitioners could plausibly seek to influence,

such as intervention uptake and compliance [29–31]. Lengthy academic timescales have been described in previous literature as a barrier to evidence informed decision making if findings are reported too late to affect decisions driven by political timescales [32, 33].

It is recognised that public health researchers generally value evaluations with robust study designs that include greater numbers of participants to provide adequate statistical power for measuring health outcomes, preferably compared with a suitable control group [34, 35]. We too value such studies but we still argue the case for evaluations that cater specifically for the more immediate needs of decision-makers. Guidance on the evaluation of complex interventions recommends such studies to explore the feasibility of interventions and help inform decisions about whether larger scale intervention and evaluation are justified, so we would argue that our approach conforms to accepted standards of good evaluation practice [35].

#### Limitations

Within the timescales of the evaluation we are unable to demonstrate any longer term outcomes such as reduced crime, anti-social behaviour, acute health harms or improved long-term health. Follow-up visits were not made to all off-licences as part of the evaluation and sampling was purposive rather than random. This research should be viewed as a ‘snapshot’ over a relatively small period of time rather than as the final and continuing result of the intervention.

The interviews were conducted by local authority staff. It is possible that this would influence the potential for interviewer bias, if (for example) participants decided that it was in their interests to emphasise their compliance and enthusiasm for RtS. Non-participation was low but interviewees were able to refuse for any reason they chose. We do not rule this bias out but we do highlight that many responses quoted in this article identified perceived problems with the intervention, and included some participants who described their refusal to participate in the intervention.

The involvement of independently funded academic researchers is intended to safeguard against the conflict of interest inherent in a local authority evaluating its intervention. However, whilst this form of ‘co-production of evidence’ between practitioners and academics is currently advocated amongst researchers, practitioners and grant holding bodies, it raises questions about the extent to which academic researchers involved can justifiably describe themselves as ‘independent’.

As many of the off-licences were small independent shops, the only member of staff available for interview was often serving customers at the same time the interview was being conducted, which meant that interviews

were necessarily kept short. As a result, price data was not collected for all shops. In addition, prices of super-strength alcohol pre-intervention relied on the recall and accurate reporting of the interview. We believe this pragmatic approach helped to keep response rates high but at the expense of a richer dataset. Interviews were conducted in English, which shop staff could speak but not always as a first language. In the absence of audio-recording, we are reliant on interviewers’ written fieldnotes. Participants were not contacted to verify these notes.

#### Policy implications

Although voluntary and community initiatives are often small scale and may have less impact than more comprehensive policy interventions, they are sometimes seen as useful for tackling specific local problems particularly in contexts where resources are limited [36]. Examples of such interventions include the Alcohol Linking Program [37], the Queensland Safety Action Project [38] and the Swedish Stockholm Prevents Alcohol and Drug Problems (STAD) initiative [39].

Reducing the Strength projects are a clear example of an innovative local solution to a national problem and over 80 local authorities have implemented RtS schemes in the absence of a national minimal unit price (MUP). Prior to the introduction of RtS, a litre of 7.5 % ABV white cider retailed for around £1.50 in Islington and Camden, which is 20p per unit of alcohol. In England the 40p MUP proposed by the Coalition government in 2012 would have delivered a minimum price of £3.00 per litre of 7.5 ABV% beer or cider [40, 41]. An alternative alcohol pricing policy came into force in May 2014 banning the sale of alcohol below the total cost of duty and VAT combined [42]. This effectively introduced a MUP that varies by drink as duty differs substantially between alcohol types. This established a minimum price for one litre of 7.5 % ABV white cider of 48p or 6.4p per unit of alcohol [40, 43], a price far below the current cost and even further below the proposed MUP from 2012. The policy did have some effect on the minimum price of a super-strength lager establishing a minimum price of £1.30 per can [40, 43], higher than the price in some Islington and Camden off-licences during the research (pre-legislation). Research modelling concluded that a 40p to 50p MUP would result in 40 to 50 times greater effect on consumption than the floor price approach [40].

From the local authority’s perspective, persuading retailers to voluntarily participate in RtS represents an extremely resource intensive way of achieving outcomes that could be potentially derived from a national MUP policy. RtS focuses on the complete removal of a narrow range of products, primarily super-strength beers and white ciders, whereas a MUP would allow consumers to

buy these products, but at a price linked to their alcoholic content, and hence likely level of harm, rather than their tax regime. In contrast, voluntary schemes such as RtS are inherently susceptible to the problem that retailers stand to potentially benefit by not complying if they attract customers away from compliant shops.

The perceived merits and limitations of voluntary alcohol interventions such as those involving alcohol retailers have been widely debated in the academic literature and policy circles [36]. The research literature on interventions to reduce population-level alcohol harms provides evidence that mandatory rather than voluntary approaches are more likely to be effective [44]. Moodie et al. concluded in 2013 that despite common reliance on industry self-regulation and public-private partnerships in policy, there is no evidence of their effectiveness [45]. Babor has argued that voluntary codes are subject to under-interpretation, under-enforcement and poor compliance [8]. A review of voluntary UK social responsibility measures found poor compliance and interventions that were judged to be not fit for purpose [46]. A study of Australia's voluntary labelling scheme found the labels were difficult to understand and did not have the desired health impact [47].

The alcohol industry has stated its interest in what is sometimes called responsible retailing. Heineken, for example delisted two high strength ciders, White Lightning and Strongbow Black, in 2008 citing recognition of the links between the product and social harms following a visit to an AddAction project [48]. The UK's Public Health Responsibility Deal, a public-private partnership where industry and government actors sign up to pledges aimed at improving public health [49], included a pledge to reduce the total alcohol in a single serving carbonated drink (e.g. a can of lager or cider) to less than the maximum recommended daily intake for an adults. The manufacturers of some super-strength drinks have signed up to this pledge [50]. In some cases, this has resulted in a reduction of can sizes to 450 ml, although the products have not been removed from sale. Changes under this Responsibility Deal were evaluated as being unlikely to contribute significantly to reductions in alcohol consumption [49].

Our findings suggest that there is some support amongst retailers for a more interventionist approach on alcohol sales, echoing evidence from a previously published cross-sectional survey of small retailers in Scotland, which found support for another regulatory intervention, MUP [51]. These findings provide a reminder that regulation need not necessarily take place against the perceived interests of the private sector (or parts of it, assuming the private sector is heterogeneous), and it is possible that some private sector stakeholders view regulation as a fairer and economically less risky option than voluntary

participation in schemes like RtS. Our findings also suggest that voluntary interventions can be perceived in different ways, with some shop keepers exercising their right not to participate in RtS, others apparently supporting the intervention, whilst others gave a more pragmatic view that participation could help them maintain good relationships with local authorities and so safeguard their business against unspecified future actions from the licensing authorities. Hence, we see that the conceptual boundaries between voluntary and mandatory action begins to look more fluid and subjective when viewed at close quarters in relation to this intervention. We speculate that within mandatory frameworks there may be points at which there is a choice, and we suggest that within voluntary frameworks the available choices may be weighted by understandings or perceptions of potential costs and benefits.

## Conclusions

The RtS interventions studied here have led to the majority of off-licences within the intervention areas removing super-strength from their shelves. Retailers remain convinced that customers often switch to non-participating shops to continue to buy these products. This illustrates the limitations of local, voluntary approaches to reducing alcohol availability as part of harm prevention strategies, even when the intervention is well delivered and achieves high rates of compliance. Even some of the retailers who refused to participate in RtS support compulsory measures which, they believe, would help them avoid negative financial impacts.

## Abbreviations

ABV, alcohol-by-volume; LSHTM, London School of Hygiene & Tropical Medicine; MUP, minimum unit price; RtS, Reducing the Strength; UK, United Kingdom.

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## Availability of data and materials

There is no additional data to be shared; participants' informed consent to participation in the study did not extend to the publishing of data.

## Authors' contributions

CS conceived and designed the study methods, managed the fieldwork, led on the analyses, and wrote the first draft of this manuscript. EM and ME contributed to the analyses and to the manuscript drafts. ED, EC and ER conducted fieldwork and contributed to the analyses. All authors have provided input into data interpretation, critically revised the manuscript and approved the final version.

### Competing interests

At the time of writing, CS was a Public Health Strategist and was involved in supporting the intervention evaluated in the article. ED, EC and ER worked in the Public Health Intelligence team and conducted fieldwork and analysis for the evaluation but were not involved in the design or implementation of the intervention.

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## Appendix D: Research paper 2: license agreement and supplementary material

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## **A complex systems perspective and alcohol research: a scoping review protocol**

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### **BACKGROUND**

Globally, alcohol and drug use are the seventh largest risk factor for disability and premature death (1). Alcohol consumption and the harms associated with it affect not just individual drinkers, but also their families, communities and the societies in which they live (2). Such harms include health harms, including chronic and communicable diseases, and broader harms including domestic abuse, crime and anti-social behaviour and the economic costs associated with the criminal justice system and losses in productivity (3, 4). In order to best design prevention efforts to reduce the individual and societal harms associated with alcohol, some researchers have argued for the need to apply a complex systems perspective to alcohol research (5, 6).

A complex system is “a set of things – people, cells, molecules or whatever – interconnected in such a way that they produce their own pattern of behaviour overtime” (7 p.2). It is characterised by non-linear relationships and feedback loops which may lead to unanticipated and unpredictable patterns of behaviour and impacts stemming from system change (8, 9). A complex system is dynamic and evolves overtime, displaying ‘emergent properties,’ or system attributes that cannot be reduced to its individual components (10). Applying a complex systems perspective, it is contended, may help researchers conceptualise and study public health problems, such as alcohol harms, in order to generate better evidence for decision making (9).

Researchers working in the field of substance misuse in general, and alcohol harm prevention specifically, have argued that research in this area has tended to be too focused on high-risk populations or risk factors that are easily modifiable at the individual level (5, 6, 11). Fewer efforts have focused on the broader environments, including the cultural, social, physical, regulatory and political systems in which alcohol is sold and consumed (12, 13). As a result, some researchers have contended that efforts to prevent alcohol-associated harms may fail (5), or even be misleading (11), because they do not account for the wide range of factors, and how they interact with each other across systems, that affect alcohol consumption and associated harms. These researchers have advocated the need to apply a complex systems perspective in order to explicitly consider the micro, meso and macro factors that interact with each other to generate patterns of alcohol consumption and associated harms (14).

While there has been an increased interest in applying a complex systems approach to the prevention of alcohol-related harms (15), to date no review has been undertaken to take stock of the literature base. We therefore aim to conduct a scoping review to identify and describe the characteristics of the literature that applies a complex systems perspective to public health research on the prevention of alcohol-associated harms.

### **METHODS**

A scoping review is useful in order to create a preliminary assessment of potential size and scope of available literature and to identify nature and extent of research evidence (16). This scoping review will follow the framework initially developed by Arksey and O'Malley (17) and subsequently revised and advanced by Levac and colleagues (18) and Daudt et al (19). The scoping review process will be completed in five stages: 1) identifying and refining the research questions and scope of the review; 2) identifying relevant studies through a range of search methods; 3) selecting studies that are relevant to the review's scope; 4) charting the data from the included studies; and 5) collating, summarising and reporting the results.

### **1) Review questions**

The review questions were developed in order to provide an overview of the current literature on the use of a complex systems lens within public health alcohol research. The questions that this scoping review will aim to answer are:

1. How has a complex systems perspective been applied to alcohol harm prevention research?
2. Which public health topics have had a complex systems perspective applied to them?
3. What populations and systems are represented within this literature base?
4. What systems methods are used in this body of literature?
5. Where are the gaps in complex systems alcohol research?

### **2) Searching**

The aim of the search is to identify studies that apply a complex systems perspective to alcohol prevention research. public health research. Therefore, a number of searching methods will be used, including searching electronic databases, handsearching and citation searching. As this is a scoping review, the search will be an iterative process and therefore it is assumed that the following list in neither exhaustive nor finalised.

The following electronic databases will be searched:

- MEDLINE
- EMBASE
- Web of Science
- Scopus

The reference list of all included studies will also be checked and studies known to the research team will be included. In addition, some small-scale handsearching will take place to identify papers not captured by the search strategy.

The following terms will initially be utilised in searching for studies to include in the review. As the review progresses, the search terms may be revised to ensure that the relevant studies are captured by the search strategy.

- Systems thinking (systems theory, systems thinking, systems science, systems lens, systems perspective, systems approach, system dynamics, systems modelling, complex system, complexity theory, complexity science, complex adaptive system, simulation model)
- Alcohol (alcohol, alcoholic beverage, alcohol consumption, alcohol adj3 drinking)

The search will run from January 2000 – current and be limited to the English language.

### **3) Study selection**

All studies that draw use a complex systems lens to address public health alcohol harm prevention efforts will be included in the scoping review. As such, all study designs will be eligible for inclusion. Public health relevance refers to students that develop alcohol consumption models or harm prevention models, as well as paper that develop or evaluate prevention efforts. Discussion papers

that advocate for the use of complex systems thinking in alcohol harm prevention will be included and data on their recommendations for evaluations will be extracted. Studies from any country are eligible for inclusion, although the search will be limited to English-language publications. Studies will be excluded if they pertain to the effects of alcohol on physiological systems, are about treatment or are conducted in animals. Conference papers and protocols will be excluded.

A random sample of 10% of abstracts will be double-screened initially (EM and MM) in order to ensure the inclusion criteria are being applied consistently. Any disagreements will be discussed by discussion and will include other members of the review team. Following the initial round of screening, adjustments may be made to the inclusion criteria and then the remaining abstracts will be screened by a single reviewer (EM).

#### *Quality assessment*

This is a scoping review and therefore no formal quality appraisal will be applied to the included studies (17-19).

#### **4) Charting the data**

Data will be extracted from each study on the following:

- Study characteristics (authors, year, setting)
- Aim
- Country
- System level
- Population
- Alcohol topic
- Intervention (if applicable)
- Systems approach taken
- Methods
- System map
- Types of findings
- Funding
- Declaration of competing interests
- Reviewer notes

The tools to chart the data will be developed by EM, reviewed by the review team, piloted on the first 5 studies and then revised. All included studies will have data extracted by EM; CR will independently screen 10% of all included papers. Any disagreements will be resolved through discussion with the review team.

#### **5) Collating, summarising and reporting the results**

The data will be analysed to produce a descriptive numerical summary of the characteristics of the included studies; these will be presented in a tabular and narrative form. A narrative analysis will also be undertaken, guided by research questions 2-4. This will be presented in a narrative form. The discussion will focus on the 5<sup>th</sup> research question in order to identify research gaps in the literature.

#### **DISSEMINATION**

The scoping review will be written as an academic article and submitted to a peer-reviewed journal. It will also form part of the background of EM's PhD thesis. The findings will also be disseminated through conference presentations and abstracts.

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## Supplementary material 2: search strategy

Search dates: January 2000 – September 2020

Limits: English language

### **EMBASE:**

#### 1) *Complex systems:*

system theory OR systems theory OR system thinking OR systems thinking OR system science OR systems science OR complex system\* OR system model?ing OR systems model?ing OR system dynamics OR systems dynamics OR system approach OR systems approach OR system lens OR systems lens OR system perspective OR systems perspective OR complexity OR complexity theory OR complexity science\* OR complex adaptive system\* OR simulation model\* OR network analysis OR network analyses OR agent-based model\* OR systems Theory/ OR systems Analysis/ OR nonlinear dynamics/

AND

#### 2) *Alcohol:*

alcohol OR drinking behavior OR drinking culture OR alcohol\* adj2 consumption OR alcohol\* adj2 drink\* OR alcohol\* adj2 beverage\* OR Alcohol consumption/ OR drinking behaviour/ OR alcoholic beverage/

### **Medline:**

#### 1) *Complex systems:*

system theory OR systems theory OR system thinking OR systems thinking OR system science OR systems science OR complex system\* OR system model?ing OR systems model?ing OR system dynamics OR systems dynamics OR system approach OR systems approach OR system lens OR systems lens OR system perspective OR systems perspective OR complexity OR complexity theory OR complexity science\* OR complex adaptive system\* OR simulation model\* OR network analysis OR network analyses OR agent-based model\* OR systems Theory/ OR systems Analysis/ OR nonlinear dynamics/

AND

#### 2) *Alcohol:*

alcohol OR drinking behavior OR drinking culture OR alcohol\* adj2 consumption OR alcohol\* adj2 drink\* OR alcohol\* adj2 beverage\* OR Alcohol consumption/ OR drinking behaviour/ OR alcoholic beverage/

### **Scopus:**

#### 1) *Complex systems:*

"system theory" OR "system thinking" OR "system science" OR "complex system" OR "system model\*" OR "system dynamics" OR "system approach" OR "system lens" OR "system perspective" OR complexity OR "complexity theory" OR "complexity science" OR "complex adaptive system" OR "simulation model\*" OR "network analysis" OR "agent-based model"

AND

#### 2) *Alcohol:*

alcohol OR "alcohol\* w/2 consumption" OR "alcohol\* w/2 drink\*" OR "alcohol\* w/2 beverage\*" OR "drinking behaviour" OR "drinking culture"

**Web of Science:**

Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI

1) *Complex systems:*

“System theory” OR “ System thinking” OR “System science” OR “Complex system\*” OR “System model\*” OR “System dynamics” OR “System approach” OR “System lens” OR “System perspective” OR Complexity OR “Complexity theory” OR “Complexity science\*” OR “Complex adaptive system\*” OR “Simulation model\*” OR “Network analysis” OR “Agent-based model”

AND

2) *Alcohol:*

alcohol OR alcoholic beverage\* OR alcohol\* drink\* OR alcohol\* consumption OR drinking behavior OR drinking culture

Supplementary material 3: PRISMA 2009 checklist

	#	Checklist item	Reported on page #
<b>TITLE</b>			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Title page
<b>ABSTRACT</b>			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
<b>INTRODUCTION</b>			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
<b>METHODS</b>			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	Supplementary material
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Supplementary material
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	5
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	5

Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	N/A
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	N/A
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., $I^2$ ) for each meta-analysis.	5

## Appendix E: Research paper 3: supplementary material

### Supplementary material 1: PRISMA 2009 Checklist

	#	Checklist item	Reported on page #
<b>TITLE</b>			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Title
<b>ABSTRACT</b>			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	Abstract
<b>INTRODUCTION</b>			
Rationale	3	Describe the rationale for the review in the context of what is already known.	Background
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	Background; final para.
<b>METHODS</b>			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	<a href="http://sphr.lshrm.ac.uk/files/2020/03/Complex-systems-perspective-in-PH-research_Protocol.pdf">http://sphr.lshrm.ac.uk/files/2020/03/Complex-systems-perspective-in-PH-research_Protocol.pdf</a>
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	Methods; para. 2&3
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	Methods; para. 1
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	S1
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	Methods; para. 2&3
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	Methods; para. 4

Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Methods; para. 4&5, Table 1
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	Methods; para. 6&7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	n/a
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., $I^2$ ) for each meta-analysis.	Methods; para. 6&7

## Supplementary material 2: S1 Text, example search strategy

Online search strategy for MEDLINE:

### 1) Complex systems:

"system\* theory" OR "system\* thinking" OR "system\* science" OR "complex system\*" OR "system\* model?ing" OR "systems\* dynamics" OR "system\* approach" OR "system\* lens" OR "system\* perspective" OR complexity OR "complexity theory" OR "complexity science\*" OR "complex adaptive system\*" OR systems Theory/ OR systems Analysis/ OR nonlinear dynamics/

### 2) Evaluation:

Evaluat\* OR "policy evaluat\*" OR "prog\* evaluat\*" OR "formative evaluat\*" OR "process evaluat\*" OR "outcome evaluat\*" OR context evaluat\* OR evaluation studies as topic/ OR programme evaluation/

### 3) Health

"public health" OR "health promotion" OR "health inequality\*" OR "health inequalities\*" OR "health inequity" OR "health inequalities" OR "health behavior" OR "well-being" OR wellbeing OR nutrition OR obesity OR "fast food\*" OR sugar OR salt OR tobacco OR smoking OR cigarette\* OR alcohol OR "illegal drug\*" OR "illicit drug\*" OR "recreational drug\*" OR "social determinant\*" OR crime OR "community safety" OR transport\* OR planning ADJ3 town OR planning ADJ3 city OR planning ADJ3 neighborhood OR planning ADJ3 urban OR renewal ADJ3 city OR renewal ADJ3 neighborhood OR renewal ADJ3 urban OR redevelopment ADJ3 town OR redevelopment ADJ3 city OR redevelopment ADJ3 neighborhood OR redevelopment ADJ3 urban OR regeneration ADJ3 city OR regeneration ADJ3 neighborhood OR regeneration ADJ3 urban OR revitali#ation ADJ3 city OR revitali#ation ADJ3 neighborhood OR revitali#ation ADJ3 urban OR "urban health" OR housing ADJ3 improvement\* OR home\* ADJ3 improvement\* OR rehousing OR "home\* refurbishment" OR "housing modification\*" OR "home modification\*" OR "healthy home\*" OR "healthy housing" OR "affordable housing" OR "affordable home\*" OR "housing intervention\*" OR education OR "whole school" OR school ADJ3 environment OR greenspace OR housing/ OR public housing/ OR crime/ OR city planning/ OR urban renewal/ OR education/ OR schools/ OR urban health/ OR fast foods/ OR tobacco/ OR smoking/ OR electronic cigarettes/ OR substance-related disorders/ OR street drugs/ OR alcohol drinking/ OR alcoholism/ OR "social determinants of health"/ OR public health/ OR health promotion/ OR health status disparities/ OR health behavior/ OR obesity/ OR smoking cessation/

Date range: 2014 – current (September 2019)

Limit: English language

## Supplementary material 3: S2 Text, case studies

### Case study 1: Rothwell et al 2010 [41]

**Aim:** To assess the implementation of the Welsh Network of Healthy School Schemes (WNHSS) at national, local, and school levels, using a systems approach drawing on the Ottawa Charter.

**Intervention:** The WNHSS is a health promotion intervention targeting pupils in Welsh primary and secondary schools. The Welsh Assembly Government gives funding to Health and Education partnerships in all Welsh local authorities, who in turn have Healthy School Coordinators (HSCs) who create and maintain local schemes. An Assembly Government official coordinates the scheme at a national level and has responsibility for the overall strategy, local accreditation, and training HSCs. Individual schools have in-school coordinators who work with the HSCs to carry out the activities considered a priority to the school and to progress through the different phases of the intervention.

**Design and methods:** The process evaluation adopted a cross-sectional case study design to assess the implementation of the program in its first six years. Data were collected at different levels within the system; a documentary review was conducted at the national level and semi-structured interviews were used to collect data at the local and school levels. A documentary review was conducted that included documents detailing national decisions on policy and funding for the program, consultation and policy documents, and Education Authority and Local Health Board policies. Evaluators also observed two national meetings for HSCs and interviewed the national coordinator of the WHNSS. To generate data at the local and school level, semi-structured interviews were conducted with HSCs from each of the local schemes and some participants provided evaluators with local or school-level documentation. Finally, three regional workshops were held wherein evaluators presented initial findings to participants from local education and health departments.

**Systems approach:** The evaluation adopted a “systems approach” and conceptualized the school-based network as a “complex adaptive system”. The evaluation team drew on a socio-ecological model to represent the system as comprised of three different *levels*: national, local, and school. The systems approach was evident in the evaluation design, sampling strategy, and analysis of findings. Specifically, the evaluation was designed to capture implementation processes at each of the three *levels* by collecting data from system *elements* at each level. Implicit in this framing was a *boundary* decision that bounded the system of inquiry to elements and behaviors within each of these three *levels*. The analysis focused on how the *relationships between elements* at the same level, and *interactions between elements at different system levels*, affected program implementation over time and between different sites. In doing so, the evaluators represented a range of different *perspectives*, although they describe in their limitations section that not all system element *perspectives* were represented; notably, no in-school coordinators were interviewed. Despite conceptualising the program and its context as a “complex adaptive system,” the evaluators only implicitly drew on one facet of complexity – *dynamism*. Implicit in the analysis was a *dynamic* nature of the intervention and the system, particularly as schools moved through different phases in the intervention. However, as the evaluators acknowledge, the evaluation was cross-sectional and therefore fairly static in nature, capturing a specific time point rather than collecting data at multiple points.

## Case study 2: Durie and Wyatt 2013 [42]

**Aim:** To evaluate a learning program designed to create transformational community change, with a focus on the program's implementation, the impact on the participants, and emergent community outcomes.

**Intervention:** Connecting Communities (C2) is asset-based community development approach that was developed by the Health Complexity Group. The aim of C2 was to create the context for service providers to consult with their communities and ensure that service provision adequately responded to community needs. The intervention involved 3 phases of inter-related components, which included case studies, workshops on practical skills and complexity theory, site visits, resident and service provider talks, and research workshops.

**Design and methods:** The evaluation adopted a case study design that used several qualitative and participatory research methods. Semi-structured interviews were conducted with a range of actors in the system, including course designers, deliverers and participants. In addition, non-participant observation was conducted during course delivery, listening events, and community partnership meetings. Finally, participants were given opportunity to input into findings by clarifying and adding to summarized findings. The different methods were chosen to examine the dynamics of the system overtime as they changed and evolved in response to the intervention, as well as to focus on the relations between those living and working in the community.

**Complexity science:** The evaluators used complexity science as an underpinning theoretical framework for the intervention and evaluation, which extended from the evaluation design to data collection and interpretation. The local area was conceptualized as a "complex adaptive system" that has an open *boundary* so that the *boundary* between the community and the wider environment is considered fluid. The researchers focused their evaluation questions and analytical focus on the "*relations between the agents [elements] in the system and their interactions and relationships with the system.*" The evaluators designed the case study to collect data from a range of different participants in order to represent different *perspectives* in the system, operating within and across different system *levels*. The account of the program describes the *system trajectory* in which the evaluators depict how the *relationships and interactions* between system elements gave rise to *emergent outcomes*, including those that were *unexpected or unanticipated*, within the case study community. The evaluators trace *non-linear relationships* whereby actions and behaviors of system *elements feedback* and shape the intervention, its components, and the system itself. The analysis focuses on describing and analysing these examples of *adaptation* and *co-evolution*, with an emphasis on how the system's *history, initial conditions* and *local rules* influence its *trajectory*. The analysis itself has a *dynamic* component, where the evaluators explore change in the community over time (a time period of two years).

## Appendix F: Research paper 4: topic guides and observation templates

### Interview topic guide: service providers (community safety and police)

#### 1. Introduction:

- Study introduction, confidentiality, audio recording
- Any questions?

#### 2 Can you tell me a bit about [*organisation/team*]? How do you operate?

*Probe around:* interaction with other parts of the organisation; interaction with other services; intelligence generation

#### 3. As an [*position*], what does your role entail?

*Probe around:* typical shift; generating taskings; usual activities

#### 4. Can you tell me a bit more about the people you tend to work with or encounter on patrols?

*Probe around:* drinkers in particular – drinking habits, purchasing habits, location of drinking, behaviours associated with drinking; co-occurrence of drinking and other behaviours

#### 5. From your perspective, what are the major alcohol-related challenges in [*LA*]?

*Probe around:* specific population groups; different types of venues; specific venues; specific areas of LA; specific drinks

- How do you think [*LA*] compares to other areas?

#### 5. Can you tell me about the Late Night Levy?

- How did the levy come about in [*LA*]?
  - *Probe around:* supporters/opponents, who drove the implementation, etc.
- What is the aim of the levy?
  - *Probe around:* targeting of intervention (drinkers, retailers)

#### 6. How has the levy changed the services you provide?

*Probe around:* working with other services, deployment of resources; focus of shifts/taskings

#### 7. Thinking about the people you encounter and the venues you engage with, do you think the initiative has had any impacts on them?

*For drinkers, probe around:* consumption and behaviour (intoxication to ASB/crime)

*For retailers:* opening hours, engagement with police/council/community safety; management practices

#### 8. Have you seen any other impacts of the initiative, either health or non-health related?

*Probe around:* why these have occurred

#### 10. Over the past few years, have you been aware of, or involved in, any other new alcohol initiatives or services?

*Probe around:* interaction with the levy, impacts on retailers and drinkers

#### 11. Wrap up and end

## Interview topic guide: drinkers

### 1. To start off, can you tell me a bit about yourself?

*Probe around:* age, work, resident/visitor

### 2. What do you like about going out/drinking in [LA]?

*Probe around:* usual places they go and why; what they drink; who they are usually with; drinking at home vs. out

### 3. Have you noticed any changes in [LA] and the places to go out here?

*Probe around:* types of places, types of people drinking in them, reasons for changes

- **Are there any changes you want to see here to make [LA] a better place to go out?**

### 4. Have changed where you like to go out or where you buy drinks over the past few years?

*Probe around:* changes to drinking patterns – locations, amount, types of drink, time they drink, etc.

### 5. Do you think there are any problems with alcohol in [LA]?

*Probe around:* specific types of people, parts of the LA, specific venues, etc.

- **Have you ever been moved on whilst drinking on the streets or come into contact with police? Ever been ejected from a premise?**

### 6. [LA] has a Late Night Levy in place – have you heard about it?

- If yes, **what do you think the levy is trying to do?**
  - *Probe around:* aims, reason to bring it in, if they have seen any changes
- If not, explain levy: **what do you think about an initiative like that?**
  - *Probe around:* community safety/police presence, venue opening times, types of venues in area, prices, what changes in might bring in, etc

### 7. Have you noticed any changes in LA's night time environment?

*Probe around:* times places are open; drink offers, how venues are managed – e.g. door staff, tolerance for rowdiness/fighting/etc, police on street, community safety on street, etc

### 8. Wrap-up and end

## Observation template: patrols

**Fieldworker:**

**Patrol Officers:**

**Date:**

**Patrol time and length:**

**Pre-patrol briefing (if applicable):**

- Specific aims of the patrol
- Areas to be patrolled
- Specific venues/locations to visit
- Previous incidents requiring follow-up action

**How the patrol operates:**

- Area of patrol
- Means of patrol (on foot, in car, etc.)
- How officers determine how to focus their attention (walk around and spot incidents, respond to calls, etc.)

**Incidents encountered: for each incident with drinking involved (or suspected):**

- Location of incident
- Name of premise (if applicable)
- Individual or group encountered
- Characteristics of the individual/group (age, gender, dress, etc.)
- Behaviour of individual/group (drunk and disorderly, aggressive, subdued, unconscious, etc.)
- How patrol officers interact with individual/group encountered:
- Individual/group reaction to intervention
- Outcome of intervention
- Other services involved (police, ambulance premise staff, etc.)
- Patrol officers' interpretation of incident

**Non-drinking incidents encountered:**

- Types of incidents
- Types of individuals/groups involved

**Patrol staff:**

- Characteristics (age, gender, physical characteristics)
- Length of time working on this patrol
- Types of individuals/groups that attract their attention
- Types of individuals/groups that do not attract their attention
- Impressions of problem drinking (types of people, areas of LA, types of premises, specific venues, specific drinks) and evolution over time
- Perceptions of LNL (aim, achieving aim? how? changes in how the service has been delivered? Relationships with other services; public, venues)
- Knowledge and impressions of other alcohol interventions: Cumulative Impact Policies, Reducing the Strength – others; interaction with the levy

**Researcher reflexivity**

## Observation template: venues

**Fieldworker:**

**Date:**

**Time of day:**

**Place name:**

**In CIZ?**

### Licensing history

#### External observations:

- Local area characteristics
- External appearance
- Door staff
- Opening hours
- Main purpose (e.g. vertical drinking establishment, food led, etc)
- Target market

#### Internal observations:

- Products are sold
- Alcohol promotions/prices
- Seating arrangements (table/bar/mixed service)
- General vibe
- Level of cleanliness
- Staff
- Any indication of engagement with Best Practice Schemes? (PubWatch, Best Bar None, etc).  
CCTV?

#### Customers:

- Number
- Age
- Gender
- Dress
- Alone/groups
- Observed behaviours (working/drinking/rowdy/etc.)
- Purchasing behaviour (buying rounds, purchasing individual drinks, etc)
- Staff and consumer interaction

### Researcher reflexivity