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**Using theories of practice to develop event-level alcohol epidemiology and policy analysis:
Studying context, consumption and harm**

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The candidate (AS) confirms that the work submitted is their own, except where work that has formed part of jointly authored publications has been included. The contribution of the candidate and the other authors to this work has been explicitly indicated below. The candidate confirms that appropriate credit has been given within the thesis where reference has been made to the work of others.

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Research achievements 2017-2021

Peer-reviewed publications

Stevely AK, Holmes J, Meier PS. Combinations of Drinking Occasion Characteristics Associated with Units of Alcohol Consumed among British Adults: An Event-Level Decision Tree Modeling Study. *Alcoholism: Clinical and Experimental Research.* 2021;45(3):630-7.

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Holmes J, Beard E, Brown J, Brennan A, Meier PS, Michie S, **Stevely AK**, Webster L, Buykx P. Effects on alcohol consumption of announcing and implementing revised UK low-risk drinking guidelines: findings from an interrupted time series analysis. *J Epidemiol Community Health.* 2020;https://doi.org/10.1136/jech-2020-213820.

Stevely AK, Holmes J, McNamara S, Meier PS. Drinking contexts and their association with acute alcohol-related harm: A systematic review of event-level studies on adults' drinking occasions. *Drug and Alcohol Review.* 2020;https://doi.org/10.1111/dar.13042.

Stevely AK, Holmes J, Meier PS. Contextual characteristics of adults' drinking occasions and their association with levels of alcohol consumption and acute alcohol-related harm: A mapping review. *Addiction.* 2019;115(2):218-29.

Holmes J, Beard E, Brennan A, Brown J, Gillespie D, Meier PS, Michie S, **Stevely AK**, Webster L, Buykx P. Effects on alcohol consumption of announcing revised UK low-risk drinking guidelines: findings from a monthly cross-sectional survey. In: Public Health Science: A National Conference Dedicated to New Research in UK Public Health. The Lancet. 2019;294(S54):10.1016/S0140-6736(19)32851-X

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Stevely AK, Buykx P, Brown J, Beard E, Michie S, Meier PS, Holmes J. Exposure to revised drinking guidelines and 'COM-B' determinants of behaviour change: descriptive analysis of a monthly cross-sectional survey in England. *BMC Public Health.* 2018;18(1):251.

Conference presentations

3 June 2020: Presented my epidemiological study at the School of Health and Related Research Postgraduate Research Conference

29 November 2019: Attended and presented a poster on an evaluation of announcing revised UK low-risk drinking guidelines at Public Health Science in London

7 November – 8 November 2019: Attended and presented both my policy analysis and an evaluation of announcing revised UK low-risk drinking guidelines at the Society for the Study of Addiction Annual Conference in Newcastle

23 October – 25 October 2019: Attended and presented my systematic review at Lisbon Addictions in Lisbon

3 June – 7 June 2019: Attended and presented my systematic review at the 45th Annual Meeting of the Kettil Bruun Society in Utrecht

24 May 2018: Presented my mapping review at the School of Health and Related Research Postgraduate Research Conference

28 May – 1 June 2018: Attended and presented my mapping review at the 44th Annual Meeting of the Kettil Bruun Society in Chiang Mai

Blog posts

Stevely AK. Are there associations between drinking contexts and harms that are not explained by the level of alcohol consumption? Institute of Alcohol Studies. 2020. Available at: bit.ly/iasbp147

Stevely AK. What do we know about the relationships between drinking contexts, the amount we drink, and the harms we suffer? Alcohol Policy UK. 2019. Available at: https://www.alcoholpolicy.net/2019/11/what-do-we-know-so-far-about-the-relationships-between-drinking-contexts-the-amount-we-drink-and-the.html

Stevely AK. New lower risk drinking guidelines – did they effect 'COM-B' determinants of behaviour change? Institute of Alcohol Studies. 2018. Available at: http://www.ias.org.uk/Blog/New-lower-risk-drinking-guidelines-did-they-effect-COM-B-determinants-of-behaviour-change.aspx

Qualifications and awards

11 June 2018: Achieved a 1st class grade in 'Advanced Quantitative Methods for Social Research'

26 March 2019: Won a poster prize at the NIHR SPHR Annual Scientific Meeting

3 July – 5 July 2019: Nominated for and attended Tenth NIHR Infrastructure Doctoral Research Training Camp on Attracting Further Research Funding

Acronyms

ABV: Alcohol by volume

ARMA: Autoregressive moving average

AUD: Alcohol use disorder

MEDLINE: Medical Literature Analysis and Retrieval System Online

PsycINFO: Psychological Information Database

SSCI: Social Science Citation Index

UK: United Kingdom

US/ USA: United States of America

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1 Summary

Background

Alcohol epidemiology and policy analysis typically treat drinking as a single behaviour, rather than considering the many different ways that people drink. This thesis applies a novel quantitative occasion- and practice-based approach to studying the varied relationships between contexts of drinking occasions (such as timing or drink type), consumption and alcohol-related harm.

Methods

Firstly, a mapping review explores the dominant methodological approaches of, and research gaps in, the existing event-level literature on drinking contexts and alcohol consumption/acute harm. Then, a systematic review synthesises the findings of studies linking contexts directly to acute harms. The third study identifies combinations of contexts that are associated with heavy consumption in adults' drinking occasions using decision-tree modelling. The fourth study uses time series methods to test hypothesised effects of the UK Licensing Act 2003 on the contextual characteristics of drinking occasions.

Results

There is a large and heterogeneous literature on drinking contexts, but this is largely conducted in the United States with young adult participants, which limits generalisability of the findings. Furthermore, few papers consider a broad set of contexts.

Drinking contexts are directly linked to acute harms, particularly drinking at the weekend, in licensed premises, and alongside illicit drug use. Contexts are also strong predictors of consumption - both individually and in combination - particularly long occasions, drinking spirits as doubles and drinking wine.

The Licensing Act 2003 had only small effects on the timing of drinking occasions, which may explain the surprising lack of substantial impacts on alcohol harms in previous evaluations.

Conclusions and recommendations

This thesis has used a practice-based approach to identify risky drinking contexts that are strongly associated with alcohol consumption for future research and prevention efforts. It has also highlighted the importance of considering combinations of contexts, and direct effects on acute harms.

2   Introduction

Alcohol is associated with a wide range of harms across health, social and economic domains (1), and is estimated to be the seventh-leading risk factor across the world for disability-adjusted life years and mortality (2). In the UK, the cost of alcohol-related harm has been estimated at £47 billion in 2016 (2.5% of the gross domestic product) (1). Whilst cost estimates vary markedly depending on the calculation method used, alcohol is undoubtedly a significant public health issue and area of policy interest for all levels of government in the UK and internationally (3–5).

Public health actors often want to deliver interventions that reduce alcohol-related harm, either directly or by reducing alcohol consumption. However, identifying effective interventions is insufficient. Researchers want to know how, why and for what types of problem or individuals interventions work (6–8). Epidemiological research often cannot answer these questions, partly because alcohol use is implicitly treated in most studies as a single behaviour by using measures that consider only the amount of alcohol consumed (7,9). This traditional approach is based in the assumption that the amount of alcohol consumed is the primary cause of alcohol-related harm, and has limited capacity to explain why interventions have varied effects and may reduce some alcohol-related harms but not others (7,10–12).

Alcohol use occurs within multiple distinct activities, which have connections to different types of alcohol-related harm. These different types of drinking activities may be amenable to different intervention approaches. For example, drinking occasions in licensed premises (such as pubs or nightclubs) are associated with increased violence and drink driving compared to drinking at home (13,14). Interventions that target activities in licensed premises will therefore be more effective in reducing violence and drink driving. To give a further example, introducing a minimum unit price is likely to be more effective at reducing consumption in activities involving cheaper alcohol, such as pre-drinking. Overall, researchers can gain a more nuanced understanding of drinking behaviour and the effects of interventions by studying the different activities that involve alcohol consumption (7).

Approaches which conceptualise alcohol use as a single activity are partially the result of individualistic theories of behaviour such as rational choice theory (10,15). These theories posit that individuals make decisions in a predictable and autonomous way based on their 'values, goals, subjective norms, perceived utilities and benefits, capabilities, motivations and intentions' (7). Research based on individualistic models of behaviour typically focuses on explaining total levels of alcohol consumption based on these cognitive factors and does not consider alcohol consumption as a feature of multiple distinct activities. This approach therefore is therefore well suited to developing our understanding of agentic health behaviour

but has limited capacity to address alcohol consumption as part of distinct and routinized drinking activities.

Furthermore, theoretical perspectives that focus on individual decision making can lead to political narratives that blame individuals for their poor health, attributing it to their health behaviour choices (7,16). Some of these theories also imply that human decision making is a purely rational process and neglect the wider context of drinking behaviour (7,10). However, there is a body of evidence that individuals do not make purely rational choices – instead, alcohol consumption is part of a set of habitual activities and is inter-related with a range of contextual factors (10,17).

2.1 Drinking culture

One approach that considers alcohol consumption as part of multiple drinking activities is to focus on wider drinking culture. Drinking culture is a complex concept which was examined by Savic *et al.* in a recent critical review, resulting in a working definition encompassing drinking norms and modes of social control (including formal and informal sanctions, such as fines, or expressed approval/ disapproval) which 'influence when, where, why and how people drink, how much they drink, their expectations about the effects of different amounts of alcohol, and the behaviours they engage in before, during and after drinking' (18).

The existing literature in this area focuses on characterising national drinking cultures and often involves emphasis on one or more key aspects of drinking in a given country. This dimensional approach is used to categorise countries into typologies based on factors such as: the regularity of drinking, extent of drunkenness, expectations about drunken behaviour, the cultural position of drinking, social control of drinking, and the nature of alcohol-related problems (19). For example, Sulkunen published a typology which focused on beverage types – discussing wine cultures, beer cultures and spirits cultures (20). A further example is the classic distinction between 'wet' and 'dry' drinking cultures (18). This classification of drinking culture is based on consideration of alcohol consumption, alcohol-related harm and the control systems in place to restrict drinking. 'Wet' cultures (such as the Mediterranean wine cultures) are characterised by frequent consumption, high levels of chronic disease and mortality attributable to alcohol, low drunkenness and permissive control structures. 'Dry' cultures (such as in the Nordic countries) are characterised by less frequent but heavy consumption, high rates of drunkenness, social disruption and violence and restrictive control structures (21).

There are three key limitations of using this approach to study alcohol consumption as part of multiple diverse activities. Firstly, dimensional typologies are not well suited to understanding differences in drinking behaviour within countries as they tend to focus on 'average' drinking. This also biases them

towards the behaviour of heavier drinking population subgroups such as men (18,22,23). Typological approaches therefore struggle to account for heterogeneity within countries such as variation between population subgroups (e.g. migrant communities or young women) (18,22). Secondly, it is difficult to explain changes in drinking activities over time within countries using dimensional typologies as these are typically gradual and multi-dimensional (21,22). Finally, since studies using this approach typically contrast multiple countries in order to highlight salient features of national drinking culture, they risk overstating the differences between countries (22).

There are a range of other approaches to studying drinking culture which address some limitations of the dominant typological approach by considering subcultures within countries. Qualitative anthropological studies have provided many rich and informative accounts of the cultural position of alcohol consumption (24,25). For example, some studies focus on stories of transgression, told after drinking (26). From this perspective, drinking and drunken behaviour is partially driven by the desire to build a portfolio of drinking stories. The carnivalesque is another theoretical focus involving the deliberate transgression of social norms (27,28). The transgressive behaviours of the carnival (e.g. the use of vulgar language and sexual behaviour in a public space) can be considered contextually permissible as they occur during licensed 'time out' from typical restrictions (12,27).

Theories of practice are a promising approach that have also been applied in qualitative drinking culture research (7,9,10,22). This theoretical perspective focuses on drinking practices, which are routinized activities that consist of a wide range of factors brought together in a particular activity. For example, pub drinking can incorporate tables and chairs, glasses, beer, friendship, relaxing after work, and buying rounds or joining a toast (9,29). Qualitative work in this area has particularly provided insights into the meanings of drinking practices such as enjoyment, relaxation and demarcation of time away from domestic tasks or childcare (30–35). This work has also considered opportunities for public health interventions. For example, Supski *et al.* discuss the drinking practices of university students and highlight the importance of orientation week recruiting new students into university drinking practices (30). They suggest that universities could target orientation week to disrupt this process and prevent the reproduction of heavy drinking practices.

However, qualitative approaches are not able to fully capture the range of drinking behaviour, the prevalence of different drinking activities, and how these are distributed socially or geographically. Whereas dimensional typological approaches make generalisations regarding national drinking cultures, qualitative anthropological approaches focus closely on particular aspects of drinking behaviour. Although this research can account for variation in drinking behaviour within countries, many studies are focused only on binge drinking and drinking in the night time economy. There have been fewer attempts to theorise other, more mundane, drinking practices. One such attempt is the literature on geographies of

alcohol consumption, which considers how place and drinking behaviours shape each other, particularly work by Valentine and Jayne (36–40).

It has been argued that theories of practice have much to offer drinking culture research, and there is increasing interest in applying them in quantitative research (7,9,10,22). For instance, they represent a radical shift away from individualistic perspectives, highlighting the habitual nature of behaviour and changing the unit of interest from the individual (the actor) to how the 'practice' is performed (the action) (7,10,15,41). A practice theoretical approach can consider both national and sub-national level drinking culture, taking a granular approach by conceptualizing culture as consisting of many inter-related practices (7,10,22). Practice theories are therefore a promising perspective from which to study drinking culture.

A brief note on language

Throughout this thesis, I refer to 'context' as well as 'culture', and these are linked but distinct concepts. Drinking context is a subset of the building blocks of drinking culture. For example, drinking context does not include government policy regarding alcohol or activities related to drinking such as buying alcohol in a supermarket to drink later. In this work, context is broadly defined and includes the material, social, or situational characteristics of drinking occasions other than alcohol consumption (42,43). Contexts of interest range from the time of day or reason for drinking to the music playing in the venue.

2.2   Thesis overview

This thesis uses a practice-based approach to understand the relationships between different forms of drinking behaviour, levels of alcohol consumption, alcohol-related harm and public health interventions. This section will outline the structure of the thesis.

Firstly chapter three discusses the theoretical context of this work, introducing theories of practice in more detail. Chapter four builds on this by describing the conceptual approach of the research presented in later chapters. Subsequent chapters describe four studies: a mapping review, a systematic review, an epidemiological study and a policy evaluation. These studies are presented in paper format as standalone works.

Chapter five presents the mapping review, which aimed to map the breadth of the existing event-level literature on drinking context, consumption and alcohol-related harm in terms of the areas covered and methods used. This work enabled the development of a broad understanding of how the contexts of drinking, which are the closest analogue to elements of practices in the existing quantitative literature, have been studied in isolation and combination to date. The existing literature on drinking occasions considers a wide range of characteristics, from aspects of the physical surroundings such as the volume of music in a

venue to the social surroundings such as the drinking or safety intentions of the friends involved in the drinking occasion (44,45). This literature also comes from a range of research traditions - including ecological or epidemiological approaches, experimental psychology, socio-cultural or sociological research, and anthropology – and papers are found in a wide range of disciplinary journals (43,46). A key feature of this literature is topical and methodological heterogeneity. Given this, conducting a mapping review was a useful approach.

Chapters six and seven follow on from the mapping review, starting with a detailed systematic review of a subsection of the literature - papers that studied the relationship between drinking occasion contexts and acute alcohol-related harm. Chapter seven is an epidemiological study, which used decision tree modelling to identify combinations of drinking contexts associated with light and heavy alcohol consumption.

Chapter eight aimed to explore the value of practice-based approaches in evaluating public health policy. The work within this chapter analysed the effect of the Licensing Act 2003 on drinking occasions in England and Wales using time series analysis and adds to the literature on the effect of extending alcohol-trading hours. Chapter nine completes the thesis by discussing the overall findings and highlighting recommendations for prevention policy and future research.

3　Theories of practice

The roots of theories of practice are in the social theory of Bourdieu, Giddens, Foucault, Heidegger and Marx (10,47–50). These theorists have diverse perspectives, which have been further developed by modern practice theorists such as Reckwitz, Schatzki, Latour and Shove (9,49,51,52). Reckwitz provides the following widely cited definition of practices:

"*A 'practice' is a routinised type of behaviour which consists of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know‑how, states of emotion and motivational knowledge.*" (49)

There is increasing interest in applying theories of practice to various areas of public health research, from studies of smoking and vaping to cooking and drinking culture (7,9,10,22,53–58). This current interest in theories of practice may be a rejection of both individualistic economic theory (which portrays human beings as rational decision makers) and the 'cultural turn' in social science (which emphasises deliberate identity construction rather than habitual or routine behaviour) (15). Authors applying theories of practice in these different areas of public health research have emphasised their value for developing insights into the nuances of 'everyday' behaviour and lived experiences (53–55).

This chapter discusses key features of theories of practice, paying particular attention to recent work by Shove *et al.* which focused on understanding changes in everyday life (9). Shove *et al.* make useful theoretical developments as they focus on changing practice through intervention. In this chapter, I start by explaining the 'flat ontology' adopted by theories of practice, which distinguishes them from both individualistic approaches such as rational choice theory and macro-level approaches such as typological studies of drinking culture (10,15,18). Then, I outline the elements of practice theorised by Shove *et al.* and their importance for understanding the spread of practices to new people and places. Finally, I discuss the place of time and space in practice theory. In order to conceptualise practices, it is important to consider their distribution across these dimensions. Chapter four builds on this background and discusses the application of theories of practice in my thesis.

3.1　Theories of practice adopt a 'flat ontology'

A key feature of theories of practice is the removal of the distinction between micro- and macro-phenomena (10,51,59). In public health research, there are strong traditions of both micro-psychological research - which emphasises the cognitive processes involved in health behaviours such as different motivations for drinking alcohol (43) - and macro-sociological research, where ill health is understood as a

result of structural and environmental factors. Practice theorists argue that both the individualistic focus on decision making and the structural position have limited scope to explain the complexity of society (7,9,10,15,60).

In order to understand the relationship between small elements of daily life (such as having a beer with a friend) and large phenomena (such as drinking culture), practice theories adopt a 'flat ontology' rather than making distinctions between micro and macro phenomena (51,60). This means that the fabric of the entire social world consists of the same components – practices. In order to understand a large phenomenon, a practice theorist would consider the practices which together make up the phenomenon (51,60). For example, Shove *et al.* discuss how the macro-level structure of capitalism consists of many practices, including standing in a queue, interviewing new workers, and designing advertisements, each of which is a recognised activity with social rules (e.g. you start at the back of the queue) (9).

3.2   Elements of practice

According to Shove *et al.*, practices consist of three types of elements: *materials*, such as glasses and alcohol; *meanings*, such as 'time out' from usual social restrictions on behaviour; and *competencies*, such as if someone is able to moderate their intoxication level (9). Practitioners combine these in performances, which are separate instances of carrying out the practice and vary slightly from each other. Through each 'practice-as-performance', the 'practice-as-entity' emerges and is then sustained as a culturally recognisable type of behaviour (e.g. the 'big night out'). For example, a 'family meal out' brings together materials (a restaurant, wine glasses), meanings (celebration, relaxation), and competencies (ordering from the menu). This classification system can be used to think about which elements of drinking practices have or should be studied from a public health perspective.

An interesting feature of this version of practice theory is that objects (materials) are an element of practice alongside meanings and competencies. This distinctive perspective builds on Schatzki's position that materials are 'arrangements' which practices are linked to through performance (9). The enmeshing of material elements into a theory of practice allows Shove *et al.* to rise to the challenge of moving beyond the 'social' and considering the material world (61). By placing a wide range of materials - such as buildings and pens - within practice, this formulation of practice theory can consider the dynamic interactions of material elements with practice. Physical elements are both the result of past practice and enmeshed in current practice (9). Incorporating material arrangements into practices is particularly helpful for studying drinking culture as we know that there are strong cultural associations with drinking venues, drink types, glassware and other objects. For example, drinking a glass of wine in a restaurant is a different type of

activity to drinking alcopops at a party with limited seating or beer in a traditional pub while watching football on a television.

In order to understand processes of cultural change within a society and their implications for public health, theories of practice must account for the spread of health-related practices to new places and people. In the version of practice theory outlined by Shove *et al.*, practices themselves cannot spread since they only exist in the instance of performance (9). For example, when a group of students pre-drink in their university accommodation they are preforming a practice, but in that moment the practice is not spreading elsewhere. For Shove *et al.,* elements of practice are key to understanding how practices relate to each other and travel between people (who Shove et al. refer to as 'carriers'). Each type of element is to some degree altered or 'codified' while travelling and requires decoding in its new local context. Material elements are packed and unpacked physically while meanings and competencies are abstracted and stored to be 'decoded' by another carrier. For example, competencies involved in cooking can be stored in a recipe book, but this information must be 'decoded' by a carrier to be reincorporated into a new cooking practice (9,62).

Elements of practice can travel by several mechanisms, such as moving between practices as the carrier of one practice incorporates the associated element into another. For example, the competency of throwing darts started in pub and community settings as part of a recreational practice and then became incorporated into the more professional practice of darts competitions. Figure 1 illustrates how two practices can share a competency which is linked to their separate meanings and materials. Meanings travel the most freely and can be deliberately spread (although somewhat unpredictably) through advertising and media (9). Shove *et al.* also discuss material elements travelling in a physical sense - such as goods moving by train. Overall, elements continue to persist in various forms when not being combined in practices and can be reincorporated into future performances.
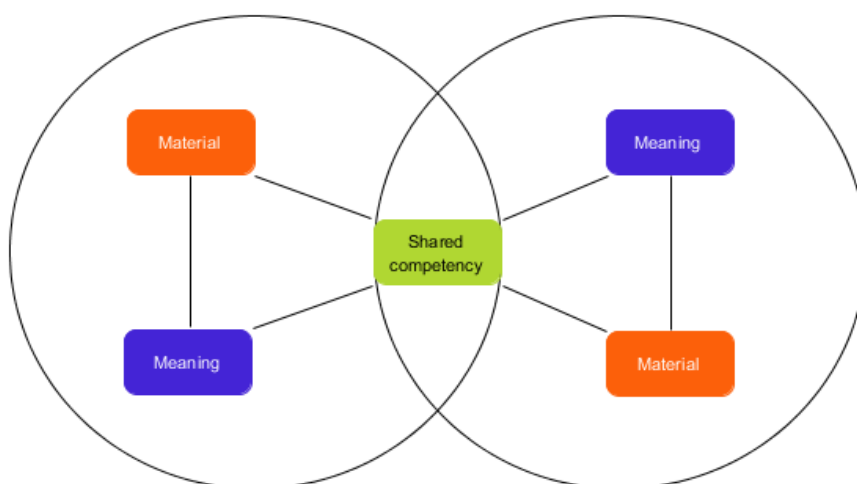
Figure 1. Elements between practices. Redrawn from The Dynamics of Social Practice (p. 37), by Shove E, Pantzar M, Watson M, London: SAGE Publications Inc; 2012.

These processes may have important public health implications, particularly for understanding health inequalities (9,10). From a public health perspective, researchers are interested in why and how groups of people become carriers of healthy or harmful practices. Understanding the spread of practices can provide insight at the individual level on the causes of harm, at the group level on social inequalities in prevalence and risk, and at the population level on trends in culture and any associated emerging harms. In order for a person to be 'recruited' to and perform a practice, the relevant elements need to be available to them (10). However, elements spread across a complex landscape and are not universally distributed. This contributes to the development of practices associated with population subgroups. For example, the classed practice of drinking in a working men's club spreads in neighbourhoods where the venues, meanings and competencies are present. Blue *et al.* argue that the distribution of elements is closely related to the structural (or macro-level) determinants of health such as income or wealth inequality, suggesting that structural patterns of health inequalities are at least partially attributable to the unequal distribution of elements of practice (10).

3.3   Time and space in theories of practice

Although time is not identified by Shove *et al.* as an element of practice, it has important interactions with practices (9,63). For example, time can be thought of as a resource for which practices compete, such as the practice of browsing the internet using a smart phone taking time away from conversation with a significant other (9,63).

However, this perspective has been argued to be somewhat simplistic, as it only accounts for one type of relationship between time and practices. More complex understandings of time include the perspective of the practitioner, for whom time represents the weaving together of practices through the rhythms of daily life (9). Southerton *et al.* discuss five understandings of time which are relevant to this perspective (63). These are duration, tempo, sequence, synchronization and periodicity. To demonstrate these different areas, the practice of eating breakfast is a helpful example. Every morning (a frequent and regimented periodicity), Miriam takes ten minutes (duration) to hurriedly (tempo) eat her breakfast. At the same time, she listens to the morning news (synchronisation). Miriam has a shower before breakfast and brushes her teeth afterwards (sequence) (63).

Space can also be considered in ways that are broadly analogous to the analysis of time above. Space is a finite resource that practices need and therefore compete for. Space is also defined and shaped by practice. For example, a group of practitioners playing online poker can be thought of as sharing a 'space' even though they are geographically dispersed. This space is created by the practice of playing the game

together online (9). Space has important implications for the practices that practitioners can perform, as the requisite elements need to be available to them in the space that they occupy (as discussed in relation to health inequalities in the previous section).

Space could also be thought of as having dimensions that are analogous to Southerton's understandings of time. I have developed one possible set of dimensions which are laid out in this paragraph. Firstly, *size* relates to the number of simultaneous practices-as-performance within the space. For example, playing virtual boardgames usually occurs in a small online space used for only one performance of this practice. Secondly, *density* is the degree of interaction between practices-as-performance within the space. For example, a romantic meal in a restaurant co-occurs with other eating practices but there is little interaction between tables so the density is low, whereas in nightclubs multiple instances of the clubbing practice occur simultaneously and there is a high level of interaction between different groups of practitioners - or a high density. Third, *positioning* describes the distribution of the space where the practice happens. For example, pub crawls take place in a series of pubs that are geographically close together and often in town centres. Finally, *overlap* relates to which other practices are sharing the space, which can be at the same or different times. For example, playing darts and drinking beer with friends both take place in the pub which leads to the close association between these practices. Thinking about different dimensions of space may aid researchers in conceptualising practices and understanding the spatial connections between them.

3.4   Summary

Overall, a key feature of theories of practice is their focus on the 'practice' as the unit of analysis and how these practices are performed (9,22). This is a radical shift away from individualised theories of behaviour change, which take the individual as the unit of analysis (10,15), and it addresses some weaknesses of macro-level approaches to studying drinking culture (18,22). In this chapter, I have discussed the ontological position of theories of practice, outlined the elements of practice as conceived by Shove *et al.* and considered the place of time and space within this framework (9). The following chapter applies this background to alcohol research, considering questions of methodology and methods for this thesis.

4 A novel practice-based approach to quantitative alcohol research

4.1 Alcohol consumption within drinking practices

Alcohol is consumed across many different settings and for many different reasons. It is consumed during communion on Sunday mornings and in the evening on the sofa. These different events are often referred to as drinking occasions in this thesis, which means any practice-as-performance in which alcohol is consumed. Considering drinking practices may appear to imply that alcohol consumption is a central and defining feature of these practices. On the contrary, it is no more conceptually valid to consider drinking in the evening on the sofa as a drinking practice than as a relaxation practice. However, alcohol is a subject of particular public health interest and so it is valuable to focus on drinking occasions (2). The terms 'drinking occasion' and 'drinking practice' therefore refer to activities where alcohol is consumed but that practitioners would not necessarily define in relation to alcohol consumption.

Practice-based perspectives frame issues of interest by emphasising the practice as the unit of analysis and bringing particular questions to the research agenda (7,9). Researchers might consider changes in practices over time, the prevalence of a particular practice, or which practices lead to harm. A practice perspective can also influence the types of interventions considered (9). In terms of harm, practice theories emphasise the context of drinking. If harmful practices and/or elements are identified, then these are good targets for policy-makers who are interested in changing drinking culture and reducing the large burden of harm associated with alcohol consumption (4,64).

4.2 Methodology

This thesis presents research with a positivist epistemological position, based on the assumption that research can identify truths about the external world. In conducting research, it is important for the methodology to be fit for purpose, i.e. well suited to the research questions (65). An early decision in the process of planning my thesis was whether to use qualitative, quantitative or mixed methods. Qualitative methods are useful for developing detailed understanding of drinking practices, especially ethnographic methods, which can provide insight into the associated meanings and competencies (30,66–69). Qualitative methods can also be used along with quantitative work as part of a mixed methods project (67). In this design, one stage often provides detailed analysis while the other gives a broader picture of the issue (70). Quantitative methods are well suited to answering questions like 'how frequent is X?', 'what is the direction and strength of the relationship between X and Y?' and 'what is the change in X over time?' (65).

Although practice-based research has typically employed qualitative (especially ethnographic) methodologies (7,37,71), there is growing interest in using quantitative approaches (7,22). There is some evidence that policy makers are more likely to use quantitative research which may therefore be a useful route for theories of practice to influence the policy agenda (72). Quantitative methods are also well-suited to answering important questions regarding the full range of drinking behaviour and associations with levels of alcohol consumption and acute alcohol-related harms (7,73).

Quantitative approaches to practice-based research are controversial, with theorists such as Latour and Venturini arguing that statistical methods are inconsistent with ontological flatness (52,60). Theorists make this argument because statistical methods often assume two levels of analysis (macro and micro). However, Shove has argued that it does not make sense to discuss practice-based research methodologies, as theories of practice provide a lens which frames research questions rather than prescribing approaches to answering them (69). Furthermore, this thesis builds on earlier theoretical work by Meier *et al.* which explores the benefits of applying a social practice theory lens to public health research on drinking occasions (7,9). Meier *et al.* argue that Shove's version of practice theory facilitates quantitative research in this area since the idea of practices being made up of interconnected elements may be useful for studying the 'clustering and covariations' of different types of elements (7,9). Meier *et al.* also suggest that the clear and specific framework provided by Shove *et al.* can facilitate thinking about and identification of the different types of elements involved in drinking practices and support the development of quantitative measures and analyses. Given this, and the importance of quantifying the effects of policy on practice and understanding practice on a larger scale, this thesis uses a practice-based quantitative approach.

4.2.1 Data collection methods

Quantitative alcohol research using a practice-based approach requires measures of drinking practices and their constituent elements. For thinking about how to do this, the distinction made by Shove *et al.* between practice-as-performance and practice-as-entity is helpful (9). Since quantitative researchers often collect data from individual 'carriers', quantitative measures are well suited to collecting information about separate practices-as-performance (or drinking occasions) (9). In order to make inferences about practices-as-entity, researchers can analyse data collected across many performances. One option for my thesis was to build on the existing literature identifying drinking practices in the United Kingdom. However, using this approach would mean that my thesis relied heavily on early exploratory quantitative work such as a recent typological study by Ally *et al.* (22). I decided to instead establish a more independent research project that focused on elements of practice, how these relate to alcohol consumption, and what they can tell us about mechanisms of effect for public health interventions.

The next question for planning my research was therefore how to operationalise elements of practice in drinking occasions. Alcohol is by definition a key material and there is a wealth of evidence that alcohol consumption is related to harm (2). Alcohol consumption is often used as an outcome measure in research. This is understandable since frequency, quantity and speed of consumption are related to negative health outcomes (2). In addition to alcohol consumption, there are a range of other materials, meanings, and competencies involved in drinking practices. In this thesis, I have operationalised these other elements as contextual characteristics of drinking occasions. There is a large existing literature in this area, studying a wide range of contexts from the day of the week (timing) to the type of venue (material) and the reason for the occasion (meaning) (74–78). Contextual characteristics are the closest analogue to elements of practice in the existing quantitative literature. This section will now review common quantitative methods for collecting data on drinking behaviour and consider how suitable they are for collecting information about contextual characteristics (elements of practice) of drinking occasions (practices-as-performance).

Firstly, alcohol consumption can be assessed using sales data (1,79,80). This method is reliable for measuring alcohol consumption but individual drinking occasions cannot be identified and minimal contextual information is collected. Sales data is therefore very limited for studying drinking practices.

Survey methods are more appropriate and survey data is often collected from large nationally representative samples (1,79,80). Survey methods can also be used to measure alcohol-related harm (81,82). However, survey measures typically fail to account for 40-60% of the volume of alcohol consumption which is captured by sales data (79,80,83–86). This is understood to be a result of a combination of factors, particularly memory deficit (or recall bias) (87,88). Surveys also suffer from non-response bias as higher risk drinkers are less likely to respond (86,89,90). Despite these weaknesses, survey measures remain widely used and are the best option for collecting information about drinking practices.

Different survey methods for studying drinking occasions have varied strengths and weaknesses and are suited to different aims (83,91,92). Often, summary information is collected about 'typical' behaviour using quantity-frequency measures, which ask participants about their usual quantity of alcohol drunk in an occasion and their usual frequency of drinking occasions (1,79,80,93). These measures can be used to collect contextual information, for example Casswell et al. report on a modified measure of typical consumption which asks within-location beverage-specific questions (80). This approach captures a higher proportion of the total volume of alcohol consumption than standard quantity-frequency measures, and includes information on drinking location and beverage type, which can be thought of as material elements of practice. However, measures of typical behaviour are not well suited to collecting a wide range of contextual information as this would require respondents to remember and accurately aggregate a lot of information from many diverse drinking occasions.

There is a further limitation of using methods, such as adapted quantity-frequency questions, which aggregate drinking occasions. Since participants are reporting on *multiple* practices-as-performance at once, there is a danger of multiple different practice entities being merged. For example, participants may report that they drink wine an average of once per week and the researcher would not be able to identify that sometimes this is when relaxing alone in the evening and other times it is with family at a restaurant. Overall, quantitative methods that collect information on typical drinking behaviour are not well suited for collecting information on contextual characteristics of drinking occasions.

I therefore decided that it would be most appropriate to use quantitative data collected about *specific* drinking occasions. This avoids the aggregation of multiple practices and makes collecting data on contextual characteristics more straightforward by asking participants about separate instances of alcohol consumption (94,95). Methods that ask respondents about their drinking at a particular time and place are commonly referred to as 'event-level' (94,95). Event-level methods are well suited to linking specific occasions with levels of alcohol consumption and acute alcohol-related harm, which is important from a public health perspective (2,94,95). The first two papers presented in this thesis therefore reviewed the existing event-level literature on contextual characteristics of drinking occasions, alcohol consumption, and acute alcohol-related harms (43,96).

Despite the strengths of event-level survey methods, it can be difficult to define and measure certain elements of practice. Material elements such as beverage type or location are easier to define and operationalise within quantitative surveys than competencies and meanings. However, simple descriptions can be used to capture aspects of meaning such as the reason for the occasion (e.g. being at a party) or reasons for drinking such as to relax (22). Such descriptions are limited to relatively straightforward meanings that are obvious to the individual practitioner and cannot capture the nuances and richness offered by qualitative research such as the historical context of meanings and the host of associations with other practices and social groups (9). Although these measures may not fully describe drinking practices, Meier *et al.* argue that they are a promising quantitative method for studying drinking practices and their constituent elements (7).

In order to collect information about specific drinking occasions, researchers first need to identify which occasions they want participants to report. If researchers are interested in occasions when a specific alcohol-related harm occurs or which are in a particular location, survey questions can ask about relevant recent occasions (13,97). For example, the respondent could be asked to give details about the last time they experienced a hangover after drinking. This approach is useful for research questions such as 'Where do people drink prior to hospitalisation for alcohol-related injuries?' (98). However, in this thesis I was more interested in capturing a representative snapshot of all drinking occasions since I did not have narrowly defined hypotheses and wanted to take a more exploratory approach.

There are two key methods for collecting event-level data about a snapshot of drinking occasions – ecological momentary assessment and drinking diaries (43,99). These methods are both well suited to collecting detailed information about the contextual characteristics of drinking occasions (22,43,99). Ecological momentary assessment involves collecting information about the occasion during or shortly after its occurrence and often includes multiple points of data collection. For example, Thrul and Kuntsche used text messaging to send participants online surveys every hour from 8pm to midnight to collect information about their drinking over the course of the evening (100). Digital aids such as text messaging are commonly used in this way to facilitate data collection (101,102). This approach is useful for avoiding recall bias as the participant is reporting information about an activity that was extremely recent (or ongoing) (92,101,102). On the other hand, retrospective drinking diaries ask respondents to fill in details about their alcohol consumption over the period just before they started the diary, often the previous week (103–105). For example, Kushnir *et al.* asked survey participants to report their alcohol consumption over the previous 7 days and found that alcohol consumption is higher on Fridays, Saturdays, Christmas Day and New Year's Eve (106). Drinking diaries are also understood to minimise recall bias as participants are not required to recall information over long periods (79,80,86,104).

Of these two promising event-level methods, I chose to use a detailed 7-day retrospective drinking diary for the primary quantitative work in my thesis. As a member of the Sheffield Alcohol Research Group, I had access to the Alcovision survey, a unique large (~30,000 participant per year from 2001-2017) market research dataset. Questionnaire development and data collection for the Alcovision survey are conducted by Kantar Worldpanel for market research purposes. The dataset is sold to a range of stakeholders, including commercial clients. This shapes the measures that are available for analysis, which are not informed by a specific theoretical perspective, and do not align perfectly with the measures in the scientific literature. For example, the measures of drinking motives do not use a validated scale such as the Drinking Motives Questionnaire (108). Alcovision also contains no explicit information on negative motivations for use (e.g. coping or getting drunk) or on harmful use of alcohol. However, the occasion characteristics captured in the Alcovision questionnaire are more detailed than any other dataset in Great Britain (and almost all global datasets). They also appear to be suitable for practice-based research as they can be interpreted using a theories of practice lens. Using pre-existing data rather than collecting primary data is an efficient approach as data collection is time intensive and it would not have been feasible within the resources of this PhD to collect detailed diary or ecological momentary assessment data from a large number of people (107).

4.2.2 Policy evaluation

Policy evaluation studies are a key aspect of public health research. To reduce alcohol-related harm, it is crucial to implement effective policies (6–8). There is a large and influential existing literature evaluating public health interventions in the alcohol field (109,110). In 2010, Babor *et al.* published the second edition of *Alcohol: No Ordinary Commodity* which includes a useful overview of the evidence for interventions that can reduce alcohol-related harm (109). Similar reviews have been published in *The Lancet* which find a rich evidence base for effective public health interventions (111,112).

In addition to a good understanding of which policies are effective, public health researchers have argued that we need to understand how interventions work. Policy evaluations should be based on a clear understanding of how the intervention is expected to work, and should assess whether the expected effects are seen on proximal outcomes on the causal pathway between the intervention and distal public health outcomes (113). For example, minimum unit pricing increases the price of the cheapest alcohol, and is therefore expected to reduce consumption among people who drink cheap alcohol and are sensitive to changes in price (114). To evaluate this, it is useful for researchers to understand who drinks the cheapest alcohol, how much of it they drink, whether the introduction of minimum unit pricing changes drinking occasions involving cheap alcohol consumption, how this affects other drinking occasions, and how any changes affect subsequent alcohol-related harm.

By applying a practice-based approach to policy questions like this one, researchers can consider the effects of a policy change on a heterogeneous set of activities relevant to the policy, some of which include directly relevant elements such as cheap alcohol. For instance, policy evaluation studies can focus on which types of activities (practices) are influenced by an intervention and how that intervention may reconfigure practices and elements within practices. In this thesis, I chose to apply a practice-based approach to evaluating the Licensing Act 2003 and to focus on its proximal effects on drinking occasions such as shifting occasions later at night. This approach may provide insight into the mechanisms of action of the policy.

4.3 Thesis rationale

In the preceding chapters, I have argued that it is important for public health research to consider alcohol consumption as occurring within multiple distinct activities, as part of a wider drinking culture. This perspective enables researchers to explore how, why and for what types of problem or individuals interventions work (6–8). I went on to consider different theoretical approaches to understanding (and trying to change) drinking culture, concluding that theories of practice are particularly promising as they provide a granular viewpoint that can be applied to consider sub-national drinking culture in detail (7,9–

12,18,22,37). They also emphasise habitual or 'everyday' activities and are therefore well suited to studying alcohol consumption in the United Kingdom, where it is a prominent aspect of many peoples' lives (9,10,22).

In previous sections of chapter four, I discussed the methodological application of a practice-based approach in this thesis. I argued that quantitative research in this area can inform policy and provide novel insights into issues such as the harm associated with particular elements of practice and the effects of policy interventions on different types of drinking occasions (7,72).

The following section presents the aim of this thesis and summarises each of the four included studies, and their research questions and objectives. Figure 2 provides a condensed summary of the thesis justification, aim and resultant studies.
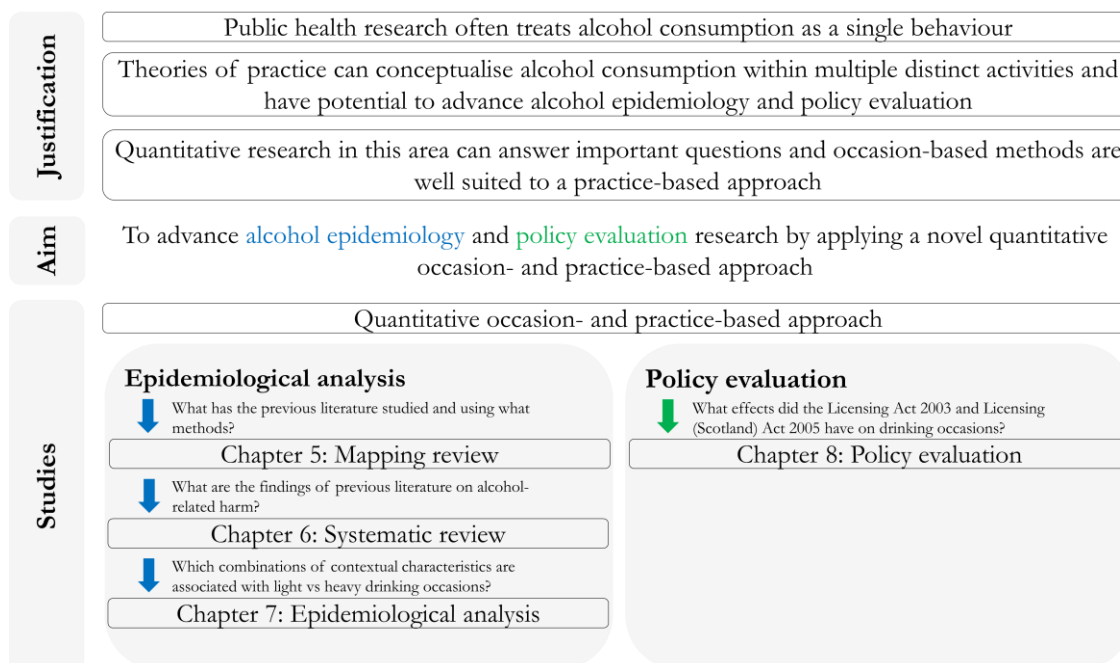
Figure 2. Summary diagram showing the justification, aim and studies of the PhD

4.4 Research aim, questions and objectives

4.4.1 Research aim

To advance alcohol epidemiology and policy evaluation research by applying a novel quantitative occasion- and practice-based approach

4.4.2 Research summary, questions, and objectives

Mapping review (chapter five)

The first study is a review of the existing event-level literature studying the links between contextual characteristics of drinking occasions and either alcohol consumption or alcohol-related harm (115,116). This literature is topically and methodologically diverse, making a mapping review methodology an ideal approach (117). I therefore use this method to map the breadth of the areas covered and methods used by the existing literature. This review is not limited to practice-based research but can be used to inform further practice-based research.

The research questions are:

1. Which contextual characteristics of adults' drinking occasions have been studied in relation to levels of alcohol consumption and/or alcohol-related harm?
2. What theoretical approaches and study designs have been used by this literature?

The research objectives are:

1. Systematically identify existing event-level literature on the relationship between the contextual characteristics of drinking occasions and levels of alcohol consumption and alcohol-related harm
2. Map the breadth of the methods used and contextual characteristics studied
3. Critically interpret the findings, make recommendations for future research, and identify a research area for planned epidemiological analysis

Systematic review (chapter six)

Chapter six presents a further systematic review building on this mapping review by synthesising the findings of studies which linked contextual characteristics of drinking occasions to harm rather than consumption only.

The research questions are:

1. What are the findings of the existing literature on the relationship between the contextual characteristics of adults' drinking occasions and alcohol-related harm?

The research objectives are:

1. Describe and narratively synthesise the findings and theoretical approach of existing research on the relationship between contextual characteristics of drinking occasions and alcohol-related harm
2. Assess the quality of the existing literature
3. Critically interpret the findings and make recommendations for future primary research

Epidemiological study (chapter seven)

Chapter seven is informed by these literature reviews, and used secondary data to identify combinations of contextual characteristics that are associated with heavy vs. light drinking occasions, explore which characteristics are the strongest predictors of consumption, and test whether contextual characteristics improve the prediction of consumption (individually and in combination) compared to demographic characteristics only.

The research questions are:

1. Which combinations of contextual characteristics in adults' drinking occasions are strongly associated with light and heavy consumption?
2. Does accounting for occasion characteristics (individually and in combination) improve the prediction of consumption?
3. What are the benefits and weaknesses of applying a quantitative occasion- and practice-based approach to alcohol epidemiology?

The research objectives are:

1. To identify combinations of contextual characteristics which are associated with light and heavy consumption
2. To generate new evidence on the relative importance of different contextual characteristics for predicting alcohol consumption
3. To analyse a uniquely detailed dataset using innovative data mining methods
4. Critically interpret these findings, make recommendations for future research and prevention policy
5. To gain insights into the benefits and weaknesses of using a quantitative occasion- and practice-based approach in epidemiological alcohol research

Policy analysis study (chapter eight)

Chapter eight explores the use of a practice-based approach in an evaluation study of the Licensing Act 2003 in England and Wales. Applying a practice-based approach to policy evaluation may elucidate mechanisms of action which would be opaque to research that measured only consumption or acute harm.

The research questions are:

1. How did drinking practices in England, Wales and Scotland change following the Licensing Act 2003?

2. What are the benefits and weaknesses of applying a quantitative occasion- and practice-based approach to alcohol policy analysis?

The research objectives are:

1. To test proposed mechanisms of effect for the Licensing Act 2003 by evaluating changes in characteristics of drinking occasions
2. To analyse a uniquely detailed dataset using innovative time-series methods
3. To gain insights into the benefits and weaknesses of using a quantitative occasion- and practice-based approach in alcohol policy analysis

5 Contextual characteristics of adults' drinking occasions and their association with levels of alcohol consumption and acute alcohol-related harm: a mapping review

This chapter presents research conducted and published in *Addiction* during the course of my studies (43). The version accepted for publication is re-produced in this chapter. The version included here has been revised according to comments from my viva voce examiners (Appendix A). An earlier version was also presented at the 44th Annual Meeting of the Kettil Bruun Society in Chiang Mai, Thailand (28th May – 1st June 2018).

This study was conceived less than a month into my PhD and was the main project I worked on during my first year. When I started my studies, I began to read the literature on drinking contexts and alcohol-related harm, finding papers on a wide range of topics. I was interested in summarising this literature to inform the direction of my research. This led me to consider producing a visual summary of the evidence or developing a formal network meta-analysis. It was not feasible to use these methods as the literature was highly heterogeneous in terms of both contextual characteristics measured and study designs used. Over the next couple of weeks, I considered the best approach to summarising this information and decided to conduct a review that described the areas covered and methods used in the literature. A few weeks later I discovered that this approach is known as a 'mapping review' (117).

The main challenges of conducting this study were search strategy and inclusion criteria development. In both cases, this was due to the disparate nature of the literature. I developed the search strategy iteratively and revised it to include alternative terms for the same concepts or new contextual characteristics that I came across in the literature. During the process of paper screening for inclusion, I had to make difficult decisions about whether studies using a wide range of designs and data collection methods met my inclusion criteria. For example, I decided to include studies that collected information about groups of drinkers but not about all drinkers in a venue (such as measuring characteristics of a pub and outcomes at the venue-level). This was because the drinking group can be conceptualised as sharing a practice-as-performance (or drinking occasion) but this is not the case across an entire venue. I made these decisions during discussions with my supervisors.

Early versions of this review did not include the theoretical frameworks used by the included papers. During my confirmation review, my examiners suggested that it would be interesting to extract this since my project has a strong theoretical focus. When I responded that most studies did not have a stated theoretical perspective, my examiners pointed out that this is in itself an interesting finding. I therefore included information about theoretical approaches in the final version of my review.

The addition of theoretical frameworks turned out to play an important role in developing my understanding of the literature. My supervisors and I felt that it partially explained the disparate nature of

the literature. These findings were instrumental in developing my epidemiological study (chapter 7), which used a practice-based approach and aimed to include a wider range of contextual characteristics than previous studies in this area.

5.1 Accepted paper

Contextual characteristics of adults' drinking occasions and their association with levels of alcohol consumption and acute alcohol-related harm: A mapping review

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Running head: Characteristics of adults' drinking occasions

ABSTRACT

Background and Aims

There is a growing literature using event-level methods to estimate associations between contextual characteristics of drinking occasions, consumption levels, and acute harms. This literature spans many research traditions and has not been brought together as a whole. This mapping review aims to identify and describe the theoretical approaches to conceptualising drinking occasions, study designs, predictors, and outcome measures used in existing research with a view to identifying dominant approaches, research gaps and areas for further synthesis.

Methods

Eligible papers studied adults' drinking occasions using quantitative event-level methods, considered one or more contextual characteristics (e.g. venue, timing, or company), and at least one event-level consumption or acute alcohol-related harm outcome. We systematically searched Ovid MEDLINE, PsycInfo, and the Web of Science Social Sciences Citation Index, extracting data on studies' theoretical approach, data collection methods, settings, populations, drinking occasion characteristics, and outcome measures.

Results

Searches identified 278 eligible papers (from 1975 to 2019), predominantly published after 2010 (n=181; 65.1%). Most papers reported research conducted in the United States (n=170; 61.2%) and half used student participants (n=133; 47.8%). Papers typically lacked a stated theoretical approach (n=203; 73.0%). Consistent with this, only 53 (19.1%) papers studied three or more occasion characteristics and most used methods that assume occasion characteristics do not change during an occasion (n=189; 68.0%). The most common outcome type considered was consumption (n=224; 80.6%) and only a few papers studied specific acute harm outcomes such as unprotected sex (n=24; 8.6%), drink driving (n=14; 5.0%) or sexual violence (n=9; 3.2%).

Conclusions

The reviewed literature is largely focused on students and consumption outcomes. Most papers considered a limited range of contextual characteristics. Future work should synthesise the findings on emerging and well-covered topics, such as venue type, and use theory-informed approaches to ensure more consistent analyses of contextual characteristics.

Key words: Drinking occasions, Contexts, Alcohol Drinking, Adverse Effects

INTRODUCTION

Globally, alcohol consumption was the seventh leading risk factor for death and disability in 2016 (1). Acute health conditions, such as injuries from violence and road traffic accidents, account for a large proportion of this burden, for example, they account for an estimated 54% of alcohol-related deaths and 65% of years of life lost in the United States (US) (2–4). Recent evidence suggests that both consumption levels and acute harmful outcomes are directly linked to the context of drinking occasions (5,6). There is less focus on the relationship between occasion characteristics and chronic harms as these are more related to long-term consumption patterns. Event-level methods, rather than measures of typical behaviour, are well suited and increasingly used to study the effects of contextual characteristics on consumption levels and acute harm (6,7). The range of characteristics studied to date is broad, including an occasion's timing, venue, situation, and participants. In the UK, drinking in pubs has been associated with violence (8). In the US college literature, themed parties were associated with increased blood alcohol concentration (9), and friends' high safety intentions for 21st birthday celebrations reduced the likelihood of negative alcohol-related consequences (10). Researchers in Switzerland and Australia also found that pre-drinking, drinking with a greater number of friends and drinking in a mixed gender group are all associated with increased alcohol consumption during an occasion (11–15). Other researchers have shown that drinking contexts and acute harm also vary across demographic groups; underage and legal drinkers differ in their drinking contexts and the alcohol-related harms that they experience (16,17).

In addition to measuring many contextual characteristics, the event-level literature linking contextual characteristics to acute consumption or harm is methodologically diverse. Researchers use experimental designs to determine how drinking behaviour is altered by factors manipulated by the researcher, such as the setting, who drinkers are with and the size or shape of the container which they are drinking from (18–20). There are also field studies in which researchers directly observe and collect data about drinking occasions (21). Intercept studies are a type of field study where participants are interviewed when entering or leaving drinking venues (22). Ecological momentary assessment is another commonly used survey approach involving eliciting reports from drinkers in real-time (or close to it), for example via smartphone apps (4,23,24). This is useful for identifying causal relationships as the temporal order of events is observed. Lastly, researchers use retrospective surveys to collect data on drinking occasions sometime after the event (25).

This large and diverse body of evidence is located in multiple research traditions, including epidemiology, experimental psychology, quantitative sociology, prevention research and anthropology. Thus, there is a need for a review to bring the published studies together and identify the dominant theoretical and methodological approaches, any research gaps, and a set of specific topic areas for further detailed review and meta-analysis (26,27). Considering theoretical approaches is important as they influence the rationale,

aims, objectives, methods and interpretation of studies (28,29). Understanding the theoretical approaches used can therefore assist in explaining other features of the literature. This mapping review aims to map the breadth of the existing event-level research that quantifies the relationship between the context of adults' drinking occasions and consumption and/or acute alcohol-related harm. In order to achieve this, it maps studies in terms of their theoretical approach, data collection methods, settings, populations, characteristics of drinking occasions analysed, other outcome predictors such as individual characteristics, and the outcome measures of consumption and/or acute alcohol-related harm used (27).

METHODS

Mapping review

Grant *et al.,* in their typology of reviews, define mapping reviews as describing the topics covered and methods used by the existing literature to identify research gaps and areas for systematic review (27). Mapping reviews are particularly useful for a research area like event-level alcohol research, where the evidence base is large, methodologically and conceptually diverse, and distributed across a poorly connected set of research traditions.

Search strategy

A systematic search was conducted using Ovid MEDLINE, Ovid PsycInfo and the Web of Science Social Science Citation Index (SSCI). Databases were searched from the earliest dates available to the 8th January 2019. The main search strategy was developed iteratively, with a scoping search used to identify key terms relating to three concepts: alcohol consumption (e.g. alcohol-related or alcoholic beverage*), event-level research (e.g. ecological momentary assessment) and characteristics of drinking occasions (e.g. venue*, weekend). These were combined such that only records containing at least one term from each concept were identified (Table S1). This search strategy captured literature on alcohol-related harms since these papers mention the included alcohol terms and use Medical Subject Headings such as Alcohol Drinking. We included search terms based on informal discussion with expert stakeholders.

Duplicates were removed using Ovid. Studies describing the effects of interventions or treatment were not of interest for this review. The search strategy therefore excluded papers using relevant database-specific subject headings and the terms 'brief intervention' present in the abstract or 'effectiveness' in the title. Citation and reference list searching were not undertaken.

Eligibility criteria

Population

Our review focuses on studies of the general population, or subsets thereof, defined by drinking level or age (including student populations). Research on clinical or other special subpopulations (e.g. pregnant women; homeless populations, young offenders, those diagnosed with specific health conditions) was excluded, as were studies with participants wholly under the legal drinking age (e.g. under 21s in the US) as underage drinkers are known to drink differently to adults and have a different harm profile (16,17).

Exposure

Eligible studies must quantitatively measure one or more contextual characteristics of individual drinking occasions other than alcohol consumption or harm. These were identified during search strategy development and are listed in the search strategy and results table (Table 1, Table S1). Contextual characteristics were organised into categories developed using the results of the scoping search (30).

Outcome

Eligible studies examine the association between a relevant contextual characteristic and at least one event-level or aggregate consumption outcome and/or acute alcohol-related harm. Acute harms were identified using the 10th Revision of the International Classification of Diseases and a 2017 review of the burden of disease of alcohol use (31–33). The resultant list of 20 harms was lengthened to include condom use, criminal activity and aggregate measures of acute harm (which aggregate several different harms into one measure). Studies on these subjects were identified by the scoping search.

Study designs and reporting

Quantitative research published in English that used event-level methods including ecological momentary assessment, experimental, retrospective diary (up to one week) and recall of specific occasion/s methods was eligible for inclusion.

We excluded studies that did not identify drinking occasions of individuals or groups, such as bar-room studies measuring bar-level characteristics and outcomes only.

Existing reviews

Where recent (2014 – present) systematic reviews of an occasion characteristic, an outcome or the relationship between a characteristic and outcome were identified during database searching, we consider the literature on that topic to be adequately mapped and exclude it from the present review, irrespective of publication date. This decision was taken to manage the scope of an already wide-ranging review. It means we did not include search terms related to the topic of the earlier review in our search strategy and we did not include otherwise identified studies if they focused only on the reviewed characteristic, outcome or

relationship. Below, we summarise the recent reviews identified by our search to give readers an overview of their content and guide them towards information that is excluded from the present study. Where older (pre-2014) systematic reviews were identified, we considered the literature to be potentially inadequately mapped, as recent studies would not be included. Therefore, we included all eligible studies within older reviews in our analysis and searched for more recent literature within our search strategy.

Four recent reviews were identified. Two of these focused on the relationship between illicit substance use and domestic violence (34,35) and the other two focused on combined use of alcohol with energy drinks (36,37). None of these reviews solely focused on event-level studies but included them alongside other literature. Choenni *et al's* review on illicit substance use and domestic violence identified few event-level studies and most of the literature focused on clinical populations (34). Bruijn *et al.* include three event-level studies of non-clinical samples on the relationship between illicit substance use and same-day domestic violence based on the table of included literature (35). Similarly, Verster *et al.* and Peacock *et al's* systematic reviews on mixing alcohol with energy drinks included few event-level studies and none that predicted acute harm outcomes (36,37). Much of the literature in the reviews by Verster *et al.* and Peacock *et al.* studied student or bar drinking samples (36,37). Overall, there is limited event-level research in these areas especially in general population samples.

We identified a number of older systematic reviews that were potentially relevant. The most important was published in 2011 by Hughes *et al.* and examines physical, staffing and social factors in drinking occasions (38). We included the 53 papers in Hughes *et al's* review in our screening and searched for new literature in this area published after 2009 (38). Other reviews on pre-drinking, craving, smoking, motives and expectancies, bar characteristics, day of the week, time of day and student drinking and intimate partner violence were identified (2,4,6,39–47). These reviews were not recent, comprehensive, systematic and event-level and so did not justify excluding these characteristics from this review.

Screening for inclusion and data extraction

Titles and abstract screening was followed by full-text screening and data extraction by one reviewer (AS).

Identifying information extracted included title, first author, journal and year of publication. Key information was then extracted about each study including the theoretical approach, data collection method, setting, population and country, study outcome measures and the individual, contextual characteristics and other predictors included. We also assessed whether the design treated drinking occasions as static or allowed for characteristics to change during the drinking occasions (such as moving venue). The results reported in each paper were not extracted since the aim of this review was to map the topics and methods covered by existing literature (27).

Analysis and reporting

Descriptive summary statistics were used to first explore theoretical approaches, then study design, followed by individual and occasion characteristics used as predictors, and finally outcome measures. Summary statistics refer to numbers of papers as some papers reported multiple studies and vice versa. Analysis is focused on study characteristics and contextual characteristics that were reported in at least five papers in order to identify where there is a body of literature.

Analysis was conducted using Microsoft Excel 2016 and Stata version 15. Figures were produced using OriginPro 2017. All searching, screening, data extraction and analysis was conducted by the first author with input from PM and JH.

RESULTS

A summary table of all included literature is available in the Appendix (Table S2).

Search results

Of the 5,590 non-duplicate titles and abstracts identified by the search, 4,429 (79.23%) were excluded after title and abstract screening. Full text screening subsequently excluded 883 papers leaving 278 eligible papers (Figure 1) (48).

Identification

Records identified through database searching
(n = 7,248)

Additional records identified from other sources
(n = 72)

Screening

Records after duplicates removed
(n = 5,590)

Full-text articles excluded, with reasons
(n = 883)
Not event-level data (382)
Not alcohol-related harm or alcohol consumption (153)
No contextual characteristics (126)
No legal age drinkers (60)
Specific population (49)
Not a journal article (33)
Not available in English (20)
Can't identify drinkers (16)
Not acute outcomes (9)
Qualitative (8)
Review (8)
Not alcohol consumption (7)
Descriptive only (6)
Cluster analysis only (5)
Inaccessible (1)

Titles and abstracts screened (n = 5,590)

Records excluded
(n = 4,429)

Eligibility

Full-text articles assessed for eligibility
(n = 1,161)

Included

Studies included in mapping review
(n = 278)

Figure 1. PRISMA diagram[1]

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[1] The eight reviews excluded during full text screening were as follows:

Sudhinaraset M, Wigglesworth C, Takeuchi DT. Social and Cultural Contexts of Alcohol Use: Influences in a Social-Ecological Framework. Alcohol Res. 2016;38(1):35-45.

Bennett LA, Campillo C, Chandrashekar CR, Gureje O. Alcoholic beverage consumption in India, Mexico, and Nigeria: a cross-cultural comparison. Alcohol Health Res World. 1998;22(4):243-52.

Litt MD, Cooney NL. Inducing craving for alcohol in the laboratory. Alcohol Res Health. 1999;23(3):174-8.

Liu, Y. and West, S.G. Weekly Cycles in Daily Report Data: An Overlooked Issue. J Pers. 2016;84:560-79.

Sinha, R. How Does Stress Lead to Risk of Alcohol Relapse? Alcohol Res. 2012;34(4):432-40.

Armeli S, Todd M, Mohr C. A daily process approach to individual differences in stress-related alcohol use. J Pers. 2005;73(6):1657-86.

Chersich MF, Rees HV. Causal links between binge drinking patterns, unsafe sex and HIV in South Africa: its time to intervene. Int J STD AIDS. 2010;21(1):2-7.

Fairbairn CE. Drinking among strangers: A meta-analysis examining familiarity as a moderator of alcohol's rewarding effects. Psychol Addict Behav. 2017;31(3):255-264.

There has been a recent rapid increase in the number of papers being published – 65.1% of papers were published after 2010 (Figure 2).
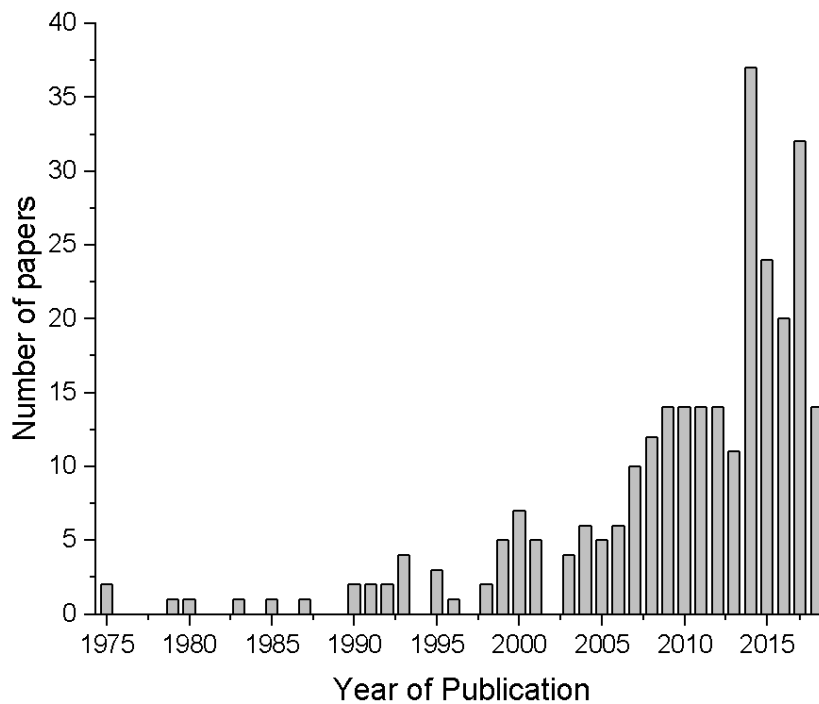
Figure 2. Year of publication for included studies

Theoretical approach

A minority of papers in this review had an explicit theoretical framework (n=75; 27.0%) (Table 1). Those that did typically used psychological theories such as the theory of planned behaviour and focused on specific contexts such as motivations (informed by motivational models) (49,50).

Study designs, locations and settings

Across all included papers, daily diary (n=70; 25.2%), single occasion recall (n=66; 23.7%) and experimental (n=43; 15.5%) designs were the most common. However, papers using ecological momentary assessment, such as by text messaging, were also used (n=39; 14.0%). The earliest ecological momentary assessment study identified was published in 2000 but most (n=27; 69.2%) were published after 2014 (Table S3). Most papers (n=189; 68.0%) used methods based on the assumption that occasion characteristics do not change across an occasion, for example, recording only one drinking venue or set of companions. Experimental (17 of 43 papers; 39.5%), daily diary (27 of 70 papers; 38.6%), and ecological

momentary assessment (14 of 39 papers; 35.9%) designs were most likely to state an explicit theoretical framework.

Much of the identified literature was conducted in the US (n=170; 61.2%). Other common countries were Australia (n=21; 7.6%), Canada (n=17; 6.1%), and Switzerland (n=17; 6.1%). Most papers reported drinking occasions across a range of settings (n=198; 71.2%) but 45 (16.2%) focused on a single type of setting only – such as licensed premises (n=9; 3.2%), nightclubs (n=7; 2.5%) or bars (n=21; 7.6%). The remaining 35 (12.6%) papers used experimental settings.

Participant characteristics were frequently included in analyses as controls (n=230; 82.7%), including sex (n=195; 70.1%), age (n=109; 39.2%) and measures of usual drinking (n=67; 24.1%).

Study populations

Student populations were the most commonly studied (n=133; 47.8%), especially in the US literature (105 of 170 papers; 61.8%). Other papers recruited adult drinkers (n=98; 35.3%), non-student young adults (n=47; 16.9%), or risky drinkers (n=33; 11.9%). There were only three papers (1.1%) which focused on older adults although they are at higher risk of alcohol-related harm (51).

Table 1. Study characteristics which applied to at least five papers [1]

	Study characteristics [2]	Total number of papers (percentage of included studies)
Theoretical approach	None	203 (73.0)
	Motivational models	17 (6.1)
	Tension-reduction models	6 (2.2)
	Social learning theory	5 (1.8)
Design	Daily drinking diary/ 24 hour recall	70 (25.2)
	Single occasion recall	66 (23.7)
	Experimental	43 (15.5)
	Ecological momentary assessment	39 (14.0)
	Portal/ intercept survey	29 (10.4)
	Retrospective drinking diary	24 (8.6)
	Field studies	20 (7.2)
Country	United States	170 (61.2)
	Australia	21 (7.6)
	Canada	17 (6.1)
	Switzerland	17 (6.1)
	England	14 (5.0)
	The Netherlands	10 (3.6)
	New Zealand	5 (1.8)
Population	Students	133 (47.8)
	Adults	98 (35.3)
	Non-student young adults	47 (16.9)
	Risky drinkers	33 (11.9)
	Experienced a specific harm [3]	16 (5.8)

[1] These findings are shown by year of publication in Table S3. [2] Some studies fit into multiple categories (e.g. they were conducted in two countries or they used both daily diary and single occasion recall methods). In such instances, we used both characteristics to define the paper. [3] For example, recruiting injured patients in accident and emergency departments.

Contextual characteristics of drinking occasions

Contextual characteristics were organised into six categories: meaning, timing, venue, company, situation (e.g. crowding) or drink type, to facilitate interpretation (30) (Table 2). *Meaning* includes mood (e.g. feeling "sad" or "dejected" (52)), drinking motives (e.g. drinking to cope (6)), stated reason for the occasion such as being at a party (53), intentions (e.g. planned number of drinks (54)) and social support/interactions (e.g. positive or negative interpersonal events such as having an argument (55)). *Timing* is mostly operationalised as the day of the week and/or time of day at which the occasion occurs (56). Common *company* characteristics measured were the number of people in the drinking occasion and the type of people involved (e.g. family or friends (57)). *Venue* characteristics include the number of different venues (58); whether they are in the on-trade, off-trade or both (59); and the type of venue, such as in a pub

versus at home (60). *Situation* relates to other features of the local environment, (e.g. crowding (61)), and a wide range of characteristics were studied. Lastly, *drink type* is the kind of alcoholic drink being consumed (e.g. liquor/spirits vs wine (62)).

The overall number of papers that studied each contextual characteristic, how many used student populations in the US, and how many used other young adult populations are shown in Table 2. There are several contextual characteristics that are well-studied in young adults but not covered by the literature on general adult populations – such as reasons, motives, number of venues and the availability of illicit drugs. Some contextual characteristics are largely studied in the US using student populations – such as the availability of food or number of drunk people in the local environment.

Table 2. Contextual characteristics measured by at least five papers [1]

	Contextual characteristics [2]	Number of papers with United States student populations	Number of papers with young adult populations [3]	Total number of papers (percentage of included studies)
Meaning	Affect/ mood	22	33	50 (18.0)
	Anxiety/ stress	7	7	19 (6.8)
	Intentions	5	9	18 (6.5)
	Subjective intoxication	7	14	18 (6.5)
	Social support/ interactions	9	9	16 (5.8)
	Reasons	10	14	15 (5.4)
	Craving	1	9	14 (5.0)
	Motives	5	11	13 (4.7)
	Alcohol cue exposure	1	5	8 (2.9)
Timing	Day of the week	31	51	81 (29.1)
	Time of day	7	21	38 (13.7)
	Duration	6	17	24 (8.6)
	Other timing (e.g. year)	10	16	23 (8.3)
	Specific/special occasions	8	14	21 (7.6)
	Sport-related	5	5	8 (2.9)
Company	Number of people	9	25	36 (13.0)
	Type of people	14	25	35 (12.6)
	Drunk people	9	17	20 (7.2)
	Gender composition	1	11	15 (5.4)
	Length of relationship	5	6	8 (2.9)
Venue	Venue type	13	25	44 (15.8)
	Pre-drinking	11	21	30 (10.8)
	On-trade versus off-trade premises	4	9	17 (6.1)
	Number of venues	3	8	8 (2.9)
Situation	Illicit drugs used	8	13	23 (8.3)
	On-trade venue features (e.g. loud music)	6	12	21 (7.6)
	Off-trade occasion features (e.g. drinking games)	14	14	16 (5.8)
	Commercial factors (e.g. discounting)	7	7	12 (4.3)
	Illicit drugs available	7	7	8 (2.9)
	Crowding	1	4	8 (2.9)
	Food available	6	6	8 (2.9)
	Ate food	0	4	7 (2.5)
	Number of drunk people	5	5	5 (1.8)

[1] These findings are shown by year of publication in Table S4. [2] Some studies fit into multiple categories (e.g. they were conducted in two countries or they used both daily diary and single occasion recall methods). In such instances, we used both characteristics to define the paper. [3] The number of papers using student and other young adult populations.

Few of the included papers measured a wide range of occasion characteristics, in line with the lack of theory-based conceptualisation of drinking occasions. A large proportion of included papers (n=117; 42.1%) measured just one type of characteristic. Few papers (n=53; 19.1%) measured three or more types of characteristics (Figure 3).
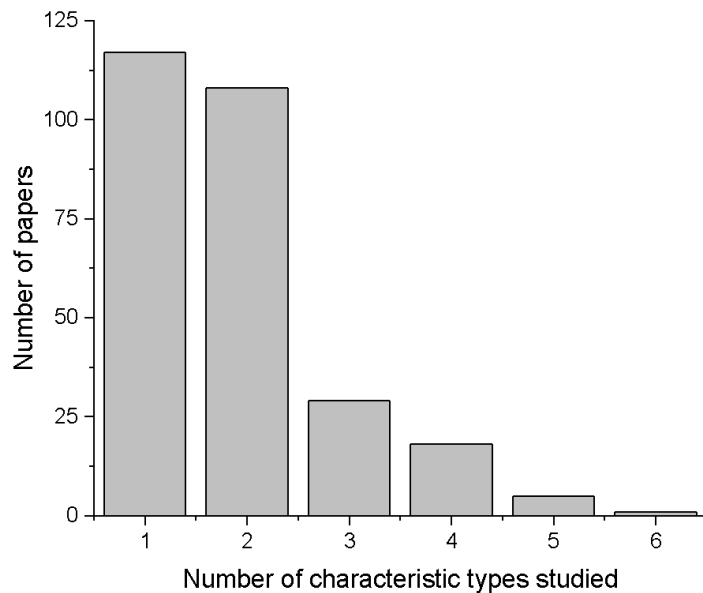
Figure 3. The number of characteristic types studied by included papers

Meaning characteristics were the most commonly studied (n=155; 55.8%), followed by timing (n=132; 47.5%), company (n=80; 28.8%), venue (n=75; 27.0%), situation (n=63; 22.7%) and drink type (n=18; 6.5%) (Table 3). This prominence of meaning is likely due to the dominance of psychological frameworks focused on particular aspects of drinking occasions. Of the 155 papers which measured meaning characteristics, 31.6% measured *only* meaning characteristics. This proportion was generally smaller for less commonly measured characteristics (e.g. timing 18.9%; company 16.3%; venue 12.0%; situation 15.9%; drink type 5.6%). There was variation in the overlaps between contextual characteristic types studied; papers with company characteristics often included meaning characteristics (60.0%) and papers with drink type characteristics often included venue (61.1%) and timing (50.0%) characteristics (Table 3).

Table 3. Proportion of papers in each category of contextual characteristics (rows) which also studied other types of contextual characteristics (columns)

	Meaning	Timing	Company	Venue	Situation	Drink type	Total papers
Meaning	31.6%	38.7%	31.0%	22.6%	18.1%	2.6%	155
Timing	45.5%	18.9%	19.7%	25.0%	18.9%	6.8%	132
Company	60.0%	32.5%	16.3%	35.0%	28.8%	3.8%	80
Venue	46.7%	44.0%	37.3%	12.0%	38.7%	14.7%	75
Situation	44.4%	39.7%	36.5%	46.0%	15.9%	9.5%	63
Drink type	22.2%	50.0%	16.7%	61.1%	33.3%	5.6%	18

The percentages show how many papers in the contextual characteristics category indicated by the row heading also measured characteristics in the category indicated by the column heading. For example, the top left cell shows that 31.6% of the papers which studied meaning characteristics only studied meaning characteristics. The next cell to the right shows that 38.7% of the papers which studied meaning characteristics also studied timing characteristics.

Alcohol consumption and harm outcome measures

The included papers primarily examined the relationship between occasion characteristics and alcohol consumption (n=224; 80.6%). Far fewer papers examined specific acute harms such as unprotected sex (n=24; 8.6%) and drink driving (n=14; 5.0%) (Table 4). There were no papers on drinking in pregnancy or drowning and just one paper on self-harm (63). Alcohol consumption was most commonly measured using the number of drinks or another measure of consumption volume (n=171; 61.5%). Smaller numbers of papers used dichotomous measures of heavy drinking (i.e. whether participants exceeded consumption thresholds) (n=42; 15.1%), estimated or measured blood alcohol concentration (n=59; 21.2%) and subjective measures of intoxication (n=12; 4.3%). The most common measures of acute harm were aggregate measures such as the Rutgers Alcohol Problem Index (RAPI) (n=30; 10.8%), which includes harms like drink driving and getting into fights (64).

Table 4. Number of papers studying each consumption and alcohol-related acute harm outcome measure

Alcohol-related acute harm[1]	Number of papers with United States student populations	Number of papers with young adult populations [2]	Total number of papers (percentage of included studies)
Alcohol consumption	83	145	224 (80.6%)
Aggregate acute harm [3]	22	27	30 (10.8)
Condom use	10	19	24 (8.6)
Accidental injuries (fall injuries and other unintentional injuries) [4]	2	4	16 (5.8)
Drink driving and transport injuries	5	6	14 (5.0)
Victim of assault	5	10	13 (4.7)
Perpetrating assault	4	10	11 (4.0)
Sexual violence	5	6	9 (3.2)
Mental and behavioural disorders (acute intoxication, dependence syndrome, withdrawal, withdrawal with delirium, psychotic episode)	4	5	5 (1.8)
Criminal activity	2	3	3 (1.1)
Intimate partner violence	2	2	2 (0.7)
Intentional self-harm	0	0	1 (0.4)
Mechanical forces	0	0	0
Drinking in pregnancy	0	0	0
Drowning	0	0	0
Intentional self-poisoning with alcohol	0	0	0
Other intentional injury	0	0	0
Alcohol poisoning, undetermined intent	0	0	0
Accidental exposure to noxious substances	0	0	0

[1] Some studies fit into multiple categories (e.g. they studied two types of harm). In such instances, we used both characteristics to define the paper. [2] The number of papers using student and other young adult populations. [3] Aggregate measures of acute harm create a single measure of harm from several different harms. For example, a score for the number of harms experienced from a list might be used. [4] The total for this category includes papers on emergency department attendance and hospitalisation.

DISCUSSION

This novel comprehensive review identified a large evidence base (278 papers) examining associations between contextual characteristics of drinking occasions, alcohol consumption and acute alcohol-related harm. Despite this, few papers included a comprehensive set of occasion characteristics and many used methods that assume drinking occasions do not evolve over their duration. This suggests the literature as a

whole lacks a clear conception of drinking occasions - and therefore how to measure and analyse them. The available literature is also limited with regard to diversity of population studied. Almost half of the papers identified focused on students in the United States, which limits the generalisability of their findings.

Although most of the identified papers studied the relationship between contextual characteristics of drinking occasions and consumption, there is a growing literature studying acute harm outcomes. The included studies on specific alcohol-related harms largely focused on unprotected sex, drink driving and assault. Studying the links between these harms and occasion characteristics is important, as alcohol consumption alone does not explain alcohol-related harm (5,6). For example, drink driving is more likely after heavy drinking occasions in on-trade venues than in off-trade venues (60). Systematic reviews and meta-analyses of sections of the identified literature are needed to identify further findings of this nature and to inform future studies of the contextual characteristics of drinking occasions and acute alcohol-related harms. Potential areas for meta-analysis include the influence on consumption or acute harms of characteristics such as day of the week, time of day or venue type, which are consistently defined and widely studied in the available literature. The authors are beginning this process by conducting a systematic review to narratively synthesise the results of studies examining the occasion-level predictors of acute alcohol-related harm (PROSPERO ID: CRD42018119701).

To gain a full and robust understanding of the relationship between contextual characteristics of drinking occasions, alcohol consumption and acute alcohol-related harm, we require studies that comprehensively capture relevant characteristics. This review identified six categories of contextual characteristics studied by the literature - meaning, timing, venue, company, situation and drink type. Most papers measured only one or two of these characteristic types and much of the literature focuses on psychological constructs (e.g. mood or stress), time of day and day of the week, with less attention paid to reasons for drinking, drinking motives, the drinking of others and the evolution of drinking occasions over their duration. This lack of comprehensiveness may reflect that the literature also lacks systematically applied occasion-focused theoretical frameworks. Future research across the disparate research traditions covered in this review could benefit from applying theoretical frameworks since theory structures our understanding of research topics, methods and interpretation (28,29). For example, in the absence of theory, researchers may overlook the complexity of drinking occasions and focus on their topic of interest – neglecting interaction with and confounding by other features of occasions.

One approach to addressing the lack of theoretical frameworks is to use insights from theories of practice (30,65,66). Ally et al. (67) and Meier et al. (30) have described how this might offer new ways to understand the contextual complexity of drinking behaviour. Their description of drinking occasions as comprising multiple intersecting elements is informed by Shove et al. (68) who propose three core types of

elements - materials (e.g. glasses or a pub), competencies (e.g. round buying or managing appropriate intoxication levels), and meanings (e.g. relaxation) (68). Theories of practice therefore offer a holistic approach to conceptualising drinking occasions that can help researchers to identify key contextual characteristics to consider for inclusion in data collection and analyses. In contrast, the literature to date offers a much-reduced view of occasions, with only a small number of occasion characteristics (or elements) included within each study and no clear rationale offered for decisions on which characteristics are or are not included.

The types of contextual characteristics studied in the literature identified in the present review do not reflect a particular theoretical approach to understanding drinking occasions but can be mapped to Shove *et al's* elements of social practice (68). The contextual characteristics in the meaning category of our typology are also meanings as conceptualised by Shove *et al.* while venue, company, situation and drink type are measured as material elements, since respondents are asked to describe where, with whom and what they are drinking. The literature could further address meanings associated with these material factors. For example, most papers used material elements (such as drinking in a loud environment (9)) as predictors for their outcome of interest. However, they did not explore the meanings the respondent associated with these materials (such as associating 'time out' from typical social restrictions with drinking in bars (69,70)) which could mediate or moderate the observed associations with outcome measures. Of the three types of elements theorised by Shove, the literature particularly lacks studies of competencies. Just two papers studied competencies of round buying and none considered other relevant competencies, such as toasting, downing drinks or managing intoxication levels, which are routinely cited within the qualitative literature (71–73).

Another theoretical framework rooted in theories of practice is Southerton's five understandings of time – how frequently and when activities take place (periodicity), how long they take (duration), how fast they happen (tempo), what order they happen in (sequence) and what other activities are happening simultaneously (synchronisation) (30,74). Although occasion timing was often studied by the reviewed literature, it was mostly operationalised as time of day or day of the week (i.e. periodicity). These studies are more limited in considering duration, tempo, sequence or synchronisation of specific drinking occasions (74,75). Furthermore, most studies used methods that assumed that drinking occasions are static, such that they cannot assess change within drinking occasions (e.g. sequencing of venues).

This study is the first comprehensive review mapping the literature on contextual characteristics of drinking occasions. This is timely as there is increasing interest in using event-level methods to develop understanding of how context is associated with levels of consumption and acute alcohol-related harm (30,65,66). We have used a detailed, systematic search strategy to identify relevant papers and reviews of subsections of this literature. A comprehensive list of acute-alcohol related harms were used to identify

papers on harm outcomes (31,32). The main limitations of this review are that a single reviewer considered the studies, there was no validation of data extraction, and the construction of the search strategy was challenging since the concepts are ill defined and the literature heterogeneous. The first two limitations are less problematic for a mapping review than for a systematic review (76) and allowed the paper to provide an overview of a large volume of literature efficiently. The final limitation may reduce the comprehensiveness of our findings but the strengths listed above and the breadth of studies identified suggest we have minimised this problem.

Overall, the study of contextual characteristics of adults' drinking occasions and their association with levels of alcohol consumption and alcohol-related harm would benefit from the application of an event-level theoretical framework such as theories of practice. Particular characteristics of occasions that require further study in general population samples include people's reasons and motives for drinking and the presence of others who are drinking heavily. There is also a need for more research to focus on comprehensive sets of occasion characteristics and specific acute harm outcomes. Future research should conduct reviews and meta-analyses of well-studied areas (e.g. mood, drinking venue, time of the week and time of day) and develop theory-based primary evidence in under-researched areas, particularly competencies, temporalities and acute alcohol-related harm.

ACKNOWLEDGEMENTS

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5.2 Supplementary material

Table S1. Systematic search strategy

Concept	Search terms			
Alcohol consumption (.mp.) (TS & TI)	bing* adj3 (drink* or consum* or intoxicat*)	alcohol* adj3 (drink* or consum* or intoxicat* or related)	heavy adj3 drink* alcoholic beverage* alcohol-related	
Alcohol consumption MEDLINE	exp Alcohol Drinking/			
Alcohol consumption PsycInfo	exp Alcohol drinking attitudes/	exp Alcohol drinking patterns/ exp binge drinking/	exp drinking behavior/ exp social drinking/	
Event-level research (.af.) (TS & TI)	ema ecological momentary assessment experience sampling diary diaries event level event level drink* adj2 event* event-specific event specific event-contingent event contingent	referral event occasion-based occasion based drink* practi?e* practi?e theor* theor* of practi?e* element* adj2 practi?e* recent* adj2 occasion recent* adj2 occasions recent* adj2 event last adj2 occasion	last adj2 occasions last adj2 event barroom bar-room bar room experimental setting experimental condition icat phone adj assessment text message*	portal survey rhdo ivr interactive voice response daily survey* handheld assessment tool* daily retrospective daily process realtime real time real-time daily account*
Contextual characteristics (.mp.) (TS & TI)	cocaine crack cocaine cannabis hashish marijuana cannabinoids (tetrahydrocannabinol) heroin ecstasy XTC amphetamines speed GHB MDMA venue* location* barroom bar-room bar* home pub restaurant* street drink*	parent* beverage choice* beverage preference* beverage type* beverage-type* drink choice* drink type* drink-type wine* spirits beer* cider* alcopop* premixed pre-mixed pre mixed rtd* ready-to-drink* ready to drink* (flavoured alcoholic beverage*)	Tuesday* Wednesday* Thursday* Friday* Saturday* Sunday* weekend* week-end* week end start-time start time duration night-time night time day-time day time daytime meal time* meal-time* mealtime* drink* adj3 mood alcohol adj3 mood stress	social support (subjective intoxication) subjective effect* (subjective experience*) (perceived intoxication) occasion adj3 type (occasion adj3 reason) party adj3 type party adj3 reason social purpose (purpose adj3 occasion) year* holiday* birthday* semester* gender composition gender ratio

Concept	Search terms			
	nightclub club hotel tavern* bottle store* wine shop* shebeen* company companion* peer* friend* colleague* family partner wife husband spouse	(flavored alcoholic beverage*) drink* adj3 (motive* or motivation* or meaning* or expect?nc* or reason*) alcohol* adj3 (motive* or motivation* or meaning* or expect?nc* or reason*) day of the week Monday*	affect anxiety craving urge desire (pre-loading and alcohol) (pre-loading and drinking) (front-loading and alcohol) (front-loading and drinking) (drinking before drinking) intention* social interaction*	sex composition sex ratio male only female only mixed sex mixed gender football rugby rowing match day* sport* patron age patron sex patron ethnicity patron race drinking game*
Contextual characteristics – situation (.mp.) (TS & TI)	dancing crowd* buy* adj3 round* facilities lighting	atmosphere music volume loud	discount* offer* promotion* marketing	advertising BOGOF drink* adj3 free alcohol* adj3 free
Exclusions for: MEDLINE	Therapeutics/ Psychotherapy/	Intervention.ti.	Brief intervention.ab.	Effectiveness.ti.
PsycInfo	Treatment/ Psychotherapy/	Intervention.ti.	Brief intervention.ab.	Effectiveness.ti.
SSCI (TS & TI)	Intervention effectiveness			

The main search strategy was developed iteratively, with a scoping search used to identify key terms relating to three concepts: alcohol consumption, event-level research, and characteristics of drinking occasions. These were combined such that only records containing at least one term from each concept were identified.

Table S2. Summary of included papers

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
Abbey, 2001 (1)	Recall specific past event/s	Male students	United States	Not occasion consumption Sexual violence	Yes		Yes	Yes		
Aberg, 1993 (2)	Recall specific past event/s	Adult male	Sweden	Not occasion consumption Drink driving	Yes		Yes			
Ahmed, 2014 (3)	Recall specific past event/s	Students	United States	Not occasion consumption Requiring medical attention	Yes			Yes		
Aldridge-Gerry, 2011 (4)	Retrospective daily diary/ 24hr recall	Students	United States		Yes	Yes				
Andreuccetti, 2014 (5)	Recall specific past event/s	Alcohol-related A&E injured patients vs non-alcohol related controls	Latin American and Caribbean	Not occasion consumption Requiring medical attention				Yes		Yes
Armeli, 2000 (6)	Retrospective daily diary/ 24hr recall	General/healthy adult	United States		Yes					
Armeli, 2005 (7)	Retrospective daily diary/ 24hr recall	Students	United States		Yes	Yes				
Armeli, 2007 (8)	EMA	Risky drinkers	United States		Yes	Yes				
Armeli, 2010 (9)	Retrospective daily diary/ 24hr recall	Students	United States		Yes					
Babor, 1980 (10)	Experimental	General/healthy adult	United States				Yes		Yes	
Bacon, 2015 (11)	Experimental	Students	United States		Yes					
Bacon, 2018 (12)	Experimental	Students	United States		Yes		Yes			

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
Bae, 2017 (13)	EMA	Young adult heavy drinkers	United States			Yes			Yes	
Barry, 2013 (14)	Portal/ intercept survey[4]	Students	United States			Yes		Yes		
Barry, 2014 (15)	Portal/ intercept survey	General/healthy adult	United States			Yes				
Beech, 2014 (16)	Experimental	General/healthy adult	United States		Yes					
Bellis MA, 2010 (17)	Portal/ intercept survey	General/healthy adult	England			Yes		Yes	Yes	
Borsari, 2007 (18)	Recall specific past event/s	Mandated college students	United States		Yes			Yes	Yes	
Bourdeau, 2015 (19)	Portal/ intercept survey	General/healthy adult	United States		Yes		Yes		Yes	
Bourdeau, 2017 (20)	Portal/ intercept survey	General/healthy adult	United States	Sexual violence Victim of assault		Yes	Yes			
Boynton, 2014 (21)	Retrospective daily diary/ 24hr recall	General/healthy adult	United States		Yes	Yes				
Braitman, 2017 (22)	Diary	Students	United States	Aggregate measure of acute harm[3]	Yes		Yes	Yes		
Brister, 2011 (23)	Recall specific past event/s	Students	United States	Aggregate measure of acute harm		Yes	Yes	Yes	Yes	
Brown, 2007 (24)	Recall specific past event/s	Students	United States	Unprotected sex			Yes			
Brown, 2016 (25)	Recall specific past event/s	Young women	United States	Not occasion consumption Unprotected sex	Yes		Yes			
Bryan, 2017 (26)	Diary	Adult female	United States	Not occasion consumption Unprotected sex	Yes		Yes			
Buettner CK, 2011 (27)	Diary	Students	United States	Aggregate measure of acute harm	Yes			Yes		

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
Butler, 2010 (28)	Retrospective daily diary/ 24hr recall	Students	United States		Yes	Yes				
Byrnes, 2014 (29)	Field studies Portal/ intercept survey	General/healthy adult	United States			Yes			Yes	
Callaghan, 2014 (30)	Routine data	Young adults	Canada	Not occasion consumption Dependence syndrome		Yes				
Callinan, 2014 (31)	Recall specific past event/s	General/healthy adult	Australia					Yes		Yes
Carlini, 2014 (32)	Portal/ intercept survey Field studies	General/healthy adult	Brazil					Yes	Yes	
Carney, 2000 (33)	Retrospective daily diary/ 24hr recall	General/healthy adult	United States		Yes					
Caudill, 1975 (34)	Experimental	Male students who are risky drinkers	United States		Yes		Yes			
Caudill, 2001 (35)	Experimental	Risky drinkers	United States		Yes		Yes			
Champion, 2009 (36)	Diary	Students	United States	Aggregate measure of acute harm		Yes				
Cherpitel, 1998 (37)	Retrospective daily diary/ 24hr recall	Experienced a skiing injury vs controls	United States	Not occasion consumption Other unintentional injuries (skiing injuries)		Yes				
Cherpitel, 1999 (38)	Recall specific past event/s	A&E patients	Canada	Not occasion consumption Requiring medical attention	Yes	Yes			Yes	
Cherpitel, 2012 (39)	Recall specific past event/s	A&E patients	Canada	Not occasion consumption Requiring medical attention					Yes	
Clapp, 2000 (40)	Recall specific past event/s	Students	United States	Not occasion consumption Aggregate measure of acute harm	Yes		Yes	Yes	Yes	

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
Clapp, 2001 (41)	Recall specific past event/s	Students	United States		Yes		Yes	Yes	Yes	Yes
Clapp, 2003 (42)	Recall specific past event/s	Students	United States		Yes			Yes	Yes	
Clapp, 2006 (43)	Recall specific past event/s	Students	United States					Yes	Yes	
Clapp, 2008 (44)	Recall specific past event/s Field studies	Students	United States	Injuries Aggregate measure of acute harm Aggression Rode with a drunk driver	Yes				Yes	
Clapp, 2008 (45)	Field studies	Students	United States		Yes	Yes	Yes	Yes	Yes	Yes
Clapp, 2009 (46)	Portal/ intercept survey Field studies	General/healthy adult	United States		Yes	Yes	Yes	Yes	Yes	
Clapp, 2014 (47)	Field studies	Students	United States	Not occasion consumption Aggregate measure of acute harm		Yes		Yes	Yes	
Clapp, 2017 (48)	EMA	Students	United States		Yes	Yes				
Colby, 2004 (49)	Experimental	Young smokers and risky drinkers	United States		Yes					
Collins, 1985 (50)	Experimental	Male students who are risky drinkers	United States		Yes		Yes			
Collins, 2007 (51)	Recall specific past event/s	Young women who were involved in an aggressive incident in a bar	United States	Not occasion consumption Perpetrating assault Victim of assault	Yes		Yes		Yes	
Collins, 2018 (52)	Experimental	Students	Canada		Yes					

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
Connor, 2014 (53)	Diary	Students	New Zealand	Not occasion consumption Aggregate measure of acute harm	Yes	Yes	Yes	Yes		
Corbin, 2008 (54)	Experimental	Students	United States		Yes					
Cotti, 2014 (55)	Recall specific past event/s	Risky drinkers	United States	Not occasion consumption Drink driving				Yes		Yes
Cousins, 2010 (56)	Recall specific past event/s	Young adults	Ireland	Not occasion consumption Unprotected sex	Yes		Yes			
Croff, 2017 (57)	Field studies	Students	United States		Yes	Yes			Yes	Yes
Cullum, 2010 (58)	Retrospective daily diary/ 24hr recall	Students	United States				Yes			
Cullum, 2012 (59)	Retrospective daily diary/ 24hr recall	Students	United States		Yes		Yes			
de Castro, 1990 (60)	Retrospective daily diary/ 24hr recall	General/healthy adult	United States		Yes	Yes	Yes		Yes	
de Castro, 2004 (61)	Retrospective daily diary/ 24hr recall	General/healthy adult	United States			Yes				
Dehart, 2008 (62)	Retrospective daily diary/ 24hr recall	Risky drinkers	United States		Yes					
DeHart, 2009 (63)	Retrospective daily diary/ 24hr recall	Students	United States		Yes	Yes	Yes			
Diep, 2016 (64)	Recall specific past event/s	Students	Vietnam		Yes	Yes	Yes	Yes	Yes	
Dietze, 2017 (65)	Recall specific past event/s	Young adult heavy drinkers	Australia			Yes		Yes		Yes
Dinc, 2015 (66)	Experimental	Students	England		Yes					

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
Dodd, 2012 (67)	Portal/ intercept survey	General/healthy adult	United States		Yes	Yes		Yes		
Dumas, 2014 (68)	Portal/ intercept survey	Young adults	Canada				Yes			
Durbeej, 2017 (69)	Portal/ intercept survey	General/healthy adult	Sweden		Yes	Yes		Yes		
Dvorak, 2014 (70)	EMA	Students	United States	Dependence syndrome	Yes	Yes				
Dvorak, 2014 (71)	EMA	Student risky drinkers	United States		Yes					
Dvorak, 2016 (72)	EMA	Students	United States	Dependence syndrome	Yes					
Engels, 2012 (73)	Experimental	Young adults	The Netherlands						Yes	
Fairbairn, 2018 (74)	EMA Experimental	Risky drinkers	United States		Yes	Yes	Yes	Yes		
Fairlie, 2015 (75)	Retrospective daily diary/ 24hr recall	Students	United States					Yes	Yes	
Fairlie, 2018 (76)	Recall specific past event/s	Young adults	United States	Not occasion consumption Unprotected sex					Yes	
Fazzino, 2013 (77)	Retrospective daily diary/ 24hr recall	Risky drinkers	United States		Yes	Yes				
Fiala, 2017 (78)	Diary	General/healthy adult	Czech Republic			Yes				Yes
Field, 2017 (79)	Experimental	Risky drinkers	England		Yes					
Fillo, 2017 (80)	Recall specific past event/s	Students	United States	Not occasion consumption Aggregate measure of acute harm			Yes			
Ford, 2017 (81)	Recall specific past event/s	Female students	United States	Not occasion consumption Sexual violence	Yes			Yes		
Foster, 2011 (82)	Recall specific past event/s	Students	United States	Consuming more than on a typical Saturday night	Yes	Yes				

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
Foster, 2015 (83)	Diary Routine data	Young men	Switzerland	Transport injuries (inc RTA)		Yes				
Fromme, 2010 (84)	Retrospective daily diary/ 24hr recall	Students	United States	Drink driving		Yes				
Geisner, 2017 (85)	Recall specific past event/s	Students	United States	Aggregate measure of acute harm	Yes	Yes				
Giraldo, 2017 (86)	Field studies	General/healthy adult	United States		Yes					
Giraldo, 2017 (87)	Field studies	General/healthy adult	United States		Yes				Yes	
Gmel, 2005 (88)	EMA Routine data	General/healthy adult	Switzerland	Not occasion consumption Transport injuries (inc RTA)		Yes		Yes		
Goldstein, 2014 (89)	EMA	Young adults	Canada		Yes					
Goodman, 2017 (90)	EMA	Students	United States		Yes	Yes				
Graham, 2014 (91)	Portal/ intercept survey	Young women	Canada	Not occasion consumption Sexual violence	Yes		Yes	Yes		
Grant, 2009 (92)	Retrospective daily diary/ 24hr recall	Students	Canada	Depressed and anxious drinking	Yes					
Greene, 2018 (93)	Retrospective daily diary/ 24hr recall	Students	United States	Aggregate measure of acute harm		Yes				
Griffin, 1987 (94)	Retrospective daily diary/ 24hr recall	Female marijuana users	United States		Yes					
Griffin, 2017 (95)	Routine data	General/healthy adult	Ireland	Not occasion consumption Intentional self harm		Yes				
Groefsema, 2016 (96)	EMA	Young adults	The Netherlands			Yes	Yes			
Groefsema, 2018 (97)	EMA	Young adults	The Netherlands			Yes				

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
Gruenewald, 1999 (98)	Recall specific past event/s	Drivers who experienced crashes	Australia	Not occasion consumption Drink driving				Yes		
Grzywacz, 2008 (99)	Retrospective daily diary/ 24hr recall	General/healthy adult	United States		Yes					
Gullo, 2017 (100)	Experimental	Young adults	Australia		Yes		Yes			
Gunn, 2018 (101)	Diary	Students	United States	Aggregate measure of acute harm		Yes			Yes	
Guéguen, 2004 (102)	Experimental Field studies	General/healthy adult	France						Yes	
Guéguen, 2008 (103)	Experimental Field studies	Adult male	France						Yes	
Hamilton, 2017 (104)	Experimental Retrospective daily diary/ 24hr recall	Students	United States		Yes		Yes			
Harford, 1983 (105)	Recall specific past event/s	General/healthy adult	United States				Yes	Yes		
Heeb, 2008 (106)	Diary	General/healthy adult	Switzerland			Yes				
Helzer, 2006 (107)	Retrospective daily diary/ 24hr recall	At risk male drinkers	United States		Yes	Yes				
Higgins, 1975 (108)	Experimental	Male students who are risky drinkers	United States		Yes					
Howard, 2015 (109)	Retrospective daily diary/ 24hr recall	Students	United States		Yes	Yes				
Howells, 2014 (110)	Recall specific past event/s	Female students	United States	Not occasion consumption Unprotected sex	Yes					

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
Huh, 2015 (111)	Retrospective daily diary/ 24hr recall	Female students	United States			Yes				
Hummer, 2013 (112)	Recall specific past event/s	Student risky drinkers	United States	Aggregate measure of acute harm			Yes	Yes	Yes	
Jih CS, 1995 (113)	Recall specific past event/s	Students	United States			Yes				
Jones, 2007 (114)	Retrospective daily diary/ 24hr recall	General/healthy adult	England		Yes					
Jones, 2013 (115)	Experimental	Risky drinkers	England		Yes			Yes		
Jones, 2016 (116)	Experimental	Students	England		Yes	Yes				
Jones, 2018 (117)	EMA	Risky drinkers	England		Yes					
Joyce, 2017 (118)	Retrospective daily diary/ 24hr recall EMA	Adult female	Canada		Yes	Yes				
Jula, 1999 (119)	Retrospective daily diary/ 24hr recall	General/healthy adult	Finland			Yes				
Kenney, 2014 (120)	Recall specific past event/s	Students	United States	Not occasion consumption Aggregate measure of acute harm					Yes	
Kerr, 2015 (121)	Retrospective daily diary/ 24hr recall	Students	United States	Not occasion consumption Unprotected sex	Yes	Yes	Yes		Yes	
Khurana, 2015 (122)	Recall specific past event/s	Students	United States	Aggregate measure of acute harm		Yes	Yes			
Kidorf, 1999 (123)	Experimental	Students	United States		Yes					

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
Kiene, 2009 (124)	Retrospective daily diary/ 24hr recall	Students	United States	Not occasion consumption Unprotected sex	Yes		Yes			
Kiene, 2013 (125)	Recall specific past event/s	General/healthy adult	sub-Saharan Africa	Not occasion consumption Unprotected sex	Yes		Yes			
Kilwein, 2018 (126)	Diary	Students	United States	Not occasion consumption Unprotected sex Sexual violence	Yes					
Knibbe, 1993 (127)	Field studies	Young adults	The Netherlands		Yes		Yes	Yes	Yes	
Kraft, 1991 (128)	Recall specific past event/s	Young adults	Norway	Not occasion consumption Unprotected sex			Yes			
Kuendig, 2011 (129)	Experimental	Students	Switzerland			Yes	Yes			
Kuendig, 2013 (130)	Experimental	Young adults	Switzerland				Yes			
Kuntsche, 2010 (131)	Retrospective daily diary/ 24hr recall	Young adults	Switzerland			Yes				
Kuntsche, 2012 (132)	EMA	Students	Switzerland			Yes				
Kuntsche, 2012 (133)	Experimental	Young adults	Switzerland				Yes			
Kuntsche, 2013 (134)	EMA	Students	Switzerland	Aggregate measure of acute harm					Yes	
Kuntsche, 2015 (135)	EMA	Students	Switzerland	Aggregate measure of acute harm		Yes	Yes	Yes		
Kushnir, 2014 (136)	Diary	General/healthy adult	Canada			Yes				
Kypri, 2007 (137)	Diary	Students	New Zealand						Yes	
Kypri, 2010 (138)	Diary	Students	New Zealand			Yes			Yes	

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
LaBrie, 2008 (139)	Recall specific past event/s	Students	United States	Aggregate measure of acute harm				Yes		
Labhart, 2013 (140)	EMA	Young adults	Switzerland	Aggregate measure of acute harm		Yes		Yes		
Labhart, 2014 (141)	EMA	Students	Switzerland			Yes				
Labhart, 2014 (142)	EMA	Students	Switzerland			Yes	Yes	Yes		Yes
Labhart, 2017 (143)	EMA	Young adults	Switzerland, Lausanne and Zurich			Yes	Yes	Yes		
Lam, 2014 (144)	Recall specific past event/s	Young adults	Australia	Unprotected sex Injuries Perpetrating assault Criminal activity (e.g. theft, vandalism)	Yes	Yes				
Lam, 2017 (145)	Recall specific past event/s	Young adult heavy drinkers	Australia			Yes			Yes	
Lang, 1995 (146)	Recall specific past event/s	General/healthy adult	Australia	Aggregate measure of acute harm	Yes		Yes	Yes	Yes	
Larsen, 2009 (147)	Experimental	Young adults	The Netherlands		Yes			Yes		
Larsen, 2010 (148)	Experimental	Young adults	The Netherlands					Yes		
Larsen, 2012 (149)	Experimental	Students	The Netherlands					Yes		
Lau-Barraco, 2018 (150)	Retrospective daily diary/ 24hr recall	Young adults	United States	Aggregate measure of acute harm	Yes					
Laws, 2017 (151)	Retrospective daily diary/ 24hr recall	General/healthy adult	United States		Yes	Yes				

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
Leigh, 2008 (152)	Retrospective daily diary/ 24hr recall	Students	United States	Not occasion consumption Unprotected sex	Yes		Yes			
Leonard, 2003 (153)	Recall specific past event/s	Young men who were involved in an aggressive incident in a bar	United States	Perpetrating assault Victim of assault Aggression severity Injury to opponent	Yes		Yes		Yes	
Lewis, 2009 (154)	Diary	Students	United States	Aggregate measure of acute harm		Yes				
Lewis, 2010 (155)	Recall specific past event/s	Students	United States	Not occasion consumption Unprotected sex			Yes			
Liang, 2015 (156)	Retrospective daily diary/ 24hr recall	General/healthy adult	United States			Yes				
Linden-Carmichael, 2018 (157)	Retrospective daily diary/ 24hr recall	Students	United States	Not occasion consumption Acute intoxication	Yes	Yes				
Lopes, 2008 (158)	Diary	Over 40s	Portugal			Yes				
Lubman, 2014 (159)	Portal/ intercept survey	Young adults	Australia	Aggression Unprotected sex Injuries	Yes	Yes			Yes	
MacKillop, 2006 (160)	Experimental	Student risky drinkers	United States		Yes					
Madden, 2019 (161)	Recall specific past event/s	Students	United States	Aggregate measure of acute harm				Yes		
Makela, 2005 (162)	Diary Routine data	General/healthy adult	Finland	Not occasion consumption Intoxication-related death		Yes				
Mallett, 2017 (163)	Diary	Students	United States	Not occasion consumption Aggregate measure of acute harm		Yes			Yes	

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
Martel, 2017 (164)	Retrospective daily diary/ 24hr recall	Female students	United States		Yes	Yes				
Marzell, 2015 (165)	Recall specific past event/s	Students	United States		Yes	Yes		Yes	Yes	
McCabe, 2013 (166)	Retrospective daily diary/ 24hr recall	Students	United States		Yes	Yes				
McClatchley, 2014 (167)	Portal/ intercept survey	General/healthy adult	England		Yes		Yes	Yes	Yes	
McGrath, 2016 (168)	Experimental	Uni students and staff	England		Yes					
McKetin, 2014 (169)	Recall specific past event/s	Young adults	Australia					Yes		
McKetin, 2014 (170)	Recall specific past event/s	Young adults	Australia						Yes	
McLean, 2009 (171)	Recall specific past event/s	Alcohol-related A&E injured patients vs non-alcohol related controls	New Zealand	Requiring medical attention	Yes			Yes		
Merrill, 2017 (172)	Diary	Students	United States	Not occasion consumption Aggregate measure of acute harm		Yes				
Mihic, 2009 (173)	Recall specific past event/s	Students	Canada	Not occasion consumption Aggression	Yes		Yes	Yes	Yes	
Miller, 2015 (174)	Portal/ intercept survey	Alcohol-related A&E injured patients	Australia	Not occasion consumption Requiring medical attention		Yes		Yes		

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
Miller, 2016 (175)	Recall specific past event/s	Mandated college students	United States					Yes		
Mohr, 2001 (176)	EMA Retrospective daily diary/ 24hr recall	Risky drinkers	United States		Yes	Yes				
Mohr, 2005 (177)	Retrospective daily diary/ 24hr recall	Students	United States		Yes		Yes			
Mohr, 2015 (178)	EMA	Risky drinkers	United States		Yes	Yes				
Mustonen, 2016 (179)	Diary	General/healthy adult	Finland		Yes	Yes	Yes	Yes		
Naimi, 2007 (180)	Recall specific past event/s	Risky drinkers	United States	Drink driving				Yes		Yes
Neal, 2005 (181)	Retrospective daily diary/ 24hr recall	Students	United States			Yes				
Neighbors, 2014 (182)	Recall specific past event/s	Students	United States	Aggregate measure of acute harm Unprotected sex Sexual violence Drink driving Aggression Criminal activity (e.g. theft, vandalism)				Yes	Yes	
Nesic, 2006 (183)	Experimental	Risky drinkers	England		Yes					
O'Callaghan, 1992 (184)	Retrospective daily diary/ 24hr recall	Students	Australia		Yes					

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
O'Grady, 2011 (185)	Retrospective daily diary/ 24hr recall	Students	United States		Yes	Yes	Yes			
O'Grady, 2011 (186)	Retrospective daily diary/ 24hr recall	Students	United States		Yes					
O'Grady, 2012 (187)	Retrospective daily diary/ 24hr recall	General/healthy adult	United States		Yes	Yes	Yes			
O'Hara, 2014 (188)	Retrospective daily diary/ 24hr recall	Students	United States		Yes	Yes				
O'Hara, 2014 (189)	Retrospective daily diary/ 24hr recall	African american students	United States		Yes	Yes				
O'Hara, 2015 (190)	Retrospective daily diary/ 24hr recall	African american students	United States		Yes	Yes				
Ogeil, 2016 (191)	Recall specific past event/s	Young adult heavy drinkers	Australia		Yes			Yes	Yes	
Ostergaard, 2014 (192)	Field studies	Young adults	United Kingdom		Yes	Yes		Yes		
Ostergaard, 2014 (193)	Field studies Retrospective daily diary/ 24hr recall	Young adults	England and Denmark			Yes		Yes		
Otten, 2014 (194)	Experimental	Students	The Netherlands		Yes					
Palfai, 2000 (195)	Experimental	Smoking risky drinkers	United States		Yes					
Palfai, 2001 (196)	Experimental	Young adult heavy drinkers	United States		Yes					
Palfai, 2006 (197)	Experimental	Young adult heavy drinkers	United States		Yes					

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
Park, 2004 (198)	Retrospective daily diary/ 24hr recall	Students	United States		Yes					
Parks, 2000 (199)	Retrospective daily diary/ 24hr recall	Adult female	United States	Not occasion consumption Victim of assault Sexual violence	Yes	Yes	Yes	Yes	Yes	
Parks, 2011 (200)	Retrospective daily diary/ 24hr recall	Young women	United States	Not occasion consumption Unprotected sex		Yes				
Parks, 2012 (201)	Retrospective daily diary/ 24hr recall	Young women	United States	Not occasion consumption Unprotected sex			Yes		Yes	
Paschall MJ, 2007 (202)	Recall specific past event/s	Students	United States		Yes	Yes		Yes		
Patrick, 2016 (203)	EMA	Students	United States	Aggregate measure of acute harm	Yes	Yes	Yes	Yes		
Peacock, 2015 (204)	EMA	Young adults	Australia		Yes					
Peltz, 2017 (205)	Retrospective daily diary/ 24hr recall	Young adults	United States		Yes	Yes				
Pennay, 2015 (206)	Portal/ intercept survey	General/healthy adult	Australia			Yes		Yes	Yes	Yes
Perrine, 2004 (207)	Retrospective daily diary/ 24hr recall	General/healthy adult	United States		Yes	Yes				
Piasecki, 2014 (208)	EMA	General/healthy adult	United States			Yes				
Quigg Z, 2013 (209)	Portal/ intercept survey	Students	United Kingdom		Yes	Yes		Yes	Yes	
Quinn, 2011 (210)	Retrospective daily diary/ 24hr recall	Students	United States	Not occasion consumption Unprotected sex Aggregate measure of acute harm	Yes	Yes				

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
				Aggression Criminal activity (e.g. theft, vandalism)						
Quinn, 2012 (211)	Retrospective daily diary/ 24hr recall	Students	United States	Not occasion consumption Drink driving	Yes	Yes				
Ragsdale, 2012 (212)	Field studies	Female students	United States	Rode with a drunk driver		Yes				
Ray, 2010 (213)	EMA	Risky drinkers	United States		Yes					
Reed, 2011 (214)	Portal/ intercept survey	General/healthy adult	United States		Yes	Yes		Yes		
Riley, 2018 (215)	Retrospective daily diary/ 24hr recall	Students	United States		Yes					
Riordan, 2015 (216)	Retrospective daily diary/ 24hr recall Diary	Students	New Zealand			Yes				
Robinson, 2016 (217)	Experimental	Students	England		Yes		Yes			
Rodriguez, 2016 (218)	Recall specific past event/s	Students	United States				Yes	Yes		
Rossheim, 2011 (219)	Portal/ intercept survey	General/healthy adult	United States			Yes				Yes
Rowland, 2012 (220)	Diary	General/healthy adult	Australia			Yes				
Russell, 2017 (221)	Retrospective daily diary/ 24hr recall	Students	United States		Yes	Yes				
Sacco, 2015 (222)	Retrospective daily diary/ 24hr recall	Older adults	United States		Yes					
Samoluk, 1996 (223)	Experimental	General/healthy adult	Canada		Yes					

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
Santos, 2015 (224)	Portal/ intercept survey	General/healthy adult	Brazil	Sexual violence Perpetrating assault Victim of assault				Yes		
Santos, 2015 (225)	Portal/ intercept survey	General/healthy adult	Brazil					Yes		
Schroder, 2007 (226)	Retrospective daily diary/ 24hr recall	General/healthy adult	United States		Yes	Yes				
Schroder, 2009 (227)	EMA	Students	United States	Not occasion consumption Unprotected sex	Yes					
Searles, 1995 (228)	Retrospective daily diary/ 24hr recall	Adult male	United States	Aggregate measure of acute harm Drink driving		Yes		Yes		
Shorey, 2014 (229)	Retrospective daily diary/ 24hr recall	Female students	United States	Not occasion consumption Intimate partner violence	Yes				Yes	
Shorey, 2016 (230)	Retrospective daily diary/ 24hr recall	Female students	United States	Not occasion consumption Intimate partner violence Sexual violence				Yes	Yes	
Simons, 2010 (231)	EMA	Students	United States	Dependence syndrome	Yes	Yes				
Simons, 2014 (232)	EMA	Students	United States	Dependence syndrome	Yes	Yes				
Simons, 2016 (233)	EMA	Students	United States	Not occasion consumption Perpetrating assault	Yes	Yes				
Simons, 2018 (234)	EMA	Young adults	United States	Not occasion consumption Unprotected sex			Yes			
Smit, 2015 (235)	EMA Retrospective daily diary/ 24hr recall	Young adults	The Netherlands				Yes			
Steptoe, 1999 (236)	Retrospective daily diary/ 24hr recall	General/healthy adult	England		Yes					

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
Stevens, 2017 (237)	Retrospective daily diary/ 24hr recall	Young adult heavy drinkers	United States		Yes	Yes				
Stockwell, 1993 (238)	Recall specific past event/s	General/healthy adult	Australia	Aggregate measure of acute harm				Yes	Yes	
Strickler, 1979 (239)	Experimental Field studies	Male students who are risky drinkers	United States					Yes	Yes	
Swendsen, 2000 (240)	EMA	General/healthy adult	United States		Yes					
Temple, 1992 (241)	Recall specific past event/s	General/healthy adult	United States	Not occasion consumption Unprotected sex	Yes		Yes			
Temple, 1993 (242)	Recall specific past event/s	General/healthy adult	United States	Unprotected sex	Yes		Yes			
Thomas, 2014 (243)	Experimental	General/healthy adult	United States		Yes					
Thombs, 2008 (244)	Portal/ intercept survey	Students	United States			Yes			Yes	
Thombs, 2009 (245)	Field studies	Students	United States			Yes				
Thombs, 2009 (246)	Portal/ intercept survey	Students	United States						Yes	
Thombs, 2009 (247)	Portal/ intercept survey	Students	United States			Yes			Yes	
Thombs, 2011 (248)	Portal/ intercept survey	General/healthy adult	United States			Yes				Yes
Thombs, 2011 (249)	Portal/ intercept survey	Students	United States			Yes			Yes	
Thrul, 2015 (250)	EMA	Students	Switzerland			Yes	Yes			
Thrul, 2016 (251)	EMA	Students	Switzerland			Yes	Yes			
Thrul, 2017 (252)	EMA	Students	Switzerland			Yes	Yes			

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
Todd, 2003 (253)	EMA	General/healthy adult	United States		Yes					
Todkill, 2016 (254)	Routine data	General/healthy adult	England	Not occasion consumption Emergency department attendance		Yes				
Torronen, 2016 (255)	Recall specific past event/s	General/healthy adult	Finland		Yes					
Treaeen, 2003 (256)	Recall specific past event/s	General/healthy adult	European countries	Not occasion consumption Unprotected sex			Yes			
Tremblay, 2010 (257)	Diary	Students	Canada			Yes				
Vallance, 2016 (258)	Recall specific past event/s	Drug using population	Canada						Yes	
van de Goor, 1990 (259)	Field studies	Young adults	The Netherlands		Yes		Yes	Yes	Yes	
Wagner, 2017 (260)	Portal/ intercept survey	People who drove to the nightclub	Brazil	Drink driving					Yes	
Walmsley, 1998 (261)	Retrospective daily diary/ 24hr recall	Older adults	Britain							Yes
Wardell, 2012 (262)	Experimental	Students	United States		Yes					
Watt, 2004 (263)	Recall specific past event/s	Alcohol-related A&E injured patients vs population controls	Australia	Requiring medical attention					Yes	Yes
Watt, 2006 (264)	Portal/ intercept survey	Alcohol-related A&E injured patients vs non-alcohol	Australia	Not occasion consumption Injury severity				Yes	Yes	Yes

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
		related controls								
Wei, 2010 (265)	Recall specific past event/s	Students	United States		Yes					
Wells, 2008 (266)	Recall specific past event/s	Students	Canada	Not occasion consumption Aggression	Yes	Yes	Yes	Yes	Yes	
Wells, 2015 (267)	Portal/ intercept survey	Young adults	Canada			Yes	Yes	Yes		
Wetherill, 2009 (268)	Recall specific past event/s	Students	United States		Yes	Yes				
Wigmore, 1991 (269)	Experimental Field studies	Male students who are risky drinkers	Canada		Yes			Yes		Yes
Williams, 2011 (270)	Recall specific past event/s Diary	Alcohol-related A&E injured patients	Australia	Not occasion consumption Requiring medical attention			Yes	Yes	Yes	
Witkiewitz, 2012 (271)	EMA	Student smokers	United States			Yes				
Wolfe, 2000 (272)	Experimental	Students	United States		Yes					
Wood, 2007 (273)	Diary Routine data	Students	United States			Yes				
Wymond, 2016 (274)	Retrospective daily diary/ 24hr recall	General/healthy adult	Australia			Yes				Yes
Yao, 2018 (275)	Field studies	Drivers who experienced crashes vs control drivers	United States	Transport injuries (inc RTA) Drink driving		Yes				
Yurasek, 2016 (276)	Recall specific past event/s	Mandated college students	United States			Yes		Yes		

First author, year	Design	Population	Country[1]	Outcomes[2]	Meaning	Timing	Company	Venue	Situation	Drink type
Zamboanga, 2013 (277)	Recall specific past event/s	Students	United States		Yes			Yes		
Zaso, 2017 (278)	Experimental	Young adult heavy drinkers	United States		Yes		Yes			

[1] Not all papers report national-level studies. Sub-national information on the location of participants was not extracted. [2] Papers which do not include a measure of consumption in the occasion as an outcome have the text "Not occasion consumption" in the outcome column as most papers include a measure of this. [3] Aggregate measures of acute harm create a single measure of harm from several different harms. For example, a score for the number of harms experienced from a list might be used. [4] Portal/ intercept surveys recruit participants as they enter or leave drinking venues, or intercept them on the street.

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Table S3. Study characteristics which applied to at least five papers by year of publication

	Study characteristics [1]	Total number of papers (percentage[2]) 1975 - 1989	Total number of papers (percentage) 1990 - 1999	Total number of papers (percentage) 2000 - 2009	Total number of papers (percentage) 2010 - 2019
Theoretical approach	None	5 (71.4)	17 (81.0)	49 (71.0)	132 (72.9)
	Motivational models	0	0	5 (7.2)	12 (6.6)
	Tension-reduction models	1 (14.3)	2 (9.5)	0	3 (1.7)
	Social learning theory	1 (14.3)	0	1 (1.4)	3 (1.7)
Design	Daily drinking diary/ 24 hour recall	1 (14.3)	7 (33.3)	19 (27.5)	43 (23.8)
	Single occasion recall	1 (14.3)	9 (42.9)	19 (27.5)	37 (20.4)
	Experimental	5 (71.4)	3 (14.3)	12 (17.4)	23 (12.7)
	Ecological momentary assessment	0	0	6 (8.7)	33 (18.2)
	Portal/ intercept survey	0	0	5 (7.2)	24 (13.3)
	Retrospective drinking diary	0	0	7 (10.1)	17 (9.4)
	Field studies	1 (14.3)	3 (14.3)	6 (8.7)	10 (5.5)
Country	United States	7 (100.0)	7 (33.3)	52 (75.4)	104 (57.5)
	Australia	0	4 (19.0)	2 (2.9)	15 (8.3)
	Canada	0	3 (14.3)	3 (4.3)	11 (6.1)
	Switzerland	0	0	2 (2.9)	15 (8.3)
	England	0	1 (4.8)	2 (2.9)	11 (6.1)
	The Netherlands	0	2 (9.5)	1 (1.4)	7 (3.9)
	New Zealand	0	0	2 (2.9)	3 (1.7)
Population	Students	4 (57.1)	4 (19.0)	34 (49.3)	91 (50.3)
	Adults	3 (42.9)	14 (66.7)	29 (42.0)	52 (28.7)
	Non-student young adults	0	3 (14.3)	6 (8.7)	38 (21.0)
	Risky drinkers	4 (57.1)	1 (4.8)	12 (17.4)	16 (8.8)
	Experienced a specific harm [3]	0	3 (14.3)	6 (8.7)	7 (3.9)

[1] Some studies fit into multiple categories (e.g. they were conducted in two countries or they used both daily diary and single occasion recall methods). In such instances, we used both characteristics to define the paper. [2] Percentage of the papers published in the relevant years. This is 7 papers from 1975 – 1989, 21 from 1990 – 1995, 69 from 2000 – 2009 and 181 from 2010 – 2019. [3] For example, recruiting injured patients in accident and emergency departments.

Table S4. Contextual characteristics measured by at least five papers by year of publication

	Contextual characteristics [1]	Total number of papers (percentage[2]) 1975 - 1989	Total number of papers (percentage) 1990 - 1999	Total number of papers (percentage) 2000 - 2009	Total number of papers (percentage) 2010 - 2019
Meaning	Affect/ mood	1 (14.3)	2 (9.5)	18 (26.1)	29 (16.0)
	Anxiety/ stress	1 (14.3)	2 (9.5)	9 (13.0)	7 (3.9)
	Intentions	0	0	2 (2.9)	16 (8.8)
	Subjective intoxication	0	1 (4.8)	4 (5.8)	13 (7.2)
	Social support/interactions	2 (28.6)	0	7 (10.1)	7 (3.9)
	Reasons	0	0	8 (11.6)	7 (3.9)
	Craving	0	0	6 (8.7)	8 (4.4)
	Motives	0	1 (4.8)	1 (1.4)	11 (6.1)
	Alcohol cue exposure	0	0	5 (7.2)	3 (1.7)
Timing	Day of the week	0	3 (14.3)	16 (23.2)	62 (34.3)
	Time of day	0	2 (9.5)	4 (5.8)	32 (17.7)
	Duration	0	0	6 (8.7)	18 (9.9)
	Other timing (e.g. year)	0	1 (4.8)	2 (2.9)	20 (11.0)
	Specific/special occasions	0	1 (4.8)	4 (5.8)	16 (8.8)
	Sport-related	1 (14.3)	0	3 (4.3)	4 (2.2)
Company	Number of people	2 (28.6)	5 (23.8)	4 (5.8)	25 (13.8)
	Type of people	1 (14.3)	4 (19.0)	11 (15.9)	19 (10.5)
	Drunk people	2 (28.6)	1 (4.8)	4 (5.8)	13 (7.2)
	Gender composition	0	3 (14.3)	1 (1.4)	11 (6.1)
	Length of relationship	0	1 (4.8)	4 (5.8)	3 (1.7)
Venue	Venue type	2 (28.6)	7 (33.3)	12 (17.4)	23 (12.7)
	Pre-drinking	0	0	4 (5.8)	26 (14.4)
	On-trade versus off-trade premises	0	0	5 (7.2)	12 (6.6)
	Number of venues	0	0	2 (2.9)	6 (3.3)
Situation	Illicit drugs used	0	1 (4.8)	6 (8.7)	16 (8.8)
	Other on-trade venue factors	1 (14.3)	3 (14.3)	8 (11.6)	9 (5.0)
	Off-trade occasion features (e.g. drinking games)	0	0	8 (11.6)	8 (4.4)
	Commercial factors (e.g. discounting)	1 (14.3)	1 (4.8)	4 (5.8)	6 (3.3)

	Illicit drugs available	0	0	5 (7.2)	3 (1.7)
	Crowding	0	2 (9.5)	2 (2.9)	4 (2.2)
	Food available	0	0	6 (8.7)	2 (1.1)
	Ate food	0	2 (9.5)	2 (2.9)	3 (1.7)
	Number of drunk people	0	0	5 (7.2)	0
Drink type	What drink types	0	1 (4.8)	5 (7.2)	10 (5.5)

[1] Some studies fit into multiple categories (e.g. they were conducted in two countries or they used both daily diary and single occasion recall methods). In such instances, we used both characteristics to define the paper. [2] Percentage of the papers published in the relevant years. This is 7 papers from 1975 – 1989, 21 from 1990 – 1995, 69 from 2000 – 2009 and 181 from 2010 – 2019.

6 Drinking contexts and their association with acute alcohol-related harm: A systematic review of event-level studies on adults' drinking occasions

This chapter describes a systematic review of the findings of the literature linking contextual characteristics of drinking occasions to acute alcohol-related harm. This study has been published in Drug and Alcohol Review (85). The version accepted for publication is re-produced in this chapter. The version included here has been revised according to comments from my viva voce examiners (Appendix A). It was also presented at both the 45th Annual Meeting of the Kettil Bruun Society in Utrecht, Netherlands (3rd June – 7th June 2019) and Lisbon Addictions, Portugal (23rd October – 25th October 2019).

I started planning this study towards the end of my first year (prior to my confirmation review). I was interested in reviewing the findings of studies with acute harm outcomes as my mapping review found a large and growing literature in this area. I noticed that some of this literature finds that contextual characteristics of drinking occasions are linked both directly and indirectly to acute harm (116,118). This means that contextual characteristics can indirectly lead to harm by increasing alcohol consumption within the occasion but can also directly cause harm which is not related to increased consumption. For example, drinking in a pub could *indirectly* increase the risk of a road traffic accident by leading to heavy alcohol consumption, but could also increase the risk *directly* by increasing the likelihood of driving late at night. Contextual characteristics (such as playing drinking games) may also have direct effects on acute harms due to associations with meanings (or norms) that are conducive to risky behaviour (96,119–121). If direct effects of contextual characteristics on acute harm outcomes are common, then future epidemiological studies should consider including measures of harm outcomes in addition to measures of alcohol consumption. Understanding direct effects on acute harms may therefore be important for informing public health research and policy. My review did not include both direct effects and effects mediated by consumption as this was not feasible within the planned scope of my thesis.

Following my confirmation review, I pre-registered this study on PROSPERO (ID: CRD42018119701). I chose to use a narrative approach to synthesise the findings of the included studies due to the heterogeneity in outcome measures, predictors, and data collection methods. Most of the work for this study was completed during the second year of my PhD.

6.1 Accepted paper

Drinking contexts and their association with acute alcohol-related harm: A systematic review of event-level studies on adults' drinking occasions

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Running title: Context and harm in adults' drinking occasions

ABSTRACT

Issues

Event-level alcohol research can inform prevention efforts by determining whether drinking contexts - such as people or places - are associated with harmful outcomes. This review synthesises evidence on associations between characteristics of adults' drinking occasions and acute alcohol-related harm.

Approach

We systematically searched Ovid MEDLINE, Ovid PsycInfo, and the Web of Science Social Sciences Citation Index. Eligible papers used quantitative designs and event-level data collection methods. They linked one or more drinking contexts to acute alcohol-related harm. Following extraction of study characteristics, methods and findings, we assessed study quality and narratively synthesised the findings. PROSPERO ID:CRD42018119701.

Key Findings

Searches identified 95 eligible papers, 65 (68%) of which study young adults and 62 (65%) of which are set in the United States, which limits generalisability to other populations. These papers studied a range of harms from assault to drink driving. Study quality is good overall although measures often lack validation. We found substantial evidence for direct effects of drinking context on harms. All of the contextual characteristics types studied (e.g. people, place, timing, psychological states, drink type) were consistently associated with harms. Certain contexts were frequently studied and associated with harms, in particular, weekend drinking, drinking in licensed premises and concurrent illicit drug use.

Implications

The findings of our review indicate target drinking contexts for prevention efforts that are consistently associated with increased acute alcohol-related harm.

Conclusion

A large range of contextual characteristics of drinking occasions are directly associated with acute alcohol-related harm, over and above levels of consumption.

Key words: Alcohol Drinking; Systematic Review; Epidemiology; Adult

INTRODUCTION

Acute harms, such as hospitalisation due to injury, are an important part of the burden caused by alcohol consumption, accounting for an estimated 54% of alcohol-related deaths and 65% of years of life lost to alcohol in the United States [1,2]. Epidemiological research typically focuses on the relationship between consumption and alcohol-related harm [3–5]. However, alcohol consumption is not a uniform behaviour. It takes place as part of a range of activities such as relaxing at home in the evening or in a noisy pub watching football with friends [6], and there is emerging evidence that such contextual characteristics of drinking occasions are associated with harm independent of consumption [7,8]. Contextual characteristics also matter from sociological and political perspectives as politicians and other public health actors want to change not just drinking volume, but undesirable aspects of drinking culture [9–11]. Identifying potentially harmful contextual characteristics of drinking can usefully inform debate in these areas.

Contextual characteristics of drinking occasions affect acute alcohol-related harm by several mechanisms that may co-occur. Firstly, a contextual characteristic can be associated with increased consumption, which mediates the association between context and harm. For example, pre-drinking occasions are longer leading to greater consumption and subsequent harm [12]. Secondly, contextual characteristics can moderate the effect of consumption. For example, alcohol consumption is associated with unprotected sex with casual partners but not with steady partners [13]. Lastly, contextual characteristics can have direct effects on acute harm, independent of consumption levels. For example, playing drinking games has been found to increase alcohol-related harms beyond the influence of elevated intoxication, such as where drinking games are associated with situational norms conducive to risky behaviour [14–16]. If direct and moderation effects are common then research needs to measure harm outcomes to fully understand the relationships between contextual characteristics and harm, informing epidemiological modelling and policy making [17].

Our recent mapping review identified and described methodological features of event-level studies estimating associations between contextual characteristics and alcohol consumption and/or acute alcohol-related harm, including highlighting the predominant methodological approaches [17]. We found a fast-growing body of literature that is diverse and fragmented across disciplinary and methodological traditions. Early literature focused mainly on the drinking environment in bars while more recent literature studies a heterogeneous range of contextual characteristics, from the drinker's mood to the day of the week and time of day [18]. Here, we build on our mapping review by providing a narrative synthesis and interpretation of the results of the identified studies to inform practice, policy and future research. Specifically, we aim to summarise the available evidence on direct and moderation effects of contextual characteristics of adults' drinking occasions on acute harm outcomes.

METHODS

Search strategy

This review uses a subset of the studies identified by the systematic search of our recent mapping review of event-level literature and was pre-registered using PROSPERO (ID: CRD42018119701). The mapping review included papers with either consumption or acute alcohol-related harm outcomes, whilst the present study synthesises only papers reporting harm outcomes. The search strategy used for the mapping review is reported in detail elsewhere [17]. Briefly, we used systematic searches of Ovid MEDLINE, Ovid PsycInfo and the Web of Science Social Science Citation Index. The search strategy included terms for three key concepts: alcohol consumption (e.g. alcohol* drink*), event-level research (e.g. occasion-based) and contextual characteristics of drinking occasions (e.g. weekend) (Table S1). We included search terms based on informal discussion with expert stakeholders. Citation and reference list searching were not undertaken. In our previous mapping review, we explained our approach to areas of the literature that have already been reviewed. Readers interested in the relationship between illicit substance use, alcohol use and domestic violence should refer to reviews by Choenni et al. [19,20] and De Bruijn and De Graaf [19,20]. Readers interested in the combined use of alcohol with energy drinks should refer to reviews by Verster et al. [21,22] and Peacock et al. [21,22]. The remainder of the methods section pertains to the current systematic review. We adhere to reporting guidance set out in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [23].

Eligibility criteria

We include English language journal articles using quantitative, event-level methods (e.g. ecological momentary assessment, experimental, and diary methods). Event-level methods are methodologically diverse and well suited to studying contextual characteristics of drinking occasions [17,24]. For instance, in experimental designs the researcher manipulates the contextual characteristics of the drinking occasion, while ecological momentary assessments collect reports from drinkers in real time (or close to it), and diary methods collect retrospective data on specific drinking occasions.

Studies use general adult population samples, or subsets of the general population (including students), excluding research on special populations such as clinical or homeless samples. Eligible studies measure one or more contextual characteristics of drinking occasions and study their associations with one or more acute alcohol-related harms. Our understanding of contextual characteristics is grounded in theories of practice and we use the term 'context' as an accessible equivalent to 'elements of practice' [25]. Contextual characteristics include materials (e.g. drink type or a pub), competencies (e.g. managing levels of intoxication) and meanings (e.g. drinking to celebrate). This broad approach includes contexts that may have direct impacts on harm independently of drinking alcohol (such as illicit drug use). These are included to comprehensively capture information on contextual characteristics within drinking occasions.

Eligible acute alcohol-related harms include all those listed in the 10th Revision of the International Classification of Diseases and a review of alcohol-related burden of disease [26,27]. Based on scoping searches, we also included unprotected sexual intercourse, criminal activity and aggregate measures of acute harm (which combine a number of different harms into one measure) (Table 1).

Table 1. Alcohol-related acute harms

Alcohol-related acute harm
Aggregate measures of acute alcohol-related harm [a]
Unprotected sexual intercourse
Accidental injuries and acute hospitalisation (fall injuries and other unintentional injuries)
Intentional self-harm
Victim of assault
Perpetrating assault
Intimate partner violence
Drink driving and transport injuries
Sexual violence
Mental and behavioural disorders (acute intoxication, dependence syndrome, withdrawal, withdrawal with delirium, psychotic episode)
Criminal activity
Mechanical forces
Drinking in pregnancy
Drowning
Intentional self-poisoning with alcohol
Other intentional injury
Alcohol poisoning, undetermined intent
Accidental exposure to noxious substances

[a] Aggregate measures of alcohol-related acute harm use several different harms to generate a single measure. For instance, a checklist of harms could be used to calculate a score for the total harm experienced.

Screening and data extraction

One reviewer conducted most screening and data extraction (AS). A second reviewer (SM) independently reassessed full-text screening for 20 randomly selected papers. This check demonstrated high consistency in the full-text screening. This study used a mixture of data extracted for the mapping review (e.g. study design) and newly extracted data (e.g. results).

Data extracted included study identifying information, research design, the definition of a drinking occasion used (e.g. single drinking location or the last 30 minutes), occasion characteristics measured and the measures used for predictors and outcomes (e.g. question asked and response scale used), statistical analysis methods, and findings (for each outcome studied we extracted statistically significant associations).

Quality assessment tools for the relevant type of observational study, as recommended by the National Institute for Health and Care Excellence, were used to assess risk of bias [28]. We used The Joanna Briggs Institute Checklist for Analytical Cross Sectional Studies, the Critical Appraisal Skills Programme tool for case control studies, and the Cochrane Effective Practice and Organisation of Care risk of bias criteria for interrupted time series studies.

Analysis and reporting

We use descriptive summary statistics to describe search results, study designs and populations followed by discussion of overall study quality and narrative synthesis of findings by acute harm outcome studied. The narrative synthesis focuses on direct associations between contextual characteristics and acute alcohol-related harms, discussing mediation and moderation via consumption where relevant. We have developed the following contextual characteristic categories for ease of interpretation, based on the areas covered by the included papers: people, place, timing, psychological states, drink type and other. *People* refers to drinking companions including measures such as the size and gender composition of the drinking group. *Place* incorporates features of the location, most commonly drinking in licensed versus unlicensed premises (e.g. in bars or at home). *Timing* characteristics include the day of the week and time of day. *Psychological states* are situational and vary from day to day, as opposed to psychological traits, which are enduring individual characteristics. The following examples can be studied as either states or traits although only states are of interest for this review. Expectancies are expectations about the outcomes of drinking [29], motives are the reasons people drink such as 'to cope with anxious mood' and affect has a similar meaning to mood [8]. Finally, *drink type* is the category of alcohol consumed, such as beer or spirits.

Summary tables of the methods and findings of the included papers are available in Tables S2 and S3. Summary tables of the quality assessment results are available in Tables S4, S5 and S6.

RESULTS

Description of the included studies

Ninety-five papers are included (Figure 1) which are based on 77 studies – most studies are reported in one (n=62; 65%) or two (n=12; 13%) papers [23].

Figure 1. PRISMA diagram

Identification

Records identified through database searching (n = 7,248)

Additional records identified from other sources (n = 72)

Screening

Records after duplicates removed (n = 5,590)

Titles and abstracts screened (n = 5,590)

Records excluded (n = 4,429)

Eligibility

Full-text articles excluded, with reasons (n = 1,066)
Not event-level data (382)
Not alcohol-related harm (336)
No contextual characteristics (126)
No legal age drinkers (60)
Specific population (49)
Not a journal article (33)
Not available in English (20)
Can't identify drinkers (16)
Not acute outcomes (9)
Qualitative (8)
Review (8)
Not alcohol consumption (7)
Descriptive only (6)
Cluster analysis only (5)
Inaccessible (1)

Full-text articles assessed for eligibility (n = 1,161)

Included

Studies included in narrative synthesis (n = 95)
*Reporting 77 studies

Figure 1. PRISMA diagram

The most common study design reported in the included papers is single occasion recall (n=42; 44%), in which respondents are asked to consider an occasion relevant to the harm of interest and a comparator occasion (e.g. the most recent sexual experience in the case of research on unprotected sex [13]) (Table 2). Other common designs are prospective daily diary/ 24 hour recall (n=16; 17%), ecological momentary assessment (n=12; 13%) and retrospective diary (n=13; 14%). There are no experimental studies.

Studies collected information about drinking occasions but the definition of these occasions varied across studies. Twenty-eight (30%) papers are based on contextual information collected about drinking during an entire day. Seven (7%) papers consider drinking in the six hours before an injury and seven (7%) measure drinking at one specific drinking location. Many papers (n=44; 46%) do not explicitly define an

occasion, allowing participants to make this judgement themselves. For example, studies ask participants about contextual characteristics of drinking prior to hospitalisation [30], during a worst date [31], or last night [32], without specifying a length of time or number of locations that are of interest.

Students (n=49; 52%) and other young people (n=16; 17%) are often studied - fewer papers cover general adult populations (n=30; 32%). Most of the study populations are in the United States (US) (n=62; 65%) with other studies set in Australia (n=9; 10%) and Canada (n=6; 6%). Few studies are set in non-Western countries (n=4; 4%).

The acute harms studied are: aggregate measures of acute harm (measures based on multiple types of harm) (n=30), unprotected sexual intercourse (n=24), accidental injuries and acute hospitalisation (n=16), assault and aggression (n=15), drink driving (n=14), sexual violence (n=9), acute alcohol use disorder symptoms (n=5) and criminal activity (n=3). Some eligible harms are not studied by this literature (e.g. drinking in pregnancy).

Table 2. Study characteristics

	Study characteristics [a]	Number of papers (percentage of the 95 included papers)
Design	Single occasion recall	42 (44)
	Prospective daily diary/ 24 hour recall	16 (17)
	Retrospective drinking diary	13 (14)
	Ecological momentary assessment	12 (13)
	Portal/ intercept survey	7 (7)
	Public services routine data (e.g. hospital records)	6 (6)
	Field studies	4 (4)
Definition of occasions	Participant defined	44 (46)
	One day	28 (30)
	One drinking location	7 (7)
	6 hours before an injury event	7 (7)
	Evening (after a certain time)	4 (4)
	Splitting the day into time segments	1 (1)
	Not clear	4 (4)
Population	Students	49 (52)
	General adult population	30 (32)
	Non-student young adults	16 (17)
	Experienced a specific harm [b]	13 (14)
	Female	12 (13)
	Male	5 (5)
	Risky drinkers	4 (4)
Country	United States	62 (65)
	Australia	9 (10)
	Canada	6 (6)
	Switzerland	5 (5)
	Brazil	2 (2)

	Ireland	2 (2)	
	New Zealand	2 (2)	
	England	1 (1)	
	European	1 (1)	
	Finland	1 (1)	
	Latin American and Caribbean	1 (1)	
	Norway	1 (1)	
	Sub-Saharan African	1 (1)	
	Sweden	1 (1)	
Alcohol-related acute harm outcome	Aggregate measures of acute harm	30 (32)	
	Unprotected sexual intercourse	24 (25)	
	Accidental injuries and acute hospitalisation	16 (17)	
	Assault and aggression	15 (16)	
	Drink driving	14 (15)	
	Sexual violence	9 (10)	
	Acute alcohol use disorder symptoms	5 (5)	
	Criminal activity	3 (3)	

[a] Some studies fit into multiple categories (e.g. they were conducted in two countries or they used both daily diary and single occasion recall methods). In such instances, we used both characteristics to define the paper. [b] For example, recruiting injured patients in accident and emergency departments.

Study quality

The quality of included papers is generally good. The main limiting factor is the use of self-report measures of occasion characteristics that lack validation. Some papers use well-validated self-report scales for more complex predictors, particularly psychological constructs such as drinking motives or mood [33,34]. Measures for some simple contextual characteristics, such as the day of the week, may not require validation. On the other hand, measures lacking validation are likely to be vulnerable to unknown sources of bias. Acute harms are also mainly assessed using simple self-report measures and less commonly using more robust measures, such as the Conflict Tactics Scale [35].

Around a third of included papers do not control for alcohol consumption in analyses (n=34; 36%). This is problematic, as studies which do not control for alcohol consumption cannot provide strong evidence for direct effects of contextual characteristics on acute harm. However, they can evidence the importance of understanding which contextual characteristics are associated with harm.

Overview of narrative synthesis findings

Overall, we find contextual characteristics of all types studied (people, place, timing, psychological states, drink type and other) are directly associated with acute alcohol-related harms (Table 3), although drink type is only studied across a limited range of acute harm outcomes. Few studies considered moderation

effects of drinking context. Most acute alcohol-related harms have been studied in relation to a variety of contextual characteristic types. However, unprotected sexual intercourse, sexual violence, acute alcohol use disorder symptoms and criminal activity have been less broadly studied.

Table 3. Summary of evidence on associations between contextual characteristics and acute alcohol-related harms

	People	Place	Timing	Psychological states	Drink type	Other [a]
Aggregate measures of acute harm [b]	✔ 5/20 [c]	✔ 11/15	✔ 7/10	✔ 6/6	✘ 0/1	✔ 14/20
Unprotected sexual intercourse	✔ 8/10		✔ 1/1	✔ 4/6		✔ 3/6
Accidental injuries and acute hospitalisation	✔ 2/2	✔ 3/4	✔ 9/9	✔ 1/1	✔ 3/11	✔ 3/11
Assault and aggression	✔ 5/7	✔ 7/8	✔ 1/3	✔ 6/9		✔ 6/11
Drink driving		✔ 3/3	✔ 5/6	✔ 1/1	✔ 3/6	✘ 0/3
Sexual violence victimisation	✔ 5/6	✔ 1/3				✔ 3/3
Sexual violence perpetration	✔ 1/1	✔ 3/3				✔ 1/1
Acute alcohol use disorder symptoms			✔ 3/3	✔ 5/9		✘ 0/1
Criminal activity			✘ 0/1	✘ 0/1		✔ 1/3

[a] For example playing drinking games, illicit drug use or drinking to celebrate. [b] Aggregate measures of acute harm draw together multiple types of acute harm to create a single measure. ✔ There is evidence of a significant association between a predictor in the contextual characteristic category and the acute alcohol-related harm outcome. ✘ There are paper/s studying association/s between a predictor in the contextual characteristics category and the acute alcohol-related harm but no significant findings. [c] Number of papers finding significant associations over the number of papers studying this association. These findings are shown for specific contextual characteristics in Table S3.

Aggregate measures of acute harm

Aggregate measures of multiple acute harms are the most commonly studied outcome (n=30; 32%). These are usually based on a checklist of harms, sometimes adapted from validated scales such as the Young

Adult Alcohol Problems Screening Test [36]. Most of these papers study student (n=25; 83%) or US (n=24; 80%) populations.

Place People

Students experience more harm, independent of increased consumption, when they drink in larger groups [37,38] and mixed sex rather than same-sex pre-drinking settings [16]. The type of company is generally not a significant predictor though having close friends who intend to encourage the celebrant to drink alcohol at 21st birthday events (the legal drinking age in the US) is linked to increased harm [36].

Place

Drinking in licensed premises is linked to increased harm, although students experience less harm in restaurants [14,38–40]. Occasions involving greater numbers of locations are also more likely to result in acute harm [15,41]. Pre-drinking is associated with increased risk in students [16,42–44], although this may be wholly mediated by greater consumption [45].

Timing

Drinking later at night [15,41], during your 21st birthday week [46], at the weekend [38,45,47], and during the weekend of an important college football game [48,49] is associated with increased acute harm.

Psychological states

Higher subjective intoxication is associated with increased harm over and above the contribution of consumption level [50,51]. Stronger drinking expectancies, both positive and negative, are also associated with increased risk [38,52].

Other

Further contextual characteristics associated with increased risk are playing drinking games, not serving food during the event, serving alcohol to the already intoxicated, music and dancing, receiving bar specials, lack of protective behavioural strategy use, and illicit drug use alongside drinking [14–16,37,39,40,53–56].

Unprotected sexual intercourse

Twenty-four papers use unprotected sex as an outcome, which is typically measured as self-reported condom use. Most of these papers study young adult (n=19; 79%) or US (n=18; 75%) populations. Thirteen papers collect data about specific recent events (e.g. recent intercourse).

People

Overall, studies of students, young women and adult men suggest unprotected sex is less likely when drinking with casual partners, particularly for young women who expect alcohol consumption to result in

disinhibition [57]. Despite this, occasions with casual partners involve heavier alcohol consumption [58] and the level of alcohol consumption has a greater effect on the likelihood of unprotected sex (a moderation effect) [59–61]. This may be because contraceptive practices are less established with casual partners, leading to greater potential for variability and increased influence of alcohol consumption.

Timing

Emerging evidence among young women suggests that sex with known partners is more likely at the weekend, but there was no effect on the likelihood of condom use [57]. One paper studying students finds unprotected sex is more likely at the weekend, although this analysis did not control for increased sexual activity [51].

Psychological states

Studies of students and young adults find that high subjective intoxication increases risk of unprotected sex [51,62,63]. There is no evidence that drinking - or having sex to reduce negative mood when drinking - is associated with unprotected sex [64]. One paper reported that unprotected sex is more likely when drinking alcohol in a positive mood [65].

Other

Illicit drug use is studied by four papers with young adult samples, broadly finding no significant effect although marijuana use alongside drinking is associated with increased unprotected sex for young women with low sexual assertiveness [66].

A study of drinking on 21st birthdays found no evidence linking playing drinking games to unprotected sex [37]. Use of protective behavioural strategies, such as leaving the drinking event at a predetermined time, is associated with decreased unprotected sex [67].

Accidental injuries and acute hospitalisation

Most of this literature uses hospitalisation or emergency department attendance as harm outcomes (n=11; 69%). These papers use varied comparison groups such as patients with non-alcohol-related injuries or the same patient on a prior occasion.

People

Injuries are more likely to occur when drinking alone or in a group of more than two people [68].

Place

Alcohol consumption in licensed premises (such as pubs) is associated with injury [68,69] although most 'last drinks' prior to injury are in unlicensed premises (such as at home), perhaps because drinking in

unlicensed premises is more common [70]. Pre-drinking is also linked to increased hospitalisation among students [30].

Timing

Some evidence suggests most alcohol-related injuries happen early on Sunday mornings [70], after midnight [71], at the weekend [70,72,73] and during the summer [74]. National holidays are also associated with emergency department attendance [70–73].

Psychological states

Higher subjective intoxication is associated with an increased risk of injury [74].

Drink type

There are mixed findings for drink type - spirits [69], a combination of drink types and beer [75,76] have each been associated with higher risk of injury than not drinking by one paper.

Other

Illicit drug use does not predict increased injury risk in drinking occasions overall but is associated with injuries for men and those over thirty [68,74–77]. Prescription medication use during the drinking occasion is associated with a small decrease in risk of injury [68].

Assault and aggression

Fifteen papers study aggressive incidents such as being involved in a fight. They mostly focus on young adult populations (n=12; 80%).

People

Victim intoxication is associated with aggressive behaviour in young men [78] and young women are more likely to be aggressive towards other women [35]. Drinking in a larger group increases aggression victimisation [79] and perpetration through increased consumption (mediation), while having a partner present increases the risk of aggression over and above any effect on consumption [80,81]. Being in a social environment with others who encourage aggression is also risky [78].

Two papers on dating violence among female students in the US find alcohol consumption particularly increases the risk of victimisation when drinking with long term partners (a moderation effect) [82,83].

Place

Drinking in two or more locations, at a party (particularly for women), or in a university residence/ fraternity versus 'other' location is associated with aggressive behaviour [80,81]. Drinking in an aggression

facilitating physical environment (based on a range of factors including being loud, dirty and crowded) is also associated with increased aggression [78].

<u>Timing</u>

Overall, the findings on the effect of weekend drinking are inconsistent, with only one study suggesting that aggression is more likely on a Friday or Saturday [51,81,84].

<u>Psychological states</u>

Among students, negative affect is associated with aggressive behaviour [84]. Angry affect also moderates the effect of alcohol and marijuana use on perpetrating dating violence among female students in the US. Alcohol consumption and marijuana use increase perpetration only when participants are angry [82]. Higher subjective intoxication is protective for injury risk but associated with increased aggression perpetration [78].

Situation-level drinking to cope increases the likelihood of aggression while aesthetic motives (e.g. to enjoy the taste) are associated with decreased risk [80].

<u>Other</u>

Other hazardous contexts include drinking to celebrate [79], with conflicting findings on using illicit drugs among school leavers in Australia [37,67,85]. Drinking with a meal reduces the likelihood of aggressive incidents [80,81]. High self-control demands (e.g. having to regulate your thoughts or mood) is associated with increased risk of aggression and assault [84].

Drink driving

Fourteen papers study drink driving, either directly (n=11; 79%) or through alcohol-related road traffic accidents (n=3; 21%).

<u>Place</u>

Licensed premises are generally associated with drink driving and accidents; sales in unlicensed premises are not associated with more accidents [86–88].

<u>Timing</u>

Some studies find that drink driving is more likely on Fridays, weekends, holidays and evenings [86–89], but students may have a higher risk of driving drunk mid-week than at the weekend [90]. Twenty-first birthday celebrations are associated with higher consumption but not increased drink driving [91].

<u>Psychological states</u>

Also in students, higher objective intoxication and lower subjective intoxication is associated with drink driving [90].

<u>Drink type</u>

Beer sales/consumption and the proportion of high strength beer sold in the last drinking venue are associated with accidents while beer sales in unlicensed premises are protective [88,92]. Beer is commonly drunk by binge drinkers and young people, and in public places, which may partially explain this relationship [93]. Some evidence links spirit sales in the last drinking venue to crash risk [92].

Sexual violence

Nine papers study sexual violence and primarily focus on victimisation rather than perpetration. Sexual violence is typically defined as unwanted touching or physically forced intercourse. Some studies include persistent unwanted sexual attention, verbally coerced intercourse, and intercourse while incapacitated (i.e. intoxicated, passed out, or asleep). A disparate set of predictors are used, making it difficult to draw conclusions.

<u>People</u>

There are contradictory findings on the effect of prior relationships between perpetrators and victims on sexual violence when drinking [31,94].

Larger, younger, female-dominated drinking groups in nightclubs are more likely to be harassed [79].

<u>Place</u>

Drinking in isolated locations (such as at home) predicts male students perpetrating sexual violence and alcohol consumption and pre-drinking are associated with victimisation [31,79,83,94–96].

<u>Other</u>

Playing drinking games on one's 21st birthday is associated with increased sexual violence perpetration and victimisation [37]. Marijuana use [83] and drinking to celebrate [79] are also associated with victimisation.

Acute alcohol use disorder symptoms

Five papers on acute alcohol use disorder (AUD) symptoms are included. Four of these use ecological momentary assessment and study students in the US. AUDs are chronic conditions, but this literature focuses on their acute symptoms [34].

<u>Timing</u>

AUD-related inpatient episodes are more likely on 19th birthdays (the legal drinking age in Canada) and there are smaller increases on subsequent birthdays [97]. Occasions on Fridays and Saturdays are consistently associated with increased AUD symptoms [32,98].

Psychological states

Negative mood is associated with increased AUD both directly and indirectly through increased consumption and coping motivations [32,34,98,99]. Emotional lability (variability in affect during the day) is also associated with increased AUD [98]. On the other hand, hostility (feeling angry, hostile or irritable) is associated with reduced acute dependence symptoms despite increasing intoxication for men [99]. Daily enhancement motives (e.g. because drinking is exciting) are directly associated with acute AUD symptoms [34]. The relationships between mood, motives, and AUD symptoms at the event-level are complex - these studies suggest both positive and negative mood may increase consumption and that negative mood is related to increased AUD symptoms.

Criminal activity

Three papers study criminal activity outcomes alongside other harms. These studies are limited in scope, focusing on school leavers, 21st birthday drinking in the US and college students.

Other

These studies find that the odds of vandalism, theft and legal problems are substantially higher when illicit drugs are used but are unaffected by use of protective behavioural strategies or drinking game participation [37,67].

DISCUSSION

We find that a large number of contextual characteristics including people, place, timing, psychological states and drink type are directly associated with acute alcohol-related harm. Few studies tested for mediation or moderation effects. Compared to the other characteristic types, drink type is studied across a limited range of acute harms. Areas of harm studied are unprotected sexual intercourse, accidental injuries and acute hospitalisation, assault and aggression, drink driving, sexual violence, acute alcohol use disorder symptoms and criminal activity. Most of the identified literature uses young adult samples in the United States, which makes it difficult to assess the generalisability of findings to wider populations. Compared to other harms, fewer types of contextual characteristics are studied for unprotected sexual intercourse, sexual violence, acute alcohol use disorder symptoms and criminal activity. Within types of contextual characteristics, weekend drinking, drinking in licensed premises and concurrent illicit drug use are commonly studied and consistently found to be associated with harm. This reflects a literature which gives

particular attention to some characteristics but neglects others (such as dancing, positive mood and the age of drinking companions).

The findings of our review are constrained by limitations of the existing literature. Our recent mapping review highlighted that papers often lack clearly stated reasons for the contextual characteristics studied, and that few studies comprehensively capture occasion characteristics [17]. As drinking occasions have not been clearly conceptualised, there may be important contextual characteristics for understanding the situational drivers of alcohol-related harm missing from the existing literature (e.g. toasting or downing drinks). The lack of comprehensive characteristics included in studies also limits the quality of study results, as associations between contextual characteristics and acute harm may be related to unstudied features of drinking occasions. A further limitation is that the diverse study designs used by this literature have different advantages and disadvantages, and this may have impacted on findings. For instance, studies using ecological momentary assessment or daily diary approaches can account for inter- and intra-individual variation as they collect data about multiple occasions [100] while studies asking participants to recall specific events are less able to do so. However, study quality was generally good and most papers relying on retrospective reports of specific events used case-control or case-crossover designs. Lastly, few studies consider mediation or moderation effects and we therefore cannot come to an informed conclusion on their likely importance.

Despite these limitations, our review can inform harm prevention efforts. We have found substantial evidence that contextual characteristics of drinking occasions are related to acute harm and have identified potential intervention targets which are consistently associated with harm. Furthermore, there is a growing evidence base for interventions altering drinking environments in licensed premises [101,102]. Our review can inform future interventions aimed at modifying drinking environments such as targeting illicit drug use or increasing the availability of food. For example, an intervention could focus on working with licensed premises to ensure that food is available at weekends or that premises are well-staffed. It is important to note that this review considered only direct effects of contextual characteristics on acute harms, and did not include studies with consumption outcomes only. The effects of contextual characteristics on alcohol consumption levels may suggest alternative intervention targets and their importance for alcohol-related harm may be greater. The policy recommendations of this study should therefore be considered alongside wider literature in this area.

This is the first comprehensive review summarising evidence to date on the association between contextual characteristics of adults' drinking occasions and any outcome. In this case, we focus on acute alcohol-related harm outcomes. We have used a detailed search strategy to identify this growing literature, which is spread across disciplinary and methodological traditions, and considered a comprehensive set of harms. The main limitations of this review include the use of a single reviewer to screen studies, although

an independent re-assessment of twenty papers for inclusion demonstrated good reliability. There was also no validation of data extraction. Since we did not include unpublished literature, there is a risk of publication bias. However, this literature is heterogeneous and widely dispersed [17] which suggests that searching for unpublished literature would be challenging and there would still be a risk of bias. This is the most comprehensive review to date and it draws on a diverse range of published records.

There is substantial evidence that contextual characteristics of drinking occasions are directly associated with acute alcohol-related harms. However, this literature has not consistently separated direct associations from potential effects mediated by consumption or moderation effects of drinking context [5]. Furthermore, there is a lack of validated measures of contextual characteristics and future research should focus on under-studied harms (such as drink driving) and contextual characteristics (such as drink type and music/ dancing in the venue), general population samples in addition to students, and additional geographical locations. This would improve our understanding of acute alcohol-related harm, and add to the evidence base informing the development of effective public health interventions. The findings of our review indicate target drinking contexts for prevention efforts that are consistently associated with increased alcohol-related acute harm, particularly drinking in licensed premises, at the weekend and concurrently with illicit drug use.

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CONFLICT OF INTEREST

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Table S1. Search strategy

Concept	Search terms			
Alcohol consumption (.mp.) (TS & TI)	bing* adj3 (drink* or consum* or intoxicat*)	alcohol* adj3 (drink* or consum* or intoxicat* or related)	heavy adj3 drink* alcoholic beverage* alcohol-related	
Alcohol consumption MEDLINE	exp Alcohol Drinking/			
Alcohol consumption PsycInfo	exp Alcohol drinking attitudes/	exp Alcohol drinking patterns/ exp binge drinking/	exp drinking behavior/ exp social drinking/	
Event-level research (.af.) (TS & TI)	ema ecological momentary assessment experience sampling diary diaries event level event level drink* adj2 event* event-specific event specific event-contingent event contingent referral event	occasion-based occasion based drink* practi?e* practi?e theor* theor* of practi?e* element* adj2 practi?e* recent* adj2 occasion recent* adj2 occasions recent* adj2 event last adj2 occasion	last adj2 occasions last adj2 event barroom bar-room bar room experimental setting experimental condition icat phone adj assessment text message*	portal survey rhdo ivr interactive voice response daily survey* handheld assessment tool* daily retrospective daily process realtime real time real-time daily account*
Contextual characteristics (.mp.) (TS & TI)	cocaine crack cocaine cannabis hashish marijuana cannabinoids (tetrahydrocannabinol) heroin ecstasy XTC amphetamines speed GHB MDMA venue* location* barroom bar-room bar* home	parent* beverage choice* beverage preference* beverage type* beverage-type* drink choice* drink type* drink-type wine* spirits beer* cider* alcopop* premixed pre-mixed pre mixed rtd* ready-to-drink* ready to drink*	Wednesday* Thursday* Friday* Saturday* Sunday* weekend* week-end* week end start-time start time duration night-time night time day-time day time daytime meal time* meal-time* mealtime* drink* adj3 mood	social support (subjective intoxication) subjective effect* (subjective experience*) (perceived intoxication) occasion adj3 type (occasion adj3 reason) party adj3 type party adj3 reason social purpose (purpose adj3 occasion) year* holiday* birthday*

Concept	Search terms			
	pub	(flavoured	alcohol adj3	semester*
	restaurant*	alcoholic	mood	gender
	street drink*	beverage*)	stress	composition
	nightclub	(flavored	affect	gender ratio
	club	alcoholic	anxiety	sex composition
	hotel	beverage*)	craving	sex ratio
	tavern*	drink* adj3	urge	male only
	bottle store*	(motive* or	desire	female only
	wine shop*	motivation* or	(pre-loading and	mixed sex
	shebeen*	meaning* or	alcohol)	mixed gender
	company	expect?nc* or	(pre-loading and	football
	companion*	reason*)	drinking)	rugby
	peer*	alcohol* adj3	(front-loading and	rowing
	friend*	(motive* or	alcohol)	match day*
	colleague*	motivation* or	(front-loading and	sport*
	family	meaning* or	drinking)	patron age
	partner	expect?nc* or	(drinking before	patron sex
	wife	reason*)	drinking)	patron ethnicity
	husband	day of the week	intention*	patron race
	spouse	Monday*	social	drinking game*
		Tuesday*	interaction*	
Contextual characteristics – situation (.mp.) (TS & TI)	dancing	atmosphere	discount*	advertising
	crowd*	music	offer*	BOGOF
	buy* adj3 round*	volume	promotion*	drink* adj3 free
	facilities	loud	marketing	alcohol* adj3 free
	lighting			
Exclusions for: MEDLINE	Therapeutics/ Psychotherapy/	Intervention.ti.	Brief intervention.ab.	Effectiveness.ti.
PsycInfo	Treatment/ Psychotherapy/	Intervention.ti.	Brief intervention.ab.	Effectiveness.ti.
SSCI (TS & TI)	Intervention effectiveness			

The search strategy includes terms relating to three concepts: alcohol consumption, event-level research, and characteristics of drinking occasions. These were combined such that only records containing at least one term from each concept were identified [17].

Table S2. Methods of included papers

First author, year	Design[3]	Population	Country[1]	State	Outcomes[2]	Occasion definition	Main statistical analyses
Abbey, 2001 [1]	Recall specific events	Male students	United States	Can't tell	Not occasion consumption Sexual violence	Participant defined	MANOVA
Aberg, 1993 [2]	Recall specific events	Adult male	Sweden		Not occasion consumption Drink driving	Participant defined	Lisrel, McNemar
Ahmed, 2014 [3]	Recall specific events	Students	United States	Mid-atlantic	Not occasion consumption Requiring medical attention	Participant defined	Logistic regression
Andreuccetti, 2014 [4]	Recall specific events	Alcohol-related A&E injured patients	Latin American, Caribbean		Not occasion consumption Requiring medical attention	Six hours before the injury event	Stuart Maxwell, McNemar's, Chi-square, student's t
Bourdeau, 2017 [5]	Portal survey	General/healthy adult	United States	California	Sexual violence Victim of assault	One drinking location	LCA, analysis of variance, chi-square
Braitman, 2017 [6]	Diary	Students	United States	Can't tell	Aggregate measure of acute harm	One day	Multi-level SEM
Brister, 2011 [7]	Recall specific events	Students	United States	Southwest	Aggregate measure	One day	Hierarchical linear regression
Brown, 2007 [8]	Recall specific events	Students	United States	Can't tell	Unprotected sex	Participant defined	Hierarchical logistic regression, chi-square
Brown, 2016 [9]	Recall specific events	Young women	United States	Southwest	Not occasion consumption Unprotected sex	Participant defined	Logistic and linear regression
Bryan, 2017 [10]	Diary	Adult female	United States	Washington	Not occasion consumption Unprotected sex	One day	SEM
Buettner CK, 2011 [11]	Diary	Students	United States	Midwest	Aggregate measure	Participant defined	Linear regression
Callaghan, 2014 [12]	Routine data	Young adults	Canada		Not occasion consumption Dependence syndrome	One day	ARIMA
Champion, 2009 [13]	Diary	Students	United States	Midwest & Midatlantic	Aggregate measure	One day	Logistic regression
Cherpitel, 1998 [14]	Daily diary/ 24hr recall	Experienced a skiing injury	United States	Northeast	Not occasion consumption Other unintentional injuries	One day	Logistic regression
Cherpitel, 1999 [15]	Recall specific events	A&E patients	Canada		Not occasion consumption Requiring medical attention	Six hours before the injury event	Logistic regression
Cherpitel, 2012 [16]	Recall specific events	A&E patients	Canada		Not occasion consumption Requiring medical attention	Six hours before the injury event	Conditional logistic regression
Clapp, 2000 [17]	Recall specific events	Students	United States	California	Not occasion consumption Aggregate measure	Participant defined	Logistic regression

Study	Method	Population	Country	Region	Outcome	Occasion definition	Analysis
Clapp, 2008 [18]	Recall specific events Field studies	Students	United States	Can't tell	Injuries Aggregate measure Aggression Rode with a drunk driver	Participant defined	Logistic regression and hierarchical models
Clapp, 2014 [19]	Field studies	Students	United States	California	Not occasion consumption Aggregate measure	Participant defined	Multi-level logistic regression
Collins, 2007 [20]	Recall specific events	Young women in an aggressive incident in a bar	United States	Can't tell	Not occasion consumption Perpetrating assault Victim of assault	One drinking location	Regression
Connor, 2014 [21]	Diary	Students	New Zealand		Not occasion consumption Aggregate measure	Participant defined	Conditional logistic regression
Cotti, 2014 [22]	Recall specific events	Risky drinkers	United States	Multiple states	Not occasion consumption Drink driving	Participant defined	Probit
Cousins, 2010 [23]	Recall specific events	Young adults	Ireland		Not occasion consumption Unprotected sex	Participant defined	Hierarchical logistic regression, SEM
Dvorak, 2014 [24]	EMA	Students	United States	Midwest	Dependence syndromeAggregate measure	Evening (after a specified time)	Multigroup multilevel path model
Dvorak, 2016 [25]	EMA	Students	United States	Midwest	Dependence syndrome	Participant defined	Mixed effects negative binomial count model
Fairlie, 2018 [26]	Recall specific events	Young adults	United States	Multiple states	Not occasion consumption Unprotected sex	Participant defined	Logistic regression
Fillo, 2017 [27]	Recall specific events	Students	United States	Can't tell	Not occasion consumption Aggregate measure	One day	Hierarchical negative binomial regression
Ford, 2017 [28]	Recall specific events	Female students	United States	Can't tell	Not occasion consumption Sexual violence	Participant defined	Logistic regression
Foster, 2015 [29]	Diary Routine data	Young men	Switzerland		Transport injuries (inc RTA)	One day	Pearson's correlation coefficients
Fromme, 2010 [30]	Daily diary/ 24hr recall	Students	United States	Can't tell	Drink driving	Participant defined	Hierarchical Linear Modeling, GEE
Geisner, 2017 [31]	Recall specific events	Students	United States	West coast	Aggregate measure	One day	Paired t-tests, negative binomial regression
Gmel, 2005 [32]	EMA Routine data	General/healthy adult	Switzerland		Not occasion consumption Transport injuries (inc RTA)	Based on specified time segments	Pearson's correlation coefficients, multiple regression
Graham, 2014 [33]	Portal survey	Young women	Canada		Not occasion consumption Sexual violence	Participant defined	Multivariate logistic regression
Greene, 2018 [34]	Daily diary/ 24hr recall	Students	United States	Northeast	Aggregate measure	One day	Multi-level mixed effects GLMs

Griffin, 2017 [35]	Routine data	General/healthy adult	Ireland		Not occasion consumption Intentional self harm	One day	Multivariate Poisson regression
Gruenewald, 1999 [36]	Recall specific events	Drivers who experienced crashes	Australia		Not occasion consumption Drink driving	Place of last drink	OLS regression
Gunn, 2018 [37]	Diary	Students	United States	South New England	Aggregate measure	One day	Generalized linear mixed models
Howells, 2014 [38]	Recall specific events	Female students	United States	Midwest	Not occasion consumption Unprotected sex	Participant defined	Two-level Bernoulli hierarchical analyses
Hummer, 2013 [39]	Recall specific events	Student risky drinkers	United States	West coast	Aggregate measure	Participant defined	Hierarchical Multiple Regression
Kenney, 2014 [40]	Recall specific events	Students	United States	West coast	Not occasion consumption Aggregate measure	Participant defined	Hierarchical multiple regression
Kerr, 2015 [41]	Daily diary/ 24hr recall	Students	United States	Can't tell	Not occasion consumption Unprotected sex	One day	Multilevel logistic regression
Khurana, 2015 [42]	Recall specific events	Students	United States	Midwest	Aggregate measure	Participant defined	Multiple linear regression
Kiene, 2009 [43]	Daily diary/ 24hr recall	Students	United States	Connecticut	Not occasion consumption Unprotected sex	Participant defined	Multilevel logistic regression
Kiene, 2013 [44]	Recall specific events	General/healthy adult	sub-Saharan Africa		Not occasion consumption Unprotected sex	Participant defined	Binomial GLM with a logit link
Kilwein, 2018 [45]	Diary	Students	United States	Midwest	Not occasion consumption Unprotected sex Sexual violence	Participant defined	Generalized Estimating Equations: binary logistic regression with AR1
Kraft, 1991 [46]	Recall specific events	Young adults	Norway		Not occasion consumption Unprotected sex	Participant defined	Stepwise multiple logistic regression
Kuntsche, 2013 [47]	EMA	Students	Switzerland		Aggregate measure	Evening (after a specified time)	Multilevel regression
Kuntsche, 2015 [48]	EMA	Students	Switzerland		Aggregate measure	Evening (after a specified time)	GMM, multilevel logistic regression
LaBrie, 2008 [49]	Recall specific events	Students	United States	West coast	Aggregate measure	Participant defined	ANOVA
Labhart, 2013 [50]	EMA	Young adults	Switzerland		Aggregate measure	Evening (after a specified time)	Multilevel SEM
Lam, 2014 [51]	Recall specific events	Young adults	Australia		Unprotected sex Injuries Aggregate measure Perpetrating assault Criminal activity	Participant defined	Logistic regression
Lang, 1995 [52]	Recall specific events	General/healthy adult	Australia		Aggregate measure	Participant defined	Logistic regression

Study	Method	Population	Country	Region	Outcomes	Time frame	Analysis
Lau-Barraco, 2018 [53]	Daily diary/ 24hr recall	Young adults	United States	Can't tell	Aggregate measure	One day	Multilevel modeling
Leigh, 2008 [54]	Daily diary/ 24hr recall	Students	United States	Northwest	Not occasion consumption Unprotected sex	Participant defined	Random-effects regression
Leonard, 2003 [55]	Recall specific events	Young men in an aggressive incident in a bar	United States	New York	Perpetrating assault Victim of assault Aggression severity Injury to opponent	Participant defined	Logistic regression
Lewis, 2009 [56]	Diary	Students	United States	Midwest	Aggregate measure	One day	Negative binomial regression
Lewis, 2010 [57]	Recall specific events	Students	United States	Can't tell	Not occasion consumption Unprotected sex	Participant defined	Negative binomial and logistic regression
Linden-Carmichael, 2018 [58]	Daily diary/ 24hr recall	Students	United States	Northeast	Not occasion consumption Acute intoxication	One day	Generalized linear mixed models
Lubman, 2014 [59]	Portal survey	Young adults	Australia		Aggression Unprotected sex Injuries	Last 12 hours	T-test, chi-square, logistic regression
Madden, 2019 [60]	Recall specific events	Students	United States	Multiple states	Aggregate measure	Participant defined	SEM, factor analysis
Makela, 2005 [61]	Diary Routine data	General/healthy adult	Finland		Not occasion consumption Intoxication-related death	One day	Mortality rate ratios and confidence intervals
Mallett, 2017 [62]	Diary	Students	United States	Northeast	Not occasion consumption Aggregate measure	Participant defined	Multilevel modelling
McLean, 2009 [63]	Recall specific events	Alcohol-related A&E injured patients	New Zealand		Requiring medical attention	Six hours before the injury event	Chi-squared
Merrill, 2017 [64]	Diary	Students	United States	South New England	Not occasion consumption Aggregate measure	One day	Logistic TVEM
Mihic, 2009 [65]	Recall specific events	Students	Canada		Not occasion consumption Aggression	Participant defined	Hierarchical linear modeling
Miller, 2015 [66]	Portal survey	Alcohol-related A&E injured patients	Australia		Not occasion consumption Requiring medical attention	One drinking location	Pearson χ^2 tests
Naimi, 2007 [67]	Recall specific events	Risky drinkers	United States	Multiple states	Drink driving	Participant defined	Not clear
Neighbors, 2014 [68]	Recall specific events	Students	United States	Northwest	Aggregate measure Unprotected sex Sexual violence Drink driving Aggression Criminal activity	One day	Logistic regression

Parks, 2000 [69]	Daily diary/ 24hr recall	Adult female	United States	New York	Not occasion consumption Victim of assault Sexual violence	One drinking location	Chi-square and ANOVA
Parks, 2011 [70]	Daily diary/ 24hr recall	Young women	United States	Can't tell	Not occasion consumption Unprotected sex	One day	Multilevel modeling
Parks, 2012 [71]	Daily diary/ 24hr recall	Young women	United States	Can't tell	Not occasion consumption Unprotected sex	One day	Hierarchical linear modeling
Patrick, 2016 [72]	EMA	Students	United States	Northwest	Aggregate measure	One day	Logistic and linear multilevel models
Quinn, 2011 [73]	Daily diary/ 24hr recall	Students	United States	Southwest	Not occasion consumption Unprotected sex Aggregate measure Aggression Criminal activity	Participant defined	Generalized Estimating Equations
Quinn, 2012 [74]	Daily diary/ 24hr recall	Students	United States	Southwest	Not occasion consumption Drink driving	Participant defined	Generalized Estimating Equations
Ragsdale, 2012 [75]	Field studies	Female students	United States	Florida	Rode with a drunk driver	Participant defined	T-tests, multiple regression
Santos, 2015 [76]	Portal survey	General/healthy adult	Brazil		Sexual violence Perpetrating assault Victim of assault	One day	Multiple logistic regression
Schroder, 2009 [77]	EMA	Students	United States	Texas	Not occasion consumption Unprotected sex	Participant defined	Hierarchical linear modeling
Searles, 1995 [78]	Daily diary/ 24hr recall	Adult male	United States	Vermont	Aggregate measure Drink driving	One day	Not clear
Shorey, 2014 [79]	Daily diary/ 24hr recall	Female students	United States	Southeast	Not occasion consumption Intimate partner violence	One day	Multilevel modeling
Shorey, 2016 [80]	Daily diary/ 24hr recall	Female students	United States	Southeast	Not occasion consumption Intimate partner violence Sexual violence	One day	Multilevel modeling
Simons, 2010 [81]	EMA	Students	United States	Can't tell	Dependence syndrome	Not clear	Negative binomal multilevel modeling
Simons, 2014 [82]	EMA	Students	United States	Midwest	Dependence syndrome	Not clear	Multilevel structural model
Simons, 2016 [83]	EMA	Students	United States	Midwest	Not occasion consumption Perpetration of assault	Not clear	Multilevel logistic regression
Simons, 2018 [84]	EMA	Young adults	United States	Can't tell	Not occasion consumption Unprotected sex	Not clear	Multilevel multinomial regression
Stockwell, 1993 [85]	Recall specific events	General/healthy adult	Australia		Aggregate measure	Participant defined	Chi-square and logistic regression

Temple, 1992 [86]	Recall specific events	General/healthy adult	United States	California	Not occasion consumption Unprotected sex	Participant defined	Logistic regression
Temple, 1993 [87]	Recall specific events	General/healthy adult	United States	Multiple states	Unprotected sex	Participant defined	Logistic regression
Todkill, 2016 [88]	Routine data	General/healthy adult	England		Not occasion consumption A&E attendance	One day	T-tests
Treaeen, 2003 [89]	Recall specific events	General/healthy adult	European countries		Not occasion consumption Unprotected sex	Participant defined	Logistic regression
Wagner, 2017 [90]	Portal survey	People who drove to the nightclub	Brazil		Drink driving	One drinking location	Multinomial logistic regression
Watt, 2004 [91]	Recall specific events	Alcohol-related A&E injured patients	Australia		Requiring medical attention	Six hours before the injury event	Conditional logistic regression
Watt, 2006 [92]	Portal survey	Alcohol-related A&E injured patients	Australia		Not occasion consumption Injury severity	Six hours before the injury event	Multinomial logistic regression
Wells, 2008 [93]	Recall specific events	Students	Canada		Not occasion consumption Aggression	Participant defined	Multivariate multi-level models
Williams, 2011 [94]	Recall specific events Diary	Alcohol-related A&E injured patients	Australia		Not occasion consumption Requiring medical attention	Six hours before the injury event	Conditional logistic regression
Yao, 2018 [95]	Field studies	Drivers who experienced crashes	United States	Virginia	Transport injuries (inc RTA) Drink driving	Time when sampled	Logistic regression

[1] Not all papers report national-level studies. Sub-national information on the location of participants was not extracted. [2] Aggregate measures of acute harm create a single measure of harm from several different harms. For example, a score for the number of harms experienced from a list might be used. [3] Portal surveys recruit participants as they enter or leave drinking venues, or intercept them on the street.

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Table S3. The numbers of papers finding significant associations between contextual characteristics and acute alcohol-related harms

Contextual characteristics	Aggregate measures of acute harm [a]	Unprotected sexual intercourse	Accidental injuries and acute hospitalisation	Assault and aggression	Drink driving	Sexual violence victimisation	Sexual violence perpetration	Acute alcohol use disorder symptoms	Criminal activity
People									
Steady rather than casual partner		8/10 [b]				-1 [c]/1	1/1		
Drinking in a larger group	2/4		1/1	1/2		1/1			
Drinking alone	0/1		1/1						
Drinking with your partner	0/2			2/2					
Drinking with friends	-1/4								
Drinking with family/co-workers	0/4								
Male group	0/1								
Female group						1/1			
Mixed sex setting	1/2								
Young group						1/2			
Intoxicated people present	0/1			0/1					
No romantic relationships between group members						1/1			
People present who encourage aggression				1/1					
Friends with low pro-safety intentions and	1/1								

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Contextual characteristics	Aggregate measures of acute harm [a]	Unprotected sexual intercourse	Accidental injuries and acute hospitalisation	Assault and aggression	Drink driving	Sexual violence victimisation	Sexual violence perpetration	Acute alcohol use disorder symptoms	Criminal activity
high pro-intoxication intentions at your 21st birthday									
Female perpetration – male opponent				-1/1					
Place									
Licensed premises	4/6		2/3		3/3		-1/1		
Pre-drinking	3/3		1/1	0/1		1/2	1/1		
More pre-drinking locations	1/1								
More drinking locations	1/1			2/2					
At a party	1/2			2/2		0/1			
Off-campus residence/ party	-1, 1[d]/2								
Isolated location							1/1		
Aggression facilitating physical environment				1/1					
Drinking in a university residence or fraternity				2/2					
Timing									

Contextual characteristics	Aggregate measures of acute harm [a]	Unprotected sexual intercourse	Accidental injuries and acute hospitalisation	Assault and aggression	Drink driving	Sexual violence victimisation	Sexual violence perpetration	Acute alcohol use disorder symptoms	Criminal activity
Weekend	3/5	1/1	3/3	1/3	2/2			2/2	0/1
Weekend of an important football match	1/2								
Later in the day	2/2		2/2		2/2				
Holidays and other special occasions			3/3		1/1				
Winter season			-1/1						
Birthday when drinking becomes legal	1/1				0/1			1/1	
Psychological states									
Subjective intoxication	2/2	3/5	1/1	-1, 1 [e]/1	-1/1				0/1
Negative mood				1/1				2/3	
Positive mood		1/1						0/2	
Angry affect				2/3					
Hostility								-1/1	
Emotional lability								1/1	
Impulsivity				0/1				0/1	
Positive expectancies	2/2								
Negative expectancies	2/2								
Coping motivation				1/1					
Enhancement motivation				0/1				1/1	

Contextual characteristics	Aggregate measures of acute harm [a]	Unprotected sexual intercourse	Accidental injuries and acute hospitalisation	Assault and aggression	Drink driving	Sexual violence victimisation	Sexual violence perpetration	Acute alcohol use disorder symptoms	Criminal activity
Aesthetic motivation				-1/1					
Drink type									
Drinking beer			1/3		2/2				
Drinking spirits			1/3		1/2				
Drinking wine			0/3		0/2				
Drinking a combination of drink types			1/2						
Non-alcoholic drinks available	0/1								
Other									
Illicit drug use	3/3	2/4	-1, 1/7	2/4		1/1			1/1
Prescription drug use			-1/1						
Over the counter medication			0/1						
Drinking games	-1, 3/5	0/1		0/2	0/1	1/1	1/1		0/1
Food available	-1/2			-2/2					
PBS	-1/1	-1/1	0/1					0/1	0/1
Music/ dancing	2/2								
Genre of nightclub music					0/1				
Serving drunk people	2/3								

Contextual characteristics	Aggregate measures of acute harm [a]	Unprotected sexual intercourse	Accidental injuries and acute hospitalisation	Assault and aggression	Drink driving	Sexual violence victimisation	Sexual violence perpetration	Acute alcohol use disorder symptoms	Criminal activity
Drinking to celebrate/ big night out	0/1			1/1		1/1			
Themed party	0/1		0/1	0/1	0/1				
Receiving bar specials	1/1								
Bring your own booze	0/1								
Self-control demands on perpetration				1/1					

[a] Aggregate measures of acute harm draw together multiple types of acute harm to create a single measure. [b] The denominator indicates the number of papers studying this association. [c] Positive numbers indicate papers finding a positive association with harm and vice versa for negative numbers (protective factors). [d] Off-campus location is more risky for hosts while on-campus is more risky for attendees. [e] Protective for injury risk, associated with increased perpetration.

Table S4. Quality assessment: papers reporting on cross-sectional studies

First author, year	Were the criteria for inclusion in the sample clearly defined?	Were the study subjects and the setting described in detail?	Was the exposure measured in a valid and reliable way?	Were objective standard criteria used for measurem-ent of the condition?	Were confound-ing factors identified?	Were strategies to deal with confound-ing factors stated?	Were the outcomes measured in a valid and reliable way?	Was appropri-ate statistical analysis used?
Abbey, 2001 (1)	Yes	Yes	Yes	NA	No	No	Yes	Yes
Aberg, 1993 (2)	Yes	Yes	No	NA	No	No	No	Yes
Ahmed, 2014 (3)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Andreucce tti, 2014 (4)	Yes	Yes	Yes	No	No	No	Yes	Yes
Bourdeau, 2017 (5)	Yes	Yes	Yes	NA	No	No	Yes	Yes
Braitman, 2017 (6)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Brister, 2011 (7)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Brown, 2007 (8)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Brown, 2016 (9)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Bryan, 2017 (10)	Yes	Yes	Yes	NA	No	No	Yes	Yes
Buettner CK, 2011 (11)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Champion, 2009 (12)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Cherpitel, 1999 (13)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cherpitel, 2012 (14)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clapp, 2000 (15)	Yes	Yes	No	NA	Yes	Yes	Yes	Yes
Clapp, 2008 (16)	Yes	Yes	Yes	NA	Yes	No	No	Yes
Clapp, 2014 (17)	Yes	Yes	Yes	NA	Yes	Yes	No	Yes
Collins, 2007 (18)	Yes	Yes	Yes	NA	Yes	No	No	Yes
Cotti, 2014 (19)	No	Yes	Yes	NA	Yes	No	Yes	Yes
Cousins, 2010 (20)	Yes	Yes	No	NA	Yes	Yes	Yes	Yes

Dvorak, 2014 (21)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Dvorak, 2016 (22)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Fairlie, 2018 (23)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Fillo, 2017 (24)	Yes	Yes	No	NA	Yes	Yes	Yes	Yes
Ford, 2017 (25)	Yes	Yes	No	NA	Yes	Yes	No	Yes
Foster, 2015 (26)	Yes	Yes	Yes	Yes	No	No	Yes	No
Fromme, 2010 (27)	Yes	Yes	Yes	NA	No	No	Yes	Yes
Geisner, 2017 (28)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Graham, 2014 (29)	Yes	No	Yes	NA	Yes	No	Yes	Yes
Greene, 2018 (30)	Yes	No	Yes	NA	Yes	Yes	Yes	Yes
Griffin, 2017 (31)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gruenewald, 1999 (32)	Yes	No	Yes	NA	No	No	Yes	Yes
Gunn, 2018 (33)	Yes	Yes	Yes	NA	Yes	Yes	No	No
Howells, 2014 (34)	Yes	Yes	Yes	NA	No	No	Yes	Yes
Hummer, 2013 (35)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Kenney, 2014 (36)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Kerr, 2015 (37)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Khurana, 2015 (38)	Yes	Yes	No	NA	Yes	No	Yes	Yes
Kiene, 2009 (39)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Kiene, 2013 (40)	Yes	No	No	NA	Yes	Yes	Yes	Yes
Kilwein, 2018 (41)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Kraft, 1991 (42)	Yes	Yes	Yes	NA	No	No	Yes	Yes
Kuntsche, 2013 (43)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Kuntsche, 2015 (44)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
LaBrie, 2008 (45)	Yes	Yes	Yes	NA	No	No	Yes	Yes
Labhart, 2013 (46)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Lam, 2014 (47)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes

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Lang, 1995 (48)	Yes	No	Yes	NA	Yes	No	Yes	Yes
Lau-Barraco, 2018 (49)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Leigh, 2008 (50)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Leonard, 2003 (51)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Lewis, 2009 (52)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Lewis, 2010 (53)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Linden-Carmichael, 2018 (54)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Lubman, 2014 (55)	Yes	Yes	Yes	NA	Yes	Yes	No	Yes
Madden, 2019 (56)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Makela, 2005 (57)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mallett, 2017 (58)	Yes	No	Yes	NA	Yes	Yes	Yes	Yes
McLean, 2009 (59)	Yes	Yes	Yes	No	Yes	No	Yes	No
Merrill, 2017 (60)	Yes	No	Yes	NA	Yes	Yes	Yes	Yes
Mihic, 2009 (61)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Miller, 2015 (62)	Yes	No	Yes	Yes	Yes	No	Yes	No
Naimi, 2007 (63)	Yes	No	Yes	NA	Yes	No	Yes	No
Neighbors, 2014 (64)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Parks, 2000 (65)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Parks, 2011 (66)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Parks, 2012 (67)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Patrick, 2016 (68)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Quinn, 2011 (69)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Quinn, 2012 (70)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Ragsdale, 2012 (71)	Yes	Yes	Yes	NA	Yes	Yes	No	Yes
Santos, 2015 (72)	Yes	No	Yes	NA	Yes	Yes	Yes	Yes
Schroder, 2009 (73)	Yes	Yes	Yes	NA	No	No	Yes	Yes

Searles, 1995 (74)	No	Yes	Yes	NA	No	No	Yes	No
Shorey, 2014 (75)	Yes	Yes	Yes	NA	No	No	Yes	No
Shorey, 2016 (76)	Yes	Yes	Yes	NA	No	No	Yes	No
Simons, 2010 (77)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Simons, 2014 (78)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Simons, 2016 (79)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Simons, 2018 (80)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Stockwell, 1993 (81)	Yes	No	No	NA	Yes	Yes	Yes	Yes
Temple, 1992 (82)	Yes	Yes	No	NA	Yes	Yes	No	Yes
Temple, 1993 (83)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Todkill, 2016 (84)	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Treaeen, 2003 (85)	Yes	Yes	No	NA	Yes	Yes	Yes	Yes
Wagner, 2017 (86)	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes
Watt, 2006 (87)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wells, 2008 (88)	Yes	Yes	No	NA	Yes	Yes	No	Yes
Williams, 2011 (89)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table S5. Quality assessment: papers reporting on case-control studies

First author, year	Did the study address a clearly focused issue?	Did the authors use an appropriate study design to answer their question?	Were the cases recruited in an acceptable way?	Were the controls selected in an acceptable way?	Was the exposure accurately measured to minimise bias?	Have the authors taken account of the potential confounding factors in the design/ analysis?	Do you believe the results?
Cherpitel, 1998 (90)	Yes	Yes	Yes	Yes	No	Yes	Yes
Connor, 2014 (91)	Yes	Yes	Yes	Yes	No	Yes	Yes
Watt, 2004 (92)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yao, 2018 (93)	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table S6. Quality assessment: papers reporting on interrupted time series analyses

First author, year	Intervention independent of other changes	Shape of the intervention effect pre-specified	Intervention unlikely to affect data collection	Knowledge of the allocated intervention adequately prevented during the study	Problematic missing outcome data	Selective outcome reporting	Other risks of bias
Callaghan, 2014 (94)	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Gmel, 2005 (95)	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk
Gruenewald, 1999 (32)	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk

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7 Combinations of drinking occasion characteristics associated with light and heavy drinking among British adults: An event-level decision tree modelling study

This chapter presents an analysis of the relationships between contextual characteristics of drinking occasions and alcohol consumption. This work was conducted during the course of my studies and the version submitted for review at *Alcoholism: Clinical and Experimental Research* is re-produced in this chapter. The version included here has been revised according to comments from my viva voce examiners (Appendix A). This study has been published and promoted by *Alcoholism: Clinical and Experimental Research* as an article of public interest (122). The paper was also accepted for presentation at the 46th Annual Meeting of the Kettil Bruun Society in Warsaw but this conference was cancelled due to COVID-19. Instead, I presented this work to the Sheffield Alcohol Research Group and the Finnish Institute for Health and Welfare as part of a digital research exchange meeting (27th April 2020). I also presented this work at my department's conference for post-graduate researchers (3rd June 2020).

This chapter of my thesis has changed substantially since my confirmation review. Initially, I proposed an epidemiological study that would test hypotheses about the relationships between contextual characteristics and hospital admission episodes (using Health Episode Statistics data (123)). This was intended to follow on from my systematic review and add to the literature on acute harm outcomes. I intended to focus on hospital admissions because my systematic review found a small literature in this area that identified promising contextual characteristics for further study (96). The existing literature also primarily focused on student and young adult populations, limiting the generalisability of previous findings. I therefore planned to contribute to this area by testing relevant hypotheses in the general population using data from the Kantar Alcovision survey and diary alongside Health Episode Statistics data (123).

I decided to change this part of the project as both I and my supervisors had concerns about the validity of the analysis. First, the Alcovision survey recruits participants from an online panel using quotas based on age, sex, social grade and geographic region (22). Although survey weights based on census data in Great Britain are used to improve representativeness, participant selection is non-random which increases the risk of selection bias (124). This limitation is particularly problematic for using data from Alcovision to predict rates of acute harm derived from a different data source as differences in the samples could bias the findings. Our second concern was about the signal to noise ratio in the data. The proposed analysis would have modelled the relationship over time between aggregate data on contextual characteristics and hospital admissions by geographic region. Initial exploratory analyses suggested that there was only a small amount of variation over time in rates of hospital admissions at this level. Furthermore, the alcohol-attributable fraction was low (i.e. most admissions are not due to alcohol consumption) and so much of

the variation in the data may have been unrelated to drinking occasions (125). Both factors would limit the ability of my models to correctly identify relationships between contextual characteristics of drinking occasions and hospital admission episodes.

Since I was not able to link data from the Alcovision survey to a data source on harm as intended, I designed a study using only data collected as part of this survey, focusing on the indirect harm caused by alcohol consumption (1). From a practice-based perspective, it is key to consider the combination of elements that make up practices (9). I therefore started by thinking about how best to model these complex relationships. I was reading a book about using data mining in the social sciences at the time and came across a method that could account for the effects of complex combinations of contextual characteristics while still providing insight into which of these were most strongly related to an outcome – decision tree analysis (126). I applied this method using data from Kantar Alcovision to identify which contexts, and combinations of contexts, are associated with alcohol consumption in drinking occasions.

7.1 Submitted paper

Combinations of drinking occasion characteristics associated with light and heavy drinking among British adults: An event-level decision tree modelling study

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Running title: Influence of contextual characteristics on alcohol consumption in adults' drinking occasions

Conflict of interest: None to declare.

ABSTRACT

Background

Alcohol consumption is influenced by the contextual characteristics of drinking occasions, for example location, timing, or participants. However, the relative importance of occasion characteristics is not yet well understood. This study aims to identify which characteristics, and combinations of characteristics, are associated with light versus heavy consumption within drinking occasions. It also tests whether accounting for occasion characteristics improves the prediction of consumption compared to using demographic information only.

Methods

The data comes from a cross-sectional, nationally representative, online market research survey. Our sample includes 18,409 British drinkers aged 18+ who recorded the characteristics of 46,072 drinking occasions using 7-day retrospective drinking diaries in 2018. We used decision tree modelling and nested linear regression to predict units consumed in occasions using information on drinking location/venue, occasion timing, company, occasion type (e.g. a quiet night in), occasion motivation, drink type and packaging, food eaten and entertainment/ other activities during the occasion. We controlled for age, sex, usual drinking frequency, and social grade in nested linear regression models. Open Science Framework pre-registration: https://osf.io/42epd.

Results

Our final models accounted for 55-71% of the variance in drinking occasion alcohol consumption (across age-sex groups). Beyond demographic characteristics (1-9%) and occasion duration (24-60%), contextual characteristics and combinations of characteristics accounted for 31-70% of the total explained variance. The contextual characteristics most strongly associated with heavy drinking occasions were long occasion duration, drinking spirits as doubles, and drinking wine. Spirits were also consumed in light occasions, but as singles. This suggests that the serving size is an important differentiator of light and heavy occasions.

Conclusions

Combinations of occasion duration and drink type are strongly predictive of heavy versus light alcohol consumption in adults' drinking occasions. Accounting for characteristics of drinking occasions, both individually and in combination, substantially improves the prediction of alcohol consumption in drinking occasions.

INTRODUCTION

There is a growing literature using event-level methods to study the relationships between contextual characteristics of drinking occasions and drinking behaviour (Stevely et al., 2019). The existing literature has identified contextual characteristics associated with increased alcohol consumption in drinking occasions such as pre-drinking, drinking with multiple friends, and drinking at the weekend (Kuntsche and Labhart, 2013; Labhart et al., 2014, 2013; Thrul et al., 2017; Thrul and Kuntsche, 2015). Research in this area can help to shape our thinking about which occasions are likely to involve problematic drinking, how policies may affect these occasions, and how to develop and refine occasion-specific interventions for occasions associated with heavy consumption (Clapp et al., 2008; Kuntsche and Labhart, 2013; Stanesby et al., 2019; Stevely et al., 2020a, 2019; Thrul and Kuntsche, 2015). However, it is not yet clear which contextual characteristics are most strongly associated with heavy versus light drinking occasions and whether occasion characteristics combine to produce important effects on outcomes, or whether there are interaction effects between characteristics (Stevely et al., 2019).

In our study, we were particularly interested in exploring the importance of joint effects of different drinking occasion characteristics on alcohol consumption. We conceptualised drinking occasions as social practices, since this theoretical perspective is well suited to studying combinations of characteristics (Blue et al., 2016; Meier et al., 2017; Shove et al., 2012). Reckwitz defines practices as:

"a routinised type of behaviour which consists of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know‑how, states of emotion and motivational knowledge."
((Reckwitz, 2014), p. 249)

For example, in the UK 'going out with friends' tends to make us think of occasions that involve characteristics of socialising and drinking with a group of friends in licensed premises, typically on a weekend evening. Crucially for the current paper, using this approach emphasises the relationships

between different aspects of the drinking context that come together to form a practice (Meier et al., 2017). So far research in this area has tended to rely on linear regression models which assume independence of effects of contextual characteristics on outcomes (Clapp et al., 2008; Stevely et al., 2019; Wells et al., 2008). Instead, we need conceptual and analytical approaches that properly account for the combined effects of contextual characteristics, which may improve our understanding of their cumulative effects on alcohol consumption.

Our study aims to identify the combinations of characteristics that are associated with heavy versus light drinking occasions in Great Britain and which characteristics are the strongest predictors of alcohol consumption within adults' drinking occasions. It also aims to test whether accounting for contextual characteristics (individually and in combinations) improves the prediction of consumption relative to models including only demographic characteristics.

MATERIALS AND METHODS

Data

We used data from the 2018 Alcovision survey, collected by the market research company Kantar. Alcovision is a continuous online survey that includes a detailed retrospective 7-day drinking diary, and measures of socio-demographic characteristics and usual drinking frequency. The drinking diary collects information about drinking occasions, defined by Kantar as periods of drinking in only the on-trade (in licensed premises such as pubs) or only the off-trade (such as at home). Our analysis instead redefined drinking occasions as periods of drinking with no two-hour gaps between drinks. This allowed occasions in the dataset to be combined to include both on- and off-trade locations (e.g. pre-loading before a night out).

The sample was taken from an online market research panel using quotas based on age, sex, social grade and geographic region. The original sample was 29,599 adults (18+) resident in Great Britain. Our analytic sample included 18,409 drinkers, excluding non-drinkers (respondents who report usually drinking 'Less often than once in 12 months' or 'Never'). Weighting was applied based on age, sex,

social grade and geographic region using Great Britain census data. Our analysis included 46,072 drinking occasions reported by the sample. Informed consent was given by all participants in the survey.

Measures

Outcome measure

Our primary outcome measure was alcohol consumption in UK units within each drinking occasion (1 unit = 8 grams of alcohol). Units were calculated based on the number of servings reported by participants, serving size, and the alcohol by volume (ABV). Participants reported brands for most servings, and we used this information to identify actual ABVs via web searches. Where brand information was not available we used standard ABVs for some beverage types.

Contextual characteristics

Contextual characteristics used in our analyses are: day of the week, start time of the occasion (11 categories), duration (measured in 9 bands and we use mid-points as point estimates), month of the year, trade type (on-trade, off-trade, pre-loading, post-loading, mixed, unclear), company type (6 categories; e.g. with friends, with family members), group structure (7 categories; e.g. male pair, female group, with children), entertainment (42 categories; e.g. watching television, listening to music), food consumption (11 categories; e.g. having a formal meal), drink type (10 categories; e.g. spirits or wine), drink packaging (20 categories; e.g. a 440ml can), venue (29 categories; e.g. a modern bar), motivation for drinking (12 categories; e.g. to wind down or chill out), type of occasion (31 categories; e.g. a sociable night in), and reason for the choice of venue (30 categories; e.g. 'it's my local'). Pre-loading occasions involved drinking in the off-trade and then the on-trade and post-loading occasions started in the on-trade and moved to the off-trade. We defined mixed occasions as switching between the on- and off-trade more than once and labelled occasions as 'unclear' when the order of on- and off-trade drinking was not reported.

The full set of contextual characteristics and their responses categories are shown in Supplementary Table S1. The table also indicates that many of these characteristics are not mutually exclusive and/or are allowed to change across the course of an occasion. We have treated categories within variables as separate binary variables where necessary in the analyses to account for this.

Controls and stratifying variables

We used measures of sex, age in years, usual drinking frequency and social grade. Usual drinking frequency was measured by the question 'Over the year as a whole, about how often do you drink any alcoholic drink of any kind?' with 10 response options (e.g. '3-5 times a week'). Social grade was recorded using National Readership Survey (NRS) categories which is an occupation-based measure ranging from workers in higher managerial positions to semi- or unskilled workers and those who are unemployed.

Statistical analysis

Pre-registered analyses

This study was pre-registered using Open Science Framework (https://osf.io/42epd (Stevely et al., 2020b)). The frequency of drinking in different contexts varies by age and sex, and there may also be differences in the relationships between contextual characteristics and consumption (Ally et al., 2016). All analyses were therefore stratified across six age-sex groups (18-35, 36-64, 65+).

The first stage of our analysis used decision tree modelling (recursive partitioning in JMP Pro 14.3) to predict alcohol consumption based on contextual characteristics of drinking occasions (details of these are in Supplementary Table S1). Decision tree models start with all drinking occasions and then choose the best contextual characteristic by which to split the data. The best split will create two groups of roughly equal size with the maximum difference in mean consumption (Hawkins et al., 2011; Kass, 1980; SAS Institute Inc, 1989-2019). For example, occasions could be split into under vs over 2 hours in duration. The modelling process is recursive as the created groups are then successively split on the next best characteristic. These models therefore inherently consider complex

combinations of contextual characteristics. The final groups created by a decision tree model are referred to as leaves and are defined by the combination of all of the splits in predictor variables.

We used k-fold cross validation (five folds) to prevent over-fitting. We also restricted the model so that the leaves would include a minimum of 1% of the sample of drinking occasions to avoid generating very small groups.

The second stage of our analysis estimated nested linear regression models (i.e. a series of models adding predictors to the previous model) to predict units consumed per occasion. We used clustered standard errors in Stata 15 to account for the clustering of drinking occasions within participants. The simplest models included age (within the age-sex strata), usual drinking frequency, and social grade. We then sequentially added: occasion duration, all of the contextual characteristics selected by decision tree models for each age-sex group, and the leaves generated by decision tree modelling (using dummy variables). Occasion duration was added in a separate step as it showed a very strong association with consumption in decision tree models. For continuous predictors – age and duration – we included polynomial terms (to model non-linear relationships) where these were significant at $\alpha = 0.1$.

The number of units per drinking occasion (our outcome variable) had a positive skew. We therefore log-transformed this variable for regression analyses. Occasions in the top 1% of the distribution of units per occasion were excluded due to concerns about extreme and possibly unreliable values. We used weighted data for all analyses.

Unplanned analyses

We noted during decision tree modelling that the duration of the drinking occasion accounted for a large proportion of the variance in alcohol consumption. Prior studies have also found that contextual characteristics can be associated with longer occasion duration (and therefore increased consumption) (Labhart et al., 2014). We therefore repeated the decision tree analysis with duration as the splitting criteria, rather than alcohol consumption, to identify contextual characteristics that predict longer

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drinking occasions. We interpreted the findings from both sets of decision tree models to identify contextual characteristics with both direct effects on alcohol consumption and effects mediated by duration.

Ethics approval

This study was approved by the University of Sheffield's ethics committee and conforms to the principles embodied in the Declaration of Helsinki. Use of this data is allowed under the terms of the contract and non-disclosure agreement between Kantar and the University of Sheffield, which requires research outputs to be submitted to the data provider ahead of publication. The data providers' right to request changes is limited to matters of accuracy regarding the data.

RESULTS

Decision tree modelling of alcohol consumption

To identify the strongest predictors of alcohol consumption, we consider the proportion of explained variance that is attributable to each predictor in decision tree models. Figure 1 shows the variables selected by the decision tree modelling of alcohol consumption in drinking occasions and their predictive contributions (results also reported in Supplementary Table S2).

The duration of drinking occasions accounts for the highest proportion of explained variance in alcohol consumption across all age-sex groups (ranging from 37.3% to 72.2%), with longer drinking occasions predictive of heavier consumption. Other important predictors are drinking spirits as doubles (particularly for 18-35 year olds – 24.4% of explained variance for 18-25 year old men and 28.6% for women) and drinking wine (4.1- 15.4%) (Supplementary Table S2). There are other patterns across age-sex groups - for example, the type of beer/ cider packaging is more important in models of consumption for 18-35 year old men. Drinking large bottles (500ml/1 pint) of beer or cider in the off-trade and draught beer or cider in the on-trade is associated with increased consumption in this group.
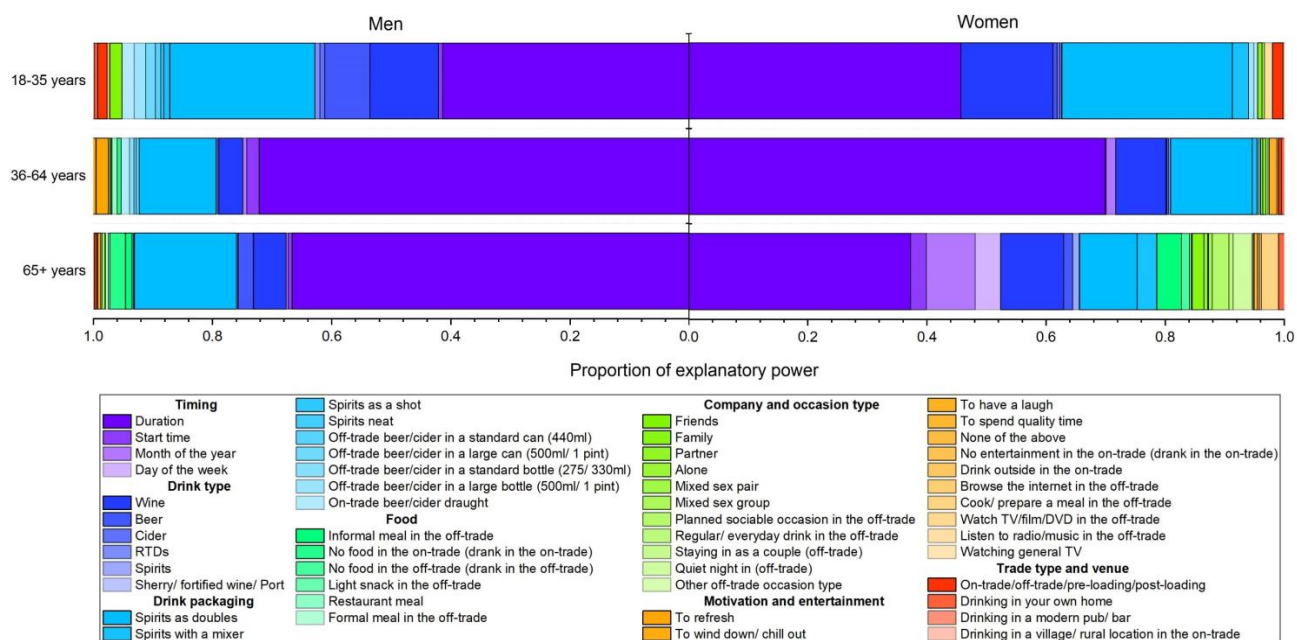
Figure 1. The proportion of explained variance attributable to each contextual characteristic in models of alcohol consumption per occasion for six age-sex groups

Combinations of contextual characteristics associated with heavy alcohol consumption

Decision tree modelling produces a set of terminal nodes, or leaves, that are a combination of the splits throughout the tree. In our analysis, these represent combinations of contextual characteristics of drinking occasions. Across the six models by age-sex groups, there are 45.5 leaves on average per model. The number of occasions per leaf ranges from 10 to 823, with an average of 167.1 occasions per leaf. This wide range is due to the different sample sizes for each age-sex group, as these groups differ in size in the Great British population and young adults are also over-sampled in the Alcovision survey.

Figure 2 shows the heaviest and lightest drinking leaves for each age-sex group (i.e. the combinations of occasion characteristics associated with the highest and lowest consumption levels), following the branches of the decision tree models and showing the mean alcohol consumption at each node. We present only the lightest and heaviest occasions as the full decision trees produce many leaves and cannot be easily summarised. This section describes an example leaf in detail to illustrate their structure before presenting the overarching findings.

The lightest drinking leaf for men aged 36-64 has a mean consumption of 1.2 units. The most important predictor is that these occasions last less than an hour and a half. Within those that were shorter than 1.5 hours, the next most important determinant of consumption is not drinking spirits as doubles, followed by not drinking wine, drinking beer or cider in standard sized bottles (275/ 330ml) in the off-trade, the respondent considering the occasion type to be a regular/ everyday drink, and starting the occasion before 2pm.

Comparing across the age-sex groups reveals many commonalities, particularly within heavy drinking occasions - which are longer in duration and typically involve drinking spirits as doubles. However, among young adults (aged 18-25 years) the heaviest drinking occasions also involve drinking wine. Light drinking occasions are generally shorter, spirits are drunk as singles, and no wine is consumed. Interestingly, spirits are drunk in both the heaviest and lightest occasion types in different ways (i.e. doubles vs. singles), suggesting that serving sizes may represent important material components of drinking practices, rather than simply incremental differences in consumption levels. The patterns by age-sex group in mean alcohol consumption in the heaviest drinking occasions are as expected – men and younger people consume more units in their heaviest occasions. Conversely, there is little variation in mean alcohol consumption across the lightest drinking occasions, suggesting that all age-sex groups have very light drinking occasions.
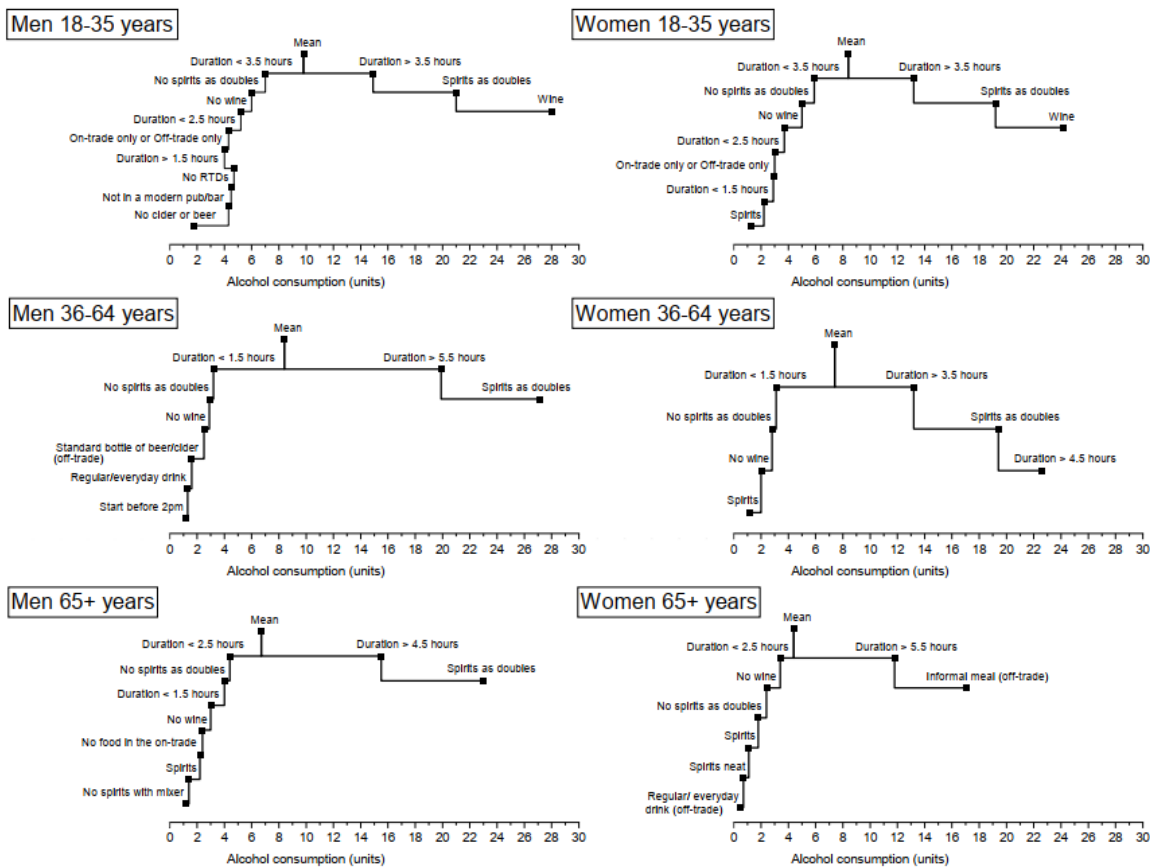
Figure 2. Pathways through decision trees to the heaviest and lightest occasions (leaves) for six age-sex groups

The pathways shown lead to the types of drinking occasions identified by decision tree models with the lowest and highest mean alcohol consumption (in units). As has happened for men aged 18-35, one or more of the steps in the process may move the mean consumption in a counterintuitive direction as long as this branch ends up with the lowest mean consumption.

Decision tree modelling of occasion duration

The duration of drinking occasions accounts for a large proportion of the explained variance in alcohol consumption (Figure 1, Supplementary Table S2). Since some contextual characteristics may influence, or be associated with consumption through longer occasions, we also used decision tree modelling to predict the duration of occasions using all of the other contextual predictors.

The trade type of drinking occasions accounts for the highest proportion of variance in occasion duration across all age-sex groups (Figure 3). Drinking in both the on- and off-trade (pre-loading or post-loading) predicts longer occasions than drinking in the on- or off-trade only. Other important predictors are the start time and drinking with friends. There is also an interaction effect between start time and trade type: when drinking occasions start earlier, mixed trade type drinking is more strongly associated with longer duration than it is in occasions that start later (Supplementary Table S3). Overall, drinking with friends is also an important predictor of longer drinking occasions.

There are patterns in the results across age-sex groups. For example, drinking in a mixed sex group and drinking spirits are more important predictors of female consumption and general use of a computer in the off-trade is more important for male consumption.
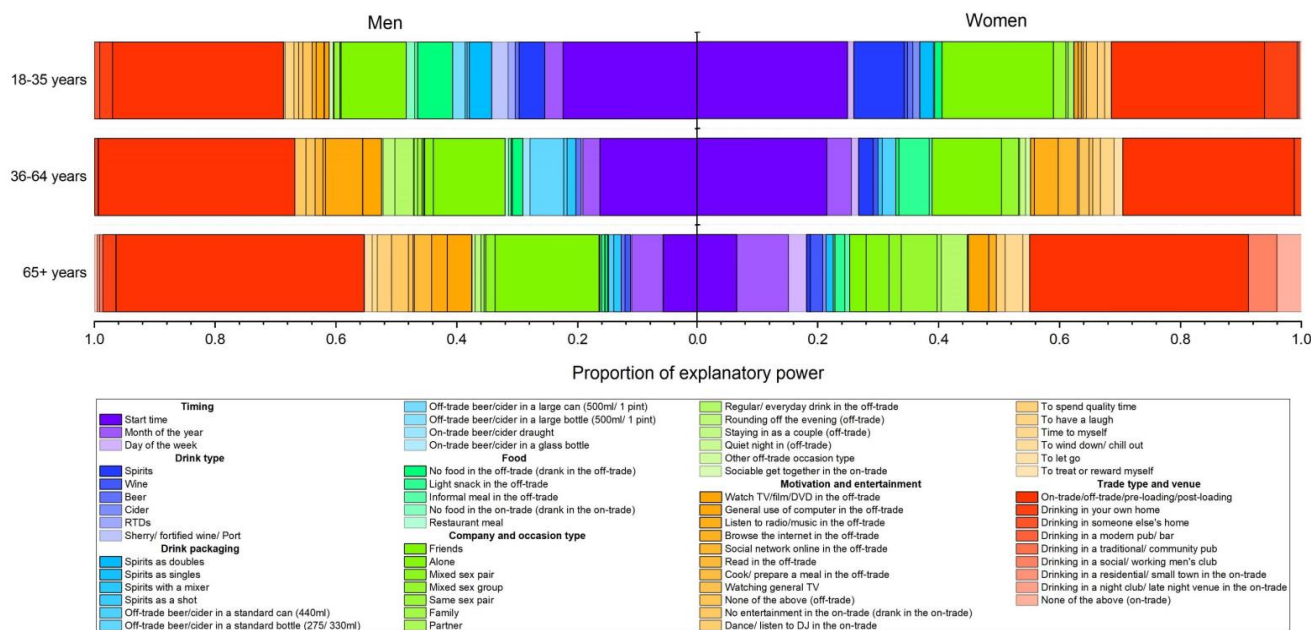

Figure 3. The proportion of explained variance attributable to each contextual characteristic in models of occasion duration for six age-sex groups

Nested models predicting occasion alcohol consumption

We used a series of nested linear regression models to predict the natural log of alcohol consumption in occasions. Firstly, individual-level factors (age in years, usual drinking frequency, and social grade) accounted for between 1-9% of the final R^2, depending on the age-sex subgroup (Table 1).

Sequentially adding occasion duration, all other contextual characteristics selected by decision tree models, and the combinations of variables within the terminal groups (leaves) of decision tree models, accounted for 24-60%, 28-54%, and 3-16% of variance, respectively. These findings suggest that each set of predictors accounted for additional variance over and above previous models.

Individual-level factors and occasion duration accounted for more of the variance among 36-64 year olds than the other age groups, while other contextual characteristics improved prediction less. A possible explanation is that their daily lives and drinking occasions are more established and routinised so there is less variation in other contextual characteristics. Adding contextual characteristics and leaves as predictors had a particularly large effect on the R^2 for women aged over 65.

Table 1. Nested linear regression models testing improvements in the prediction of alcohol consumption

Model predictors	Male 18-35 R^2 (proportion of total R^2)	36-64	65+	Female 18-35	36-64	65+
Individual-level factors[1]	0.00 (1)	0.06 (9)	0.03 (5)	0.01 (1)	0.03 (5)	0.04 (6)
+ Occasion duration	+0.24 (44)	+0.38 (60)	+0.31 (51)	+0.25 (45)	+0.31 (53)	+0.17 (24)
+ Contextual characteristics[2]	+0.27 (48)	+0.18 (28)	+0.22 (36)	+0.27 (49)	+0.21 (37)	+0.38 (54)
+ Leaves[3]	+0.04 (8)	+0.02 (3)	+0.05 (8)	+0.03 (5)	+0.03 (6)	+0.12 (16)
Total R^2	0.56 (100)	0.64 (100)	0.61 (100)	0.55 (100)	0.58 (100)	0.71 (100)

[1] *Age in years, usual drinking frequency, National Readership Survey social grade.* [2] *The contextual characteristics selected by decision tree models out of the full set listed in Supplementary Table S1.* [3] *The terminal groups of occasions produced by decision tree models, representing combinations of contextual characteristics. Models used clustered standard error to account for individuals reporting multiple occasions.*

DISCUSSION

This study is the first to estimate alcohol consumption in drinking occasions using a wide range of contextual characteristics. We found that the duration of drinking occasions, beverage type, and serving size are strongly predictive of alcohol consumption in adults' drinking occasions. Contextual characteristics improve the prediction of alcohol consumption both individually and in combination relative to models including only demographic characteristics. Combinations of contextual characteristics are therefore useful for understanding the differences between light and heavy drinking occasions.

The contextual characteristics measured in the Alcovision survey were not informed by a specific theoretical perspective and our review of previous literature suggests this is common with event-level alcohol research. However, the occasion characteristics measured appear to be suitable for interpretation through a theories of practice lens. In our previous work, we have drawn on Shove *et al.'s* description of the main elements of social practice - materials, meanings and competences – and

extended these to include temporal elements (Ally et al., 2016; Meier et al., 2017; Stevely et al., 2019). In this study we find that temporal factors are particularly important - duration is the strongest predictor of alcohol consumption, and start time is strongly related to occasion duration. The day of the week was a less important predictor than might be expected given the cultural association of binge drinking with Friday and Saturday nights in Britain. Our findings suggest that weekend drinking is not heavier once occasion duration is accounted for. However, weekend occasions will involve heavier drinking if they are more likely to have a long duration. Weekend drinking may have characteristics that are associated with longer occasions, such as drinking in both the on- and off-trade, with friends, and starting earlier in the day. Material elements are also important predictors of occasion consumption and duration – particularly drink type, drink packaging and venue type. The measures of meaning included in the Alcovision survey were not strong predictors of consumption or duration. This may have been due to the limitations of the market research-oriented measures as we have some findings that suggest the importance of meaning elements. For example, spirits were drunk in both the heaviest and lightest occasions in different ways (i.e. as doubles vs. singles). These differences are evocative of different meanings - perhaps the light occasions involve enjoying a relaxing tipple of whiskey for an hour or so while the heavy ones involve downing shots which could be linked to 'determined drunkenness' (Haydock, 2016; Measham and Brain, 2005). We did not have measures of competencies, such as round-buying or downing drinks.

Our findings offer some important insights that build on the existing literature. A recent mapping review by Stevely *et al.* (2019) found that the most commonly studied contextual characteristics in event-level alcohol research are the day of the week, affect/mood and venue type (e.g. pub or restaurant). Just 8.6% of the included papers studied duration of drinking occasions. Based on this analysis, the contextual characteristics commonly studied may not be the most important predictors of alcohol consumption and greater attention should be given to other material and temporal elements. The effects of drinking context also vary across age-sex groups (moderation effects) – however, Stevely *et al.* found that few studies on drinking contexts and acute alcohol-related harm tested for

mediation or moderation effects, partly because the literature has a heavy focus on young adult populations (Stevely et al., 2020a).

We used detailed data on the contextual characteristics of drinking occasions collected by the Alcovision survey to estimate alcohol consumption. Although it offers novel analytical possibilities, there are important limitations of the Alcovision dataset (Ally et al., 2016). The variables are designed for market research purposes and are often not well-aligned with measures designed for scientific purposes. Furthermore, we have not analysed factors that are associated with having a drinking occasion in the first place. For example, people may be much more likely to drink at the weekend, but weekend drinking occasions may not involve heavier consumption (Table S1).

Our findings suggest future research and prevention efforts may benefit from using theories of practice to systematically consider elements of drinking occasions. Prevention campaigns building on these findings could promote shorter occasions (or shorter forms of existing practices – such as knowing 'when to call it a night'), drunk people could be more stringently excluded from entering on-trade venues to prevent very long occasions across multiple venues, and on-trade venue licensing could restrict the availability of spirits as doubles. Future research could contribute to developing, testing and evaluating interventions in these areas. It would be particularly valuable to follow up this exploratory work by testing for causal mechanisms that link contextual characteristics and alcohol consumption including combinations, mediation via occasion duration, and moderation by age-sex group.

ADDITIONAL DISCUSSION

Decision tree modelling

In our analysis, we aimed to account for complex combination effects of occasion characteristics based on our conceptualisation of drinking occasions as performances of social practices (Blue et al., 2016; Meier et al., 2017; Shove et al., 2012). However, we have not interpreted the leaves produced by decision tree analyses as representing distinct practices, as we do not know which leaves drinkers would classify as separate practices versus variations on the same practice-as-entity. Future research

applying decision tree modelling in this area may benefit from collecting qualitative data on how drinkers interpret the model results.

Previous research in this area has used latent class analyses to produce typologies of drinking occasions. For example, Ally *et al.* (2016) used data from the Alcovision survey and derived eight types of drinking occasion in Great Britain. Rather than building on this typological approach, this study used decision tree modelling, which facilitated the exploration of which combinations of characteristics explained the most variation in alcohol consumption. This topic is important from a public health perspective as it can inform the targeting of prevention efforts. This approach shares some strengths with latent class analysis as it can model data with a high degree of multi-dimensionality, making it well suited to considering a range of contextual characteristics of drinking occasions. Both methods are also well suited to exploratory research in this area, though they are less appropriate for testing pre-specified hypotheses about the effects of specific contextual characteristics. Both methods account for combinations of contextual characteristics, latent class analysis using a clustering approach and decision tree modelling producing a recursive tree structure. Decision tree analysis can account for more complex interaction effects due to the flexible model structure.

One limitation of my approach is that the resultant decision trees were very large and complex. While this enabled the models to predict alcohol consumption more accurately, I was not able to present the full trees in the paper. As a result of this the results presented in the paper rely to some degree on data that is not presented. Most importantly, the direction of the association between each contextual characteristic and alcohol consumption is not clearly shown. However, example leaves are shown in Figure 2, which illustrate the effects of the three most predictive contextual characteristics on alcohol consumption within drinking occasions. One possibility for future research using this method is to increase the size of the leaves in order to produce simpler decision trees.

Contributions of contextual characteristics to predicting alcohol consumption

This study found that occasion duration, separate occasion characteristics, and combinations of occasion characteristics each contributed to explaining variance in alcohol consumption within drinking occasions, in order of decreasing importance. Future research in this area should therefore strongly consider including the separate occasion characteristics that explained the most variance in consumption (occasion duration, drinking wine, and drinking spirits as doubles). Further combinations of occasion characteristics accounted for between 3% and 16% of the explained variance in nested models of alcohol consumption. This demonstrates that treating occasion characteristics as independent predictors does not fully capture their relationship with alcohol consumption within drinking occasions, and provides support for occasion-based theoretical perspectives such as theories of practice.

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CONFLICT OF INTEREST

None to declare.

DATA ACCESSIBILITY STATEMENT

The Alcovision survey is a commercial product and therefore cannot be made publically accessible.

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7.2   Supplementary material

Table S1. Contextual characteristics of drinking occasions

	Response categories	Proportion of occasions	Mean alcohol consumption in units
Timing[1]			
Duration[2]	Less than an hour (30 minutes)	23.8	3.5
	1 hour but less than 2 (1.5 hours)	26.1	5.8
	2 hours but less than 3 (2.5 hours)	21.0	8.7
	…	…	
	7 hours but less than 8 (7.5 hours)	0.9	19.6
	8 or more hours (8.5 hours)	0.0	20.8
Start time	Before midday (11:00)	3.5	8.9
	Between midday and 1.59 pm (12:00)	7.6	7.9
	Between 2.00 pm and 4.59 pm (14:00)	10.2	9.6
	Between 5.00 pm and 5.59 pm (17:00)	10.2	9.6
	Between 6.00 pm and 6.59 pm (18:00)	14.0	8.5
	Between 7.00 pm and 7.59 pm (19:00)	19.1	8.3
	Between 8.00 pm and 8.59 pm (20:00)	16.5	7.5
	Between 9.00 pm and 9.59 pm (21:00)	10.5	7.5
	Between 10.00 pm and 10.59 pm (22:00)	4.8	7.4
	Between 11.00 pm and 11.59 pm (23:00)	2.0	8.0
	Midnight or later (24:00)	1.5	8.4
Month of the year	January	8.1	8.6
	February	8.3	8.1
	March	8.4	8.3
	April	8.2	8.9
	May	8.7	8.2
	June	8.1	8.2
	July	8.6	8.0
	August	8.6	8.2
	September	8.3	7.9
	October	7.9	8.2
	November	8.1	8.5
	December	8.8	8.2
Day of the week	Monday	8.9	7.6
	Tuesday	9.4	7.5
	Wednesday	10.2	7.7
	Thursday	9.7	7.4
	Friday	20.4	8.7
	Saturday	26.4	9.3
	Sunday	15.1	7.8
Drink type			
Drink type	Beer	41.8	8.5
	Cider	15.9	9.8
	Spirits	25.0	11.6
	Wine	29.0	9.9
	Sherry/ fortified wine/ port	2.5	9.1
	RTDs	4.9	12.0
	Other alcohol	2.4	8.6
	Soft drink	3.4	7.7
	Hot drink	1.3	9.3
	Non or low alcohol beer	0.5	6.2
Drink packaging			
On-trade beer/ cider packaging	Glass bottle	6.4	9.4
	Plastic bottle	0.9	15.1
	Can	1.5	12.0
	Draught	14.2	10.6
Off-trade beer/ cider packaging	Small/ stubby bottle (250ml)	2.9	8.2
	Standard bottle (275/ 330ml)	11.8	6.6

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	Response categories	Proportion of occasions	Mean alcohol consumption in units
	Large bottle (500ml/ 1 pint)	7.4	10.2
	Very large bottle (660ml/750ml beer only)	0.7	12.6
	Plastic bottle (1-3 litre)	0.8	16.8
	Small can (330ml)	2.4	11.7
	Standard can (440ml)	9.8	9.7
	Large can (500ml/ 1 pint)	5.6	10.8
	Draught	1.3	12.9
How spirits were served	With a mixer	16.7	12.0
	Neat	6.2	12.1
	As a shot	2.0	16.9
	As a slammer	0.5	18.8
	As a chaser	0.4	16.8
	As a double	15.9	15.0
	As a single	10.6	7.5
Food			
On-trade food	No food in the on-trade (drank in the on-trade)	20.0	10.4
	Crisps/ Nuts/ Bagged Snacks	1.8	13.1
	Sandwich/ Baguette/ Panini	1.6	13,6
	Light Snack/ Bar Snack	1.9	13.2
	Bar Meal	2.6	9.8
	Restaurant Meal	6.8	7.7
Off-trade food	No food in the off-trade (drank in the off-trade)	30.0	7.3
	Formal Meal	5.7	9.4
	Dinner Party	3.2	13.0
	Informal Meal	25.4	8.6
	Light Snack	15.4	9.7
Company			
Type of company	Family	21.6	8.4
	Friends	29.7	11.3
	Spouse or partner	41.0	8.0
	Work colleagues	3.5	11.8
	Other	1.0	10.1
	No-one I was alone	23.1	7.5
Group structure	Male pair	7.9	8.7
	Female pair	4.4	7.4
	Mixed sex pair	28.6	7.0
	Male group	6.0	11.6
	Female group	3.6	10.1
	Mixed sex group	37.0	10.3
	With children (on-trade only)	4.2	9.7
Trade type[1, 3]			
Trade type	Off-trade	66.2	7.4
	On-trade	22.4	8.2
	Pre-loading	5.9	13.3
	Post-loading	3.3	13.5
	Mixed	0.6	20.4
	Unclear	1.6	13.6
Type of occasion			
On-trade occasion type	Going clubbing	1.3	14.2
	Out on the pull/ chatting up	0.4	13.5
	Big night out	1.1	14.2
	Special celebration	2.1	12.0
	Sociable get-together	6.8	11.1
	Catch up	3.7	10.7
	Quiet drink	3.9	9.5
	Drink after work	2.0	10.4
	Regular/ everyday drink	2.2	11.8
	Going out as a couple	3.3	9.2
	On a date	0.9	10.9
	Family occasion	2.5	8.0

	Response categories	Proportion of occasions	Mean alcohol consumption in units
	Live event	1.4	11.9
	Business drink/ meal	0.5	10.3
	Break from work	1.0	9.3
	Part of another occasion	1.4	8.7
	Other	2.3	8.8
Off-trade occasion type	Big night in	1.5	14.2
	Special celebration	2.9	11.4
	Planned sociable occasion	5.7	11.0
	Friends/ family unplanned	2.6	11.1
	Catch up	5.1	11.0
	Drink after work	5.1	8.2
	Regular/ everyday drink	13.6	7.7
	Staying in as a couple	10.0	8.1
	Quiet night in	19.3	7.8
	A drink before going out	3.5	12.9
	Rounding of the evening	5.6	7.2
	Barbeque/ picnic	1.5	11.0
	Outdoor event	0.8	12.3
	Other	6.5	6.9
Motivation			
Motivation for the occasion	To wind down or chill out	29.9	8.2
	To have time for myself	6.8	9.6
	To treat or reward myself	9.1	8.0
	To have a break	7.6	8.5
	To recharge or invigorate	2.8	10.5
	To refresh	8.2	6.9
	To spend quality time	13.3	9.1
	To bond with others	8.4	10.3
	To feel part of a group	4.4	10.7
	To have a laugh	12.0	12.8
	To let go	4.6	11.4
	None of the above	8.7	7.1
Entertainment			
On-trade entertainment	No entertainment in the on-trade (drank in the on-trade)	15.1	7.8
	Smoke	3.9	14.1
	Watch TV	3.7	12.9
	Games machine	0.8	15.5
	Fruit machine	1.1	15.4
	Quiz machine	0.6	16.5
	Take part in a quiz	1.0	12.3
	Play pool/ snooker	1.7	14.9
	Play darts	0.9	14.8
	Take part in/ watch karaoke	0.6	16.8
	Play any board or card games	0.6	14.7
	Use the juke box	1.0	16.5
	Listen to or watch a live band or act	2.4	13.9
	Dance/ listen to DJ	3.9	14.4
	Children's play area	0.5	12.5
	Bowling	0.5	15.6
	Use the internet	3.7	10.2
	Drink outside	3.9	13.6
Off-trade entertainment	Play games console	2.8	11.8
	Browse the internet	10.7	9.9
	Gamble online	1.0	14.2
	Social network online	7.2	11.3
	Shop online	1.9	12.8
	Play cards (not online)	1.4	15.3
	Play games/ board games	2.4	13.2
	Read	2.9	8.8
	Listen to radio/ music	13.4	11.1

	Response categories	Proportion of occasions	Mean alcohol consumption in units
	Cook/ prepare a meal	7.8	9.6
	Work/ study	1.1	11.1
	Do housework	1.8	11.7
	Gardening/ hobbies	1.1	11.4
	Watch TV/ film/ DVD	36.4	8.0
	General use of computer	5.5	10.4
	Get ready to go out	2.9	13.8
	Have a bath	2.2	12.1
	None of the above	14.4	7.7
Watching TV	General sport	1.7	11.5
	Football	4.4	10.8
	Rugby	0.6	11.7
	Cricket	0.3	13.0
	General TV	24.4	7.7
	Film/ DVD	9.3	8.7
Venue			
On-trade venue type	Nightclub/ late night venue	2.9	14.2
	Modern pub/ bar	6.2	12.3
	Traditional/ community pub	11.6	11.6
	Family pub	3.0	10.0
	Pub restaurant/ gastro pub	5.7	9.9
	Student union bar/ student pub	0.5	13.1
	Café bar/ wine bar	0.4	12.7
	Social/ working men's club	1.4	11.9
	Sports venue/ club/ gym	0.7	11.0
	Restaurant	4.6	8.0
	None of the above	3.0	10.4
On-trade venue location	Village/ rural location	6.5	10.2
	High street/ small town	6.2	10.8
	Residential/ small town	6.1	11.1
	Centre/ large town or city	7.0	10.7
	High street/ large town or city	5.4	11.2
	Residential area/ large town	3.3	11.6
	Retail/ entertainment complex	1.5	10.4
	University/ college	0.8	13.2
	Holiday park village or complex	0.6	11.9
	Form of transport	0.3	13.9
	Airport/ bus/ station	0.3	11.3
	Other	0.2	8.6
Off-trade venue type	My own home	63.1	7.8
	Someone else's home	11.2	11.4
	Holiday home/ cottage/ caravan	1.9	11.7
	Outdoors	1.9	11.4
	At an event/ festival	1.3	11.2
	Other	0.8	10.4
Reason for on-trade venue choice	It's my regular place	4.3	11.4
	It's my local	5.8	11.3
	Convenient to where I work	1.2	10.7
	Convenient to where I live	5.9	10.6
	Convenient to where I was going	4.6	10.1
	I feel at home there	2.9	11.7
	I know lots of people there	3.2	12.5
	I know I will be safe there	1.5	12.4
	I know I will be comfortable	3.7	10.4
	It is a good place to meet up	4.5	10.8
	It has a friendly atmosphere	5.7	10.3
	It has a lively atmosphere	3.4	12.3
	It is quiet	2.4	10.2
	The staff are friendly	3.8	10.8
	It is cheap	5.9	11.8
	It is open late	2.2	14.0

Response categories	Proportion of occasions	Mean alcohol consumption in units
The quality of the drinks	3.1	11.9
The quality of the food	4.3	8.2
The quality of the service	2.4	10.8
It is clean	2.5	10.3
Someone else chose/ planned	3.3	10.3
Recommended/ advertised	1.2	11.8
You can watch sport there	1.5	13.9
It has the right music	2.3	13.5
You can drink outside	2.0	12.3
It is suitable for children	1.0	9.7
Special offer on food	2.4	12.5
The range of drinks available	1.7	9.1
Other	0.9	8.5
Don't know	0.0	N/A

[1] *Categories within these variables are the only contextual characteristics that are mutually exclusive and do not change across the course of an occasion. Categories of all other contextual characteristic variables are entered into analyses as binary variables.* [2] *The duration of occasions in our analysis can be longer than 8.5 hours as we combined reported occasions with no two-hour gaps between drinks to match our definition of a distinct drinking occasion. We calculated new occasion durations based on start times and existing durations.* [3] *Pre-loading occasions involve drinking in the off-trade (such as at home) and then the on-trade (in licensed premises such as pubs) and post-loading starts in the on-trade and moves to the off-trade. We define mixed occasions as switching between the on- and off-trade more than once and unclear occasions as reporting on- and off-trade drinking at the same time.*

Table S2. The proportion of explained variance attributable to each contextual characteristic in models of alcohol consumption per occasion for six age-sex groups

	Male 18-35	36-64	65+	Female 18-35	36-64	65+
Timing[1]						
Duration	41.4%	72.2%	66.6%	45.7%	69.9%	37.3%
Start time	0.7%	2.1%	0.7%		0.2%	2.7%
Month of the year		0.7%	0.3%		1.6%	8.2%
Day of the week			0.1%			4.3%
Drink type						
Wine	11.5%	4.1%	5.5%	15.4%	8.5%	10.6%
Beer	7.6%		2.5%	0.7%	0.2%	1.5%
Cider	0.8%	0.2%	0.1%	0.5%	0.3%	
RTDs	0.9%			0.3%		
Spirits		0.3%	0.2%	0.1%	0.3%	1.1%
Sherry/ fortified wine/ Port						0.1%
Drink packaging						
Spirits as doubles	24.4%	12.9%	17.1%	28.6%	13.7%	9.7%
Spirits with a mixer	1.0%		0.0%	2.7%	0.8%	3.2%
Spirits as a shot	0.5%					
Spirits neat						0.1%
Off-trade beer/cider in a standard can (440ml)	0.9%	0.5%	0.1%		0.2%	
Off-trade beer/cider in a large can (500ml/ 1 pint)	1.7%	0.4%	0.3%		0.3%	
Off-trade beer/cider in a standard bottle (275/ 330ml)		0.8%			0.0%	
Off-trade beer/cider in a large bottle (500ml/ 1 pint)	1.9%		0.0%	0.9%		
On-trade beer/cider draught	2.1%	1.4%		0.7%		
Food						
No food in the on-trade (drank in the on-trade)		0.6%	2.6%			
No food in the off-trade (drank in the off-trade)			0.3%			1.3%
Light snack in the off-trade	0.0%					0.3%
Informal meal in the off-trade			1.1%			4.1%
Restaurant meal		0.9%				
Formal meal in the off-trade			0.5%			
Company						
Friends	2.0%	0.2%		0.8%	0.4%	0.1%
Family					0.5%	2.0%
Partner		0.0%	0.1%			0.6%
Alone						0.2%
Mixed sex pair			0.5%			0.6%
Mixed sex group		0.3%	0.3%	0.4%	0.4%	
Trade-type[1,2]						
On-trade/off-trade/pre-loading/post-loading	1.5%		0.4%	1.8%	0.5%	
Type of occasion						
Planned sociable occasion in the off-trade						2.8%
Regular/ everyday drink in the off-trade		0.1%				0.7%
Staying in as a couple (off-trade)					0.2%	
Quiet night in (off-trade)						3.1%
Other off-trade occasion type						0.2%
Motivation						
To refresh		2.1%				0.2%

	Male			Female		
	18-35	36-64	65+	18-35	36-64	65+
To wind down/ chill out		0.5%	0.5%			
To have a laugh					1.3%	
To spend quality time						0.6%
None of the above			0.2%			0.3%
Entertainment						
No entertainment in the on-trade (drank in the on-trade)						0.3%
Drink outside in the on-trade	0.5%					
Browse the internet in the off-trade					0.3%	
Cook/ prepare a meal in the off-trade						2.8%
Watch TV/film/DVD in the off-trade			0.1%			
Listen to radio/music in the off-trade				1.3%		
Watching general TV						0.1%
Venue						
Drinking in your own home	0.6%			0.2%	0.5%	0.9%
Drinking in a modern pub/ bar	0.2%					
Drinking in a village/ rural location in the on-trade			0.1%			

[1] These variables are the only contextual characteristics that are mutually exclusive and do not change across the course of an occasion. All other contextual characteristics are entered into analysis as binary variables. [2] Pre-loading occasions involve drinking in the off-trade (such as at home) and then the on-trade (in licensed premises such as pubs) and post-loading starts in the on-trade and moves to the off-trade. We define mixed occasions as switching between the on- and off-trade more than once and unclear occasions as reporting on- and off-trade drinking at the same time. Empty cells indicate that the variable was not selected by the model.

Table S3. The proportion of explained variance attributable to each contextual characteristic in models of occasion duration for six age-sex groups

	Male			Female		
	18-35	36-64	65+	18-35	36-64	65+
Trade-type[1,2]						
On-trade/off-trade/pre-loading/post-loading	28.3%	32.5%	41.0%	25.3%	28.4%	36.2%
Timing[1]						
Start time	22.4%	16.3%	5.8%	24.9%	21.5%	6.6%
Month of the year	3.0%	2.8%	5.2%		4.1%	8.6%
Day of the week		0.3%	0.2%	1.0%	1.2%	3.0%
Company						
Friends	10.8%	11.8%	17.2%	18.4%	11.5%	2.7%
Family	0.1%	0.6%		0.4%		
Partner		0.1%	0.6%	0.9%	0.2%	0.7%
Alone	0.2%	1.5%				3.8%
Same sex pair		0.7%				
Mixed sex pair		0.1%	1.5%			2.0%
Mixed sex group	1.0%	0.3%	0.3%	2.0%	2.8%	5.9%
Entertainment						
No entertainment in the on-trade (drank in the on-trade)	0.7%	1.8%	2.8%	1.8%	0.6%	
Dance/ listen to DJ in the on-trade	0.7%					
Browse the internet in the off-trade				0.5%		
General use of computer in the off-trade	1.3%	6.2%	2.6%			
Social network online in the off-trade		1.3%			3.2%	
Cook/ prepare a meal in the off-trade			0.2%			
Watch TV/film/DVD in the off-trade	0.8%	3.1%	4.0%	0.7%	0.7%	3.4%
Listen to radio/music in the off-trade	0.7%	0.4%			4.0%	1.2%
Watching general TV			0.7%	0.3%	0.3%	
Read in the off-trade			2.9%			
None of the above (off-trade)	1.5%	1.5%			0.5%	1.7%
Food						
No food in the on-trade (drank in the on-trade)	1.4%		0.2%			
No food in the off-trade (drank in the off-trade)	5.8%	1.7%	0.5%	1.2%	0.5%	0.3%
Light snack in the off-trade		0.2%	0.5%		5.0%	1.6%
Informal meal in the off-trade	0.5%	0.5%	0.3%		0.5%	0.8%
Restaurant meal		0.6%				
Drink type						
Wine			0.9%	0.6%	0.8%	2.1%
Beer	0.7%	0.9%	0.7%	0.9%		
Cider				1.1%		0.6%
RTDs	1.2%					
Spirits	4.2%			8.3%	2.4%	0.7%
Sherry/ fortified wine/ Port	2.7%					
Drink packaging						
Spirits as doubles	3.7%			2.3%		
Spirits as singles						1.2%
Spirits with a mixer		1.5%	1.2%		0.7%	
Spirits as a shot	0.4%					
Off-trade beer/cider in a standard can (440ml)	0.3%	0.6%	0.9%		2.3%	
Off-trade beer/cider in a standard bottle (275/ 330ml)		5.6%				
Off-trade beer/cider in a large can (500ml/ 1 pint)	2.1%					
Off-trade beer/cider in a large bottle (500ml/ 1 pint)			0.2%			

	Male			Female		
	18-35	36-64	65+	18-35	36-64	65+
On-trade beer/cider draught		1.2%				
Venue						
Drinking in your own home	2.1%	0.6%	2.1%	5.4%	1.2%	
Drinking in someone else's home	0.9%					
Drinking in a modern pub/ bar				0.4%		
Drinking in a traditional/ community pub		0.1%				
Drinking in a social/ working men's club			0.6%			4.7%
Drinking in a residential/ small town in the on-trade			0.4%			
Drinking in a night club/ late night venue in the on-trade				0.3%		
None of the above (on-trade)						4.0%
Motivation						
To treat or reward myself			0.1%			
To wind down/ chill out	0.2%		1.3%			1.1%
To have a laugh	1.5%			1.1%	2.3%	
To spend quality time			2.3%	1.2%	1.3%	1.5%
Time to myself			0.8%			2.9%
To let go					1.4%	
Type of occasion						
Sociable get together in the on-trade	0.7%					
Regular/ everyday drink in the off-trade		3.1%				4.3%
Staying in as a couple (off-trade)					1.0%	0.1%
Quiet night in (off-trade)		0.3%	0.5%			
Rounding off the evening (off-trade)		2.0%	1.0%			
Other off-trade occasion type			0.1%		0.8%	0.1%
Reason for on-trade venue choice						
It's my local			0.5%			

variables are the only contextual characteristics that are mutually exclusive and do not change across the course of an occasion. All other contextual characteristics are entered into analysis as binary variables. ² Pre-loading occasions involve drinking in the off-trade (such as at home) and then the on-trade (in licensed premises such as pubs) and post-loading starts in the on-trade and moves to the off-trade. We define mixed occasions as switching between the on- and off-trade more than once and unclear occasions as reporting on- and off-trade drinking at the same time. Empty cells indicate that the variable was not selected by the model.

8   Evaluating the effects of the Licensing Act 2003 on the characteristics of drinking occasions in England & Wales: A theory of change-guided evaluation of a natural experiment

This chapter presents the first practice-theory informed evaluation of a major alcohol intervention (the Licensing Act 2003), which tested for effects of the Act on various contextual characteristics of drinking occasions. This work was conducted during the course of my studies and the version submitted for review at *Addiction* is reproduced in this chapter. The version included here has been revised according to comments from my viva voce examiners (Appendix A). Following revisions, this paper has been published online (127). I presented this study at the Society for the Study of Addiction Annual Conference in Newcastle, UK (7th November – 8th November 2019).

I planned this study prior to my confirmation review and did most of the work during the second year of my project. From the beginning of my PhD, I wanted to explore the value of applying a practice-based approach to alcohol policy evaluation. I chose to focus on licensing changes in England, Scotland and Wales as the existing evaluation literature on these major policy interventions had mixed findings that did not align with expectations prior to policy implementation, and pointed to a potential explanatory role of contextual variables. As such, I wanted to explore whether my approach could provide insights into the mechanisms of effect of changing licensing policy.

The main challenges of planning this study were developing the hypotheses and designing an analytical approach that could test them. I began by reading the existing evaluation literature and drawing on proposed but untested mechanisms suggested by the authors. From this background and in discussions with my supervisors, I developed a set of hypotheses relating to the expected effects of extending licensing hours on drinking occasions. I then developed an analysis plan, collaborating with Frank de Vocht from Bristol University – an expert in time series methodologies. We initially planned a controlled interrupted time series analysis of two related Acts implemented respectively by the UK Government for England and Wales and by the Scottish Government for Scotland. Data from Scotland acted as a control for the effects of the Licensing Act 2003 and data from England and Wales acted as a control for the Licensing (Scotland) Act 2005. Including evaluation of two policy changes that deregulated trading hours was intended to provide a more robust understanding of the effects on drinking occasions.

After developing my hypotheses and analysis plan, I started initial data analysis to understand the time series data in the Alcovision survey. I needed to check the consistency of the full time series (from 2001 – 2016) as the Alcovision survey moved from in-street to online sampling in 2009. The Licensing (Scotland) Act was implemented in 2009 so to evaluate its effects I would need to use data from before the methods change to estimate pre-intervention trends. The full time series (2001 – 2016) was also required for a large

project in my research group so I collaborated with colleagues (particularly Alessandro Sasso) to check and clean this data.

A further barrier to producing complete time series for my outcome measures was that the new dataset (2009 – 2016) made several changes to the survey questions and response options. For example, the Alcovision survey asks about what type of occasion is being reported and response options in the 2001 – 2008 dataset included 'meeting friends' and 'while travelling' which were not present in the 2009 – 2016 dataset. These changes resulted in larger than expected discontinuities between the two datasets. I therefore developed a 'harmonised' version of the dataset running from 2001 – 2016, merging variables where possible. This was a large job as the survey includes a wide range of measures and many of these had changed in 2009. However, further investigation showed that our attempts at harmonising the dataset did not sufficiently resolve the discontinuities in the time series, especially in relation to some of the key variables I was going to use. For example, the average start time of drinking occasions was between 17:30 and 18:00 from 2001-2008 but changed suddenly in 2009 to 18:30. There was also an increase in the total number of occasions being reported, likely due to having more time to complete an online survey versus in-street survey completion. When I examined this change, I found that there was a greater drop off in reporting across the diary week (i.e. more occasions being reported for day 1 and fewer for day 7) in 2001 – 2008 compared to 2009 – 2016.

We had hoped to resolve these discontinuities and my colleague Alessandro tried a range of modelling techniques. This included creating new survey weights using day of the week as a target variable to adjust for the drop off in reporting across the diary week. He also tried to use propensity score matching models to increase the similarity of the samples in the 2001 – 2008 dataset and 2009 – 2016 dataset. Unfortunately, despite significant efforts, we were unable to resolve the discontinuities in the time series. We decided that the full dataset (2001 – 2016) could not be used as a continuous time series and I therefore evaluated only the Licensing Act 2003, using data from Scotland as a control.

8.1 Submitted paper

Evaluating the effects of the Licensing Act 2003 on the characteristics of drinking occasions in England & Wales: A theory of change-guided evaluation of a natural experiment

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Running head: Evaluating the Licensing Act 2003

Abstract

Background and Aims

The Licensing Act 2003 deregulated trading hours in England and Wales (E&W). Previous evaluations have focused on consumption and harm outcomes, finding mixed results. Several evaluations speculated on the reasons for their results, noting the role of changes in the characteristics of drinking occasions. This study therefore aims to test proposed mechanisms of effect for the Licensing Act 2003 by evaluating changes in characteristics of drinking occasions.

Design, setting and participants

Interrupted monthly time series analysis of effects in E&W versus a Scottish control series, using 2001-2008 data collected via 7-day drinking occasions diaries by the market research company Kantar (N=89,192 adults aged 18+).

Measurements

Outcomes were start and end time of each reported occasion, variation in finish time, prevalence of pre-loading, post-loading and late-night drinking, and alcohol consumption (in units).

Findings

After the introduction of the Act, occasions started shifting slightly later at night in E&W relative to Scotland (finish time changed by 1.8 minutes per month; 95% CI=1·2-2·4). More occasions involved pre-loading (0·02% increase; 95% CI=0·01-0·03). There was no evidence of changes in variation in finish time, post-loading, late-night drinking, or alcohol consumption.

Conclusions

The Licensing Act 2003 had only limited effects on the characteristics of drinking occasions. This may help to explain the lack of substantial impacts on alcohol harms.

Introduction

Controlling the spatial and temporal availability of alcohol is one of the most effective ways of reducing alcohol consumption and related harm.[1] In countries such as England & Wales, availability is controlled through a system of licenses permitting the sale of alcohol.[1] In England & Wales, licensing is currently regulated under the Licensing Act 2003 (implemented in November 2005), which liberalised licensing policy to help regenerate struggling local economies and encourage a change in drinking culture.[2] The Act has been criticised from a public health perspective as the international literature suggests that extending licensing hours may increase alcohol-related harm.[3,4]

The Act made a number of changes including moving responsibility for licensing to newly formed licensing committees, which include elected members of local councils, and restricting the ability of licensing authorities to withhold licenses or restrict trading behaviours.[5,6] The most widely discussed change was the liberalisation of both on-trade and off-trade alcohol outlet trading hours, which had previously ended at 11pm for most outlets.[5–7] The Act removed fixed licensing hours in England & Wales; premises were allowed to apply for and receive licenses to trade for longer periods up to 24 hours a day unless licensing authorities could demonstrate this would undermine one of the four newly introduced licensing objectives (the prevention of crime and disorder; public safety; the prevention of public nuisance; and the protection of children from harm).[6,8,9] Although public debate around the Act focused on the possibility of 24-hour-drinking, the changes that actually occurred were less dramatic than those enabled by the legislation.[9,10] Some premises already traded after 11pm under Special Hours Certificates as a result of previous liberalisation processes.[10] Furthermore, only a small number of premises applied for 24-hour licenses, but around 80% of venues did extend their opening hours past the previous standard closing time of 11pm.[9]

Existing evaluations of the Act have mixed findings, with some studies finding increases in violent crime and emergency department attendance following implementation while others find that violence, emergency department attendance and alcohol-related traffic accidents decreased or did not change significantly.[8,10–16] Some existing evaluations were not able to adjust for all important confounding factors or lacking adequate pre-implementation data.[4,17] Existing evaluations also largely focus on harm outcomes such as violent crime and emergency department attendance. There is a lack of evaluation examining proximal outcomes. For example, changes in characteristics of drinking occasions (e.g. the timing or location of alcohol consumption) which produce distal outcomes such as consumption and alcohol-related harm. Several evaluations speculated on the reasons for their results, noting the possible role of changes in the characteristics of drinking occasions.[9,12,18–21] These occasion characteristics are of increasing public health interest as a growing literature suggests that they are associated with levels of consumption and acute alcohol-related harm within drinking occasions.[22] Consideration of occasion characteristics can help to understand the changes that occurred, add clarity to mixed findings on the effects of the Act, and inform future policy making.[23,24]

This study therefore aims to test mechanisms of effect for the Licensing Act 2003 by evaluating changes in characteristics of drinking occasions.

Methods

Hypotheses

We iteratively developed a set of hypotheses for the possible effects of the Licensing Act 2003 on drinking occasions, based on explanations proposed in previous evaluations and informal discussion with stakeholders (Table 1).[8,17,25,26] This analysis was not pre-registered and the results should be considered exploratory.

Table 1. Table of hypotheses

Hypothesis	Rationale and sources	Outcome measure	Support from results
1 Timing			
H1a. Occasions finish later, especially at the weekend	Previous evaluations hypothesised that because fewer venues closed at a standard closing time (11pm) customers may have left on-trade venues later.[9,12,18] This is expected to be most pronounced at the weekend, where there were greater changes in trading hours.[9,12] The timing of off-trade drinking occasions may also have changed as alcohol became available later at night.[9]	Mean occasion finish time (start time + occasion length)	Partially
H1b. More variation in finish times (increased standard deviation)	It has been hypothesised by previous evaluations that the closing times of venues became more varied so people may have left on-trade venues at more varied times.[12,18]	Standard deviation of occasion finish time	No
H1c. On-trade and mixed on/off-trade occasions started at a similar time and finished later (tested separately) especially at the weekend and for those under 25 years old	Drinking occasions may have continued to start at a similar time (with a possible shift towards starting in the off-trade) while ending later.[19] These changes may be more pronounced among under 25 year olds as there is evidence suggesting that their drinking occasions start at a constant time at the weekend and they are generally likely to pre-load.[19,21]	Mean occasion start and finish times	Partially
2 Pre- and post-loading			
H2a. There were more mixed location occasions which started in the off-trade and proceeded to the on-trade, especially at the weekend and for those under 25 years old	Longer opening hours of on-trade venues may have encouraged people to drink in the off-trade first (pre-loading) since alcohol is cheaper and there would still be plenty of time to drink in the on-trade later.[20] These changes may be more pronounced among under 25 year olds as there is evidence suggesting that their drinking occasions start at a constant time at the weekend and they are generally likely to pre-load.[19,21]	Proportion of occasions which began in the off-trade and proceeded to the on-trade	Partially
H2b. There were fewer mixed location occasions which started in the on-trade and proceeded to the off-trade	It may have become less common to move to the off-trade after on-trade drinking as on-trade drinking could continue later at night.	Proportion of occasions which began in the on-trade and proceeded to the off-trade	No
3. Alcohol consumption			
H3a. The same number of units were drank per hour in on-trade and mixed location occasions, which led to higher mean consumption per occasion if H1c is supported	Given a stable rate of consumption, longer occasions may have led to higher overall consumption.[27]	Mean number of units drank in the on-trade per occasion	No

Hypothesis	Rationale and sources	Outcome measure	Support from results
H3b. Mean off-trade consumption per occasion increased	The Act also removed restrictions on trading hours for off-trade sales but hypothesising the effects of this is not straightforward as alcohol can be bought in the off-trade in advance of the drinking occasion. Nonetheless, we hypothesise that longer off-trade trading hours may have led to increased consumption in off-trade drinking occasions as people could buy more alcohol and continue drinking later at night.[1]	Mean number of units drank in the off-trade per occasion	No
4. Demographic groups involved in late-night drinking occasions			
H4a. More drinking occasions among over 25s started after 11pm	A greater proportion of over 25s' drinking occasions may have been late-night drinking due to this greater variety of available venues.	Proportion of occasions which started after 11pm	No
H4b. More drinking occasions among full-time employees started after 11pm, especially at the weekend	People in full time employment are expected to have late-night drinking occasions at the weekend since they are typically working during the week.	Proportion of occasions which started after 11pm	No

Research design

In line with these hypotheses, we analysed the effect of the Licensing Act 2003 on the timing of, location type of, and level of alcohol consumption during drinking occasions using ARMA models and controlled interrupted time series methods. This is a quasi-experimental design that makes efficient use of the natural experiment of the Act being introduced.[28] We used data from Scotland to control for time-varying confounders under the assumption that these followed similar time trends across Great Britain.[29]

Data

We used data from the 2001-2008 Alcovision survey, which is collected by Kantar Worldpanel, a market research company. Alcovision is a continuously collected cross-sectional survey that includes measures of usual alcohol consumption, socio-demographic variables and a detailed 7-day retrospective drinking diary.

The sample was an in-street quota sample of ~12,500 adults per year (18+) in Great Britain. The present analysis includes 185,772 drinking occasions nested within 89,192 respondents who reported drinking during the diary week. All persons gave their informed consent prior to their inclusion in the survey. Great Britain census derived weights based on age, social grade, sex and geographic region are used.

The diary begins by identifying those days in the last week on which the respondent drank in off-trade locations (e.g. drinking at home) or on-trade (e.g. pubs, restaurants). Participants describe characteristics of up to two off-trade and two on-trade occasions per day including who they were with, the reason for the occasion, and what type of alcohol they drank. Since real-world drinking occasions can span on- and off-trade locations, we define occasions differently as periods of drinking with no more than a two-hour gap between drinks.

Measures

Outcome measures

We have nine outcome measures split across four domains: timing, pre- and post-loading, alcohol consumption, and demographic groups involved in late-night drinking occasions. The timing measures are start and finish time of each occasion, and standard deviation of finish time of all occasions. The alcohol consumption measures are drinking speed (units/ hr), on-trade consumption, and off-trade consumption. Finally, we measure the proportion of all occasions that are late-night drinking occasions. To address our hypotheses, we analyse these outcomes across pre-specified subgroups selected by age, drinking location (on-trade, off-trade, mixed on- and off-trade location), weekend vs weekday, and employment status. We used weighted data from all occasions within the sample to calculate population-representative monthly time series of average values of the outcome variables. We excluded respondents who did not report any drinking during the diary week.

Start times of each occasion are measures in bands such as 14:00-17:00 and 19:00-20:00, we use the earliest time in each band for analyses. The finish time of each occasion is calculated by adding the occasion length (which is measured in bands and we use mid-points to create point estimates) to the start time. We also use standard deviation of occasion finish times, which we use to assess variation in finish times.

Pre-loading occasions are when alcohol is consumed first in the off-trade (e.g. at home) and then the on-trade (e.g. a pub) and vice versa for post-loading occasions. We measure this as the monthly proportion of occasions that involve pre-loading. Proportion of post-loading occasions is calculated in the same way.

Units are calculated from variables recording serving size, number of servings consumed and ABV. We used units to construct three consumption outcome measures: the mean number of units drank per hour in each drinking occasion (drinking speed), the mean number of units consumed in the on-trade per occasion (on-trade consumption), and the mean number of units consumed in the off-trade per occasion (off-trade consumption).

Our final domain related to late-night drinking. The main outcome measure is the proportion of occasions that are 'late-night'. We hypothesised that more occasions started after 11pm but the Alcovision survey collects data on occasion start times in bands starting at 10pm and midnight, and therefore we a priori decided to define late-night occasions as those starting after midnight. We conducted a sensitivity analysis defining late-night occasions as starting after 10pm.

Licensing Act 2003

Models included a dummy variable representing the Licensing Act 2003 (to evaluate whether there was a step change in the outcome variable in November 2005 when the Act was implemented) and an interaction term of this dummy variable with the monthly time term (to evaluate whether there was a slope change in the outcome variable). The coefficients of the step change and slope variables are the key results of interest for each model. Step changes indicate an immediate change in the outcome measure, for example, an increase in the variation of drinking occasion finish times in November 2005. Slope changes indicate a change in the trend of the outcome measure. For example, mean finish times could have been getting gradually earlier from 2001 but then shown a change in trend and started shifting later at night from November 2005 onwards.

Stratifying variables

To test our hypotheses, we also use stratifying variables including age (under and over 25) and employment status (whether in full time employment). The Alcovision survey asks respondents to give their age in years and employment status is measured by the question 'Can you please indicate your employment status?' with 13 response options e.g. 'Working full time (30+ hours)' or 'Unemployed more than 11 months'.

Respondents also report the day of the week for each drinking occasion and we use this to identify weekend drinking - defined as Fridays and Saturdays.

Statistical analysis

To specify our ARMA models, we used autocorrelation and partial autocorrelation plots to identify auto-correlation for each outcome measure and corrected it where necessary by including an auto-regressive term of order one. We accounted for seasonality in the time series by including year and dummy variables for the calendar month as predictors. In order to control for time-varying confounders, we modelled the series created by subtracting monthly series of each variable in Scotland from the monthly series in England & Wales. The resulting series is referred to as the differenced series.

We modelled each outcome variable separately in both England & Wales and Scotland before modelling the differenced series. A change in the differenced series will occur when there is a change in England & Wales that did not take place in Scotland and vice versa. The underlying assumption is that trends in time-varying confounders do not differ between England & Wales and Scotland and remain stable before and after the introduction of the Licensing Act. All analyses were conducted using Stata version 15.

Ethics approval

This study was approved by the University of Sheffield's ethics committee and conforms to the principles embodied in the Declaration of Helsinki. Use of this data is allowed under the terms of the contract and non-disclosure agreement between Kantar Worldpanel and the University of Sheffield, which requires research outputs to be submitted to the data provider ahead of publication. The data providers' right to request changes is limited to matters of accuracy regarding the Alcovision survey data.

Role of funding source

The funders of the study had no role in the study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

To provide context for the results, mean values for main outcome measures based on the full monthly time series are shown in Table 2. The results of all models can be found in the supplementary tables.

Table 2. Mean values of main outcome measures based on full monthly time series (2001 - 2008)

Outcome measure	England and Wales	Scotland
1: Timing		
Finish time	19:47	20:35
Finish time – standard deviation	3·11	2·87
Start time for on-trade or mixed drinking occasions	17:08	17:17
Finish time for on-trade or mixed drinking occasions	20:17	20:47
2: Pre- and post-loading		
Proportion of pre-loading occasions (%)	2.46	2.89
Proportion of post-loading occasions (%)	1.44	1.18
3: Alcohol consumption		
Drinking speed (units/ hr) for on-trade or mixed drinking occasions	3.09	3.29
On-trade consumption (units/ occasion)	2.69	3.39
Off-trade consumption (units/ occasion)	3.54	4.35
4: Range of venues and demographic groups involved in late-night drinking occasions		
Proportion of late drinking occasions among over 25 year olds (%)	0.32	0.26
Proportion of late drinking occasions among those in full-time employment during the week (%)	0.40	0.09
Proportion of late drinking occasions among those in full-time employment at the weekend (%)	0.55	0.26

1: Timing

H1a: Occasions finish later, especially at the weekend

Immediately following the Act, the mean finish times of drinking occasions moved later in the evening in both England & Wales (+11·4 minutes; 95% CI = 3·6 – 19·2) and Scotland (from around 8:45pm to 8:55pm). Since this happened in all countries, there is no evidence of an immediate impact of the Act (i.e. no significant step change in the differenced series) (Figure 1, Table 3, Supplementary Table 1).

However, there was a change in trend over time (slope change) towards earlier mean finish times in Scotland but not England & Wales. The significant change in the differenced series suggests that finish times might have also become slightly earlier in England & Wales if it were not for the implementation of the Act (+1·8 minutes per month; 95% CI = 1·2 – 2·4) (Figure 1, Table 3). This pattern was seen in on-trade and off-trade occasions, while the effect size was also similar on week days and weekends (Supplementary Tables 3 – 5).

Table 3. Key differenced series results

1: Timing

Finish time

Step change				Slope change		
B	**95% Confidence interval**	**P**		**B**	**95% Confidence interval**	**P**
-0·01	-0·29 - 0·26	0·92		0·03	0·02 - 0·04	0·00

Finish time – standard deviation

Step change				Slope change		
B	**95% Confidence interval**	**P**		**B**	**95% Confidence interval**	**P**
0·18	-0·04 - 0·41	0·10		0·01	0·00 - 0·02	0·08

Start time for on-trade or mixed drinking occasions

Step change				Slope change		
B	**95% Confidence interval**	**P**		**B**	**95% Confidence interval**	**P**
-0·22	-0·62 - 0·18	0·28		0·02	0·00 - 0·03	0·02

Finish time for on-trade or mixed drinking occasions

Step change				Slope change		
B	**95% Confidence interval**	**P**		**B**	**95% Confidence interval**	**P**
-0·21	-0·67 - 0·26	0·38		0·02	0·01 - 0·04	0·01

2: Pre- and post-loading

Proportion of pre-loading occasions

Step change				Slope change		
B	**95% Confidence interval**	**P**		**B**	**95% Confidence interval**	**P**
0·02	0·01 - 0·03	0·00		0·00	-0·00 - 0·00	0·22

Proportion of post-loading occasions

Step change				Slope change		
B	**95% Confidence interval**	**P**		**B**	**95% Confidence interval**	**P**
0·00	0·00 - 0·01	0·53		0·00	-0·00 - 0·00	0·61

3: Alcohol consumption

Drinking speed (units/ hr) for on-trade or mixed drinking occasions

Step change				Slope change		

B	95% Confidence interval	P		B	95% Confidence interval	P
-0·19	-0·56 - 0·18	0·31		0·00	-0·01 - 0·02	0·73

On-trade consumption

Step change				Slope change		
B	95% Confidence interval	P		B	95% Confidence interval	P
0·08	-0·36 - 0·51	0·72		0·01	0·00 - 0·03	0·15

Off-trade consumption

Step change				Slope change		
B	95% Confidence interval	P		B	95% Confidence interval	P
0·01	-0·29 - 0·3	0·97		-0·01	-0·02 - 0·00	0·14

4: Range of venues and demographic groups involved in late-night drinking occasions

Proportion of late drinking occasions among over 25 year olds

Step change				Slope change		
B	95% Confidence interval	P		B	95% Confidence interval	P
0·00	-0·01 - 0·00	0·63		0·00	-0·00 - 0·00	0·50

Proportion of late drinking occasions among those in full-time employment during the week

Step change				Slope change		
B	95% Confidence interval	P		B	95% Confidence interval	P
0·00	0·00 - 0·01	0·51		0·00	-0·00 - 0·00	0·82

Proportion of late drinking occasions among those in full-time employment at the weekend

Step change				Slope change		
B	95% Confidence interval	P		B	95% Confidence interval	P
0·00	-0·01 - 0·00	0·04		0·00	-0·00 - 0·00	0·84

Differences = Differenced series created by subtracting the Scotland series from the England and Wales series. B = regression coefficient. P = p-value. All outcome measures are monthly series of weighted drinking occasion characteristics. Start time, finish time, drinking speed, on-trade consumption and off-trade consumption are monthly averages. Finish time – standard deviation is monthly weighted standard deviations of occasion finish times. Pre-loading occasions are when alcohol is consumed in the off-trade (e.g. at home) and then the on-trade (e.g. a pub) and vice versa for post-loading occasions. Proportion of pre-loading occasions is the monthly weighted number of pre-loading occasions as a proportion of the weighted number of total occasions that month. Proportion of post-loading occasions and late drinking occasions are calculated in the same way. Late drinking occasions are defined as occasions starting after midnight. Drinkers are those who consumed at least one alcoholic beverage during the diary week.

H1b: More variation in finish times

There was a small step change in the standard deviation of monthly occasions finish times in England & Wales (+4·8 minutes; 95% CI = 0·0 – 10·2) and a slope change (+0·6 minutes per month; 95% CI = 0·0 - 0·6) following the introduction of the legislation, which was not observed in Scotland. However, the findings for the differenced series showed no significant effect of the Act (Figure 1, Table 3, Supplementary Table 1).
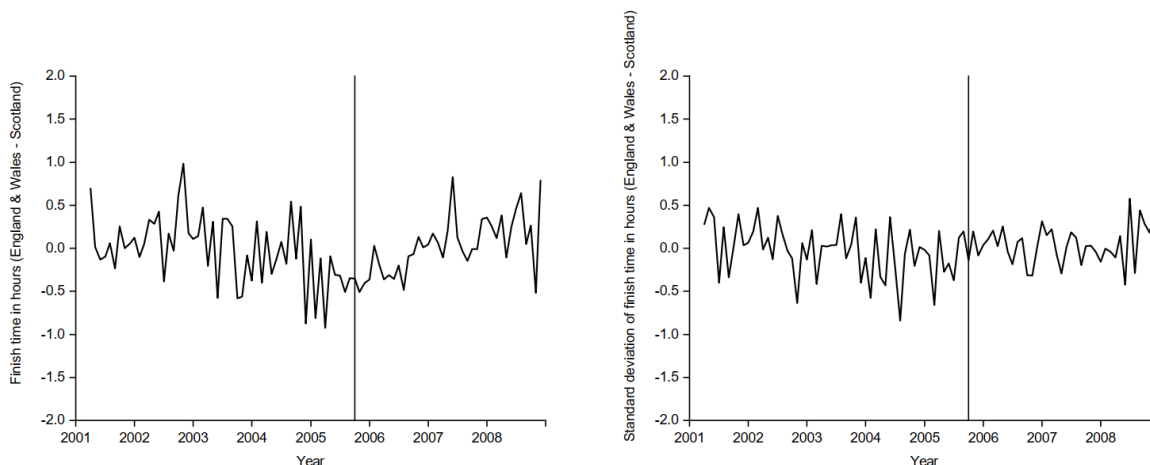

Figure 1. Monthly deseasonalised mean occasion finish time and standard deviation of mean occasion finish time, differenced England & Wales minus Scotland.

Vertical line = implementation of the Licensing Act 2003, November 2005

H1c: Later finish but same start for on-trade and mixed location occasions especially young peoples' and weekend drinking

On-trade and mixed location occasions in England & Wales became longer after the implementation of the Act – driven by the step change in mean finish times (+22·2 minutes; 95% CI = 8·4 – 35·4). Mean start times and finish times both showed changes in slope towards later in the evening, shifting occasions later at night but overall not contributing to the increased duration as the changes in slope were similar for mean start and finish times (Supplementary Table 4).

In Scotland, occasions also became longer because of a step change in finish times (+28·2 minutes; 95% CI = 7·8 – 48·0). However, in contrast to England and Wales, a trend towards earlier mean start times and finish times was observed in Scotland, shifting occasions earlier overall (Supplementary Table 4). The impact of the introduction of the Act, as modelled based on the differenced series, indicated a significant slope change towards later start and finishing times (Figure 2, Table 3), suggesting that the Act contributed to occasions shifting later at night in England & Wales but not getting longer.

The pattern of results was broadly similar for on-trade and mixed drinking occasions at the weekend in England & Wales and Scotland, but the changes were not significant in the differenced series (Supplementary Table 3). On-trade or mixed drinking occasions among under 25 year olds again showed a

similar pattern of results, with only the slope change in finish times being significant in the differenced series (+1·8 minutes per month; 95% CI = 0·0 – 3·0) (Supplementary Table 2).
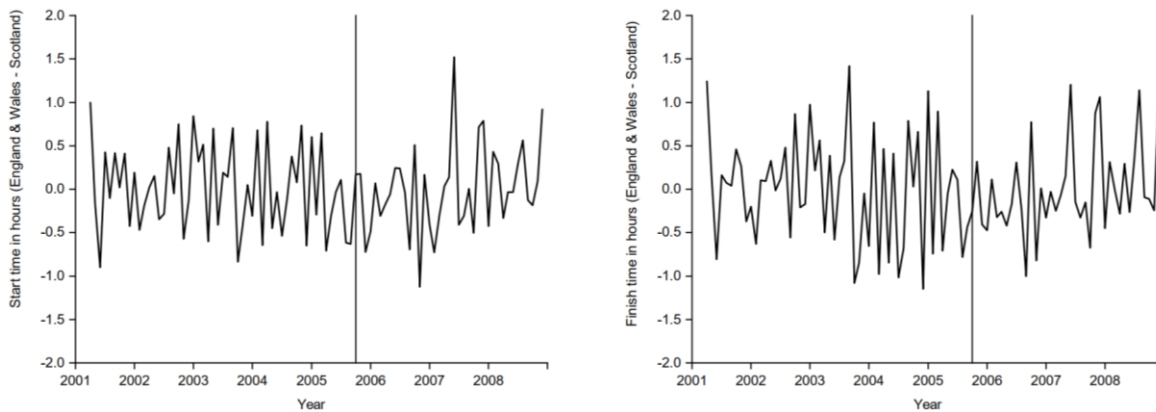

Figure 2. Monthly deseasonalised mean on-trade or mixed occasion start time and finish time, differenced England & Wales minus Scotland.

Vertical line = implementation of the Licensing Act 2003, November 2005

2: Pre- and post-loading

H2a: More pre-loading, especially young peoples' and weekend drinking

There was a step change towards less pre-loading in Scotland (-0·02% of occasions involving pre-loading; 95% CI = -0·03 – 0·00) and pre-loading increased by 0·01% (95% CI = 0·00 - 0·01) in England & Wales (Supplementary Table 1). The estimated effect of the Act was significant (+0·02% of occasions involving pre-loading; 95% CI = 0·01 – 0·03) (Figure 3, Table 3). This change was of a similar magnitude at the weekend and among under 25 year olds (Supplementary Tables 6 and 7). There was no significant slope change in the differenced series.

H2b: Fewer mixed location occasions that started in the on-trade and finished in the off-trade

There were no significant changes in the proportion of post-loading occasions (Figure 3, Table 3, Supplementary Table 1).
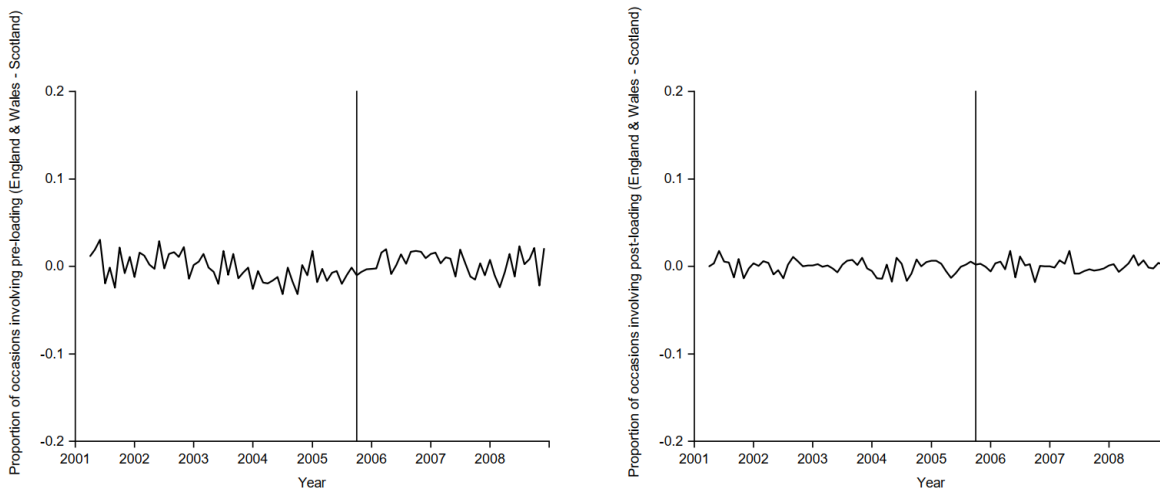
Figure 3. Monthly deseasonalised proportion of occasions involving pre-loading and post-loading (%), differenced England & Wales minus Scotland.

Vertical line = implementation of the Licensing Act 2003, November 2005

3: Alcohol consumption

H3a: Speed of drinking remains constant, leading to higher per-occasion consumption

Average drinking speed in on-trade and mixed location occasions fell in both England & Wales (-0·24 units per hour; 95% CI = -0·45 - -0·03) and Scotland (-0·37 units per hour; 95% CI = -0·73 - -0·01) (Supplementary Table 4). There was no significant change in the differenced series, suggesting that the decrease in England & Wales may not be attributable to the Act (Figure 4, Table 3).

As previously discussed, occasions in England, Wales and Scotland got longer after the implementation of the Act. However, because this combined with a similarly-sized reduction in drinking speed across England, Wales and Scotland, there was no change in mean consumption per on-trade occasion in the differenced series (Figure 4, Table 3, Supplementary Table 1).

H3b: Overall consumption in off-trade occasions increased

There was no significant step change or change in slope for mean off-trade consumption per occasion in England & Wales or Scotland (Figure 4, Table 3, Supplementary Table 1).
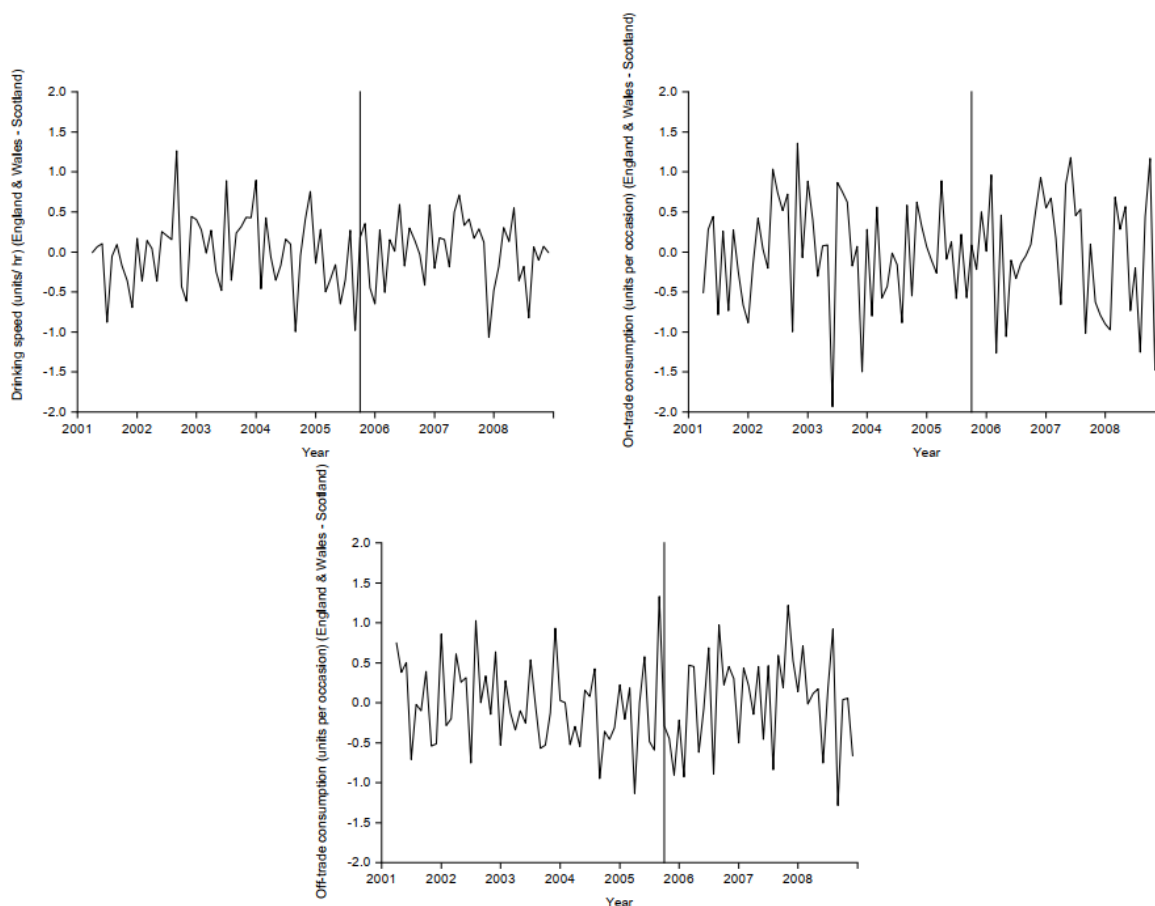
Figure 4. Monthly deseasonalised mean drinking speed (units/ hour) of on-trade or mixed drinking occasions, on-trade consumption and off-trade consumption, differenced England & Wales minus Scotland.

Vertical line = implementation of the Licensing Act 2003, November 2005

4: Demographic groups involved in late-night drinking occasions

H4a: More drinking occasions among over 25s were late-night drinking (after 11pm)

None of the models showed a significant step change or change in slope for the proportion of late drinking occasions among over 25 year olds after the Act (Figure 5, Table 3, Supplementary Table 8). This result did not change in the sensitivity analysis where late-night drinking was defined as occasions starting after 10pm.
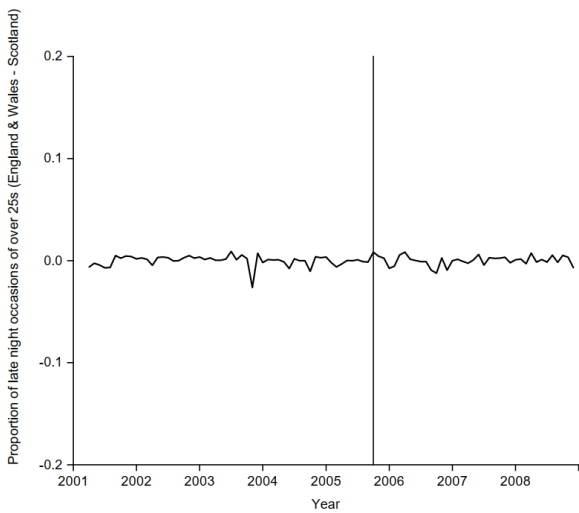
Figure 5. Monthly deseasonalised proportion of late night occasions among over 25s (%), differenced England & Wales minus Scotland.

Vertical line = implementation of the Licensing Act 2003, November 2005

H4b: More drinking occasions among full-time employees were late-night drinking, especially at the weekend

There was only one significant change in the differenced series (a step change), suggesting that those in full-time employment had marginally more late-night drinking occasions at the weekend in Scotland relative to England & Wales (Figure 6, Table 3, Supplementary Table 9). This contradicts the hypothesis. This result also remained the same in the sensitivity analysis.
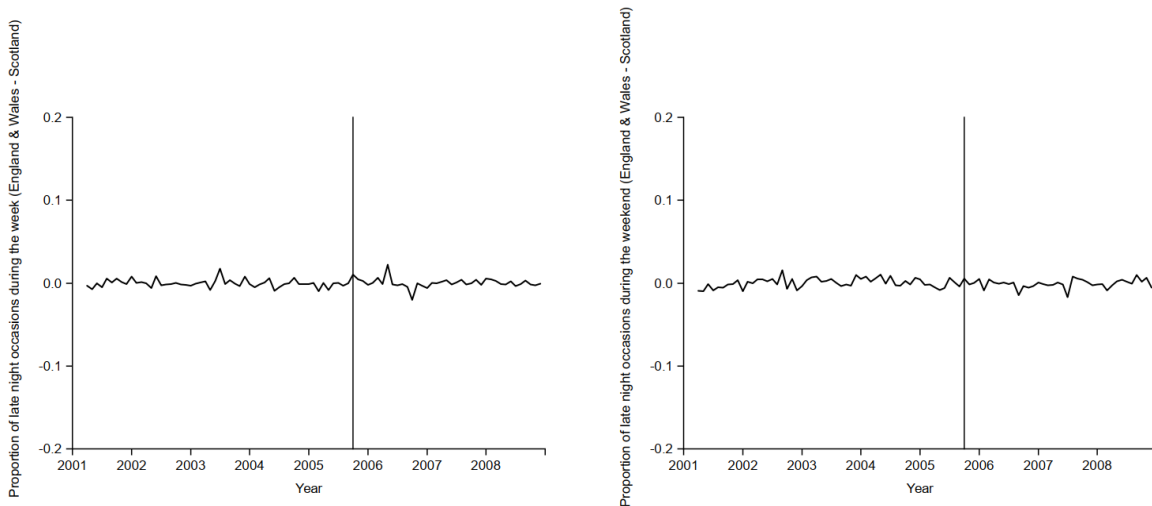
Figure 6. Monthly deseasonalised proportion of late night occasions among full time employees during the week and the weekend, differenced England & Wales minus Scotland.

Vertical line = implementation of the Licensing Act 2003, November 2005

Discussion

Our paper evaluated the effects of trading hour deregulation in England and Wales by systematically testing different mechanisms at the occasion-level by which such policies were hypothesised to affect consumption and harm. These mechanisms were based on explanations proposed in previous evaluations and informal discussion with stakeholders for the mixed and often inconclusive evaluation results generated to date.[8,10–12] We found limited evidence that the Licensing Act 2003 had the hypothesised effects on drinking occasion characteristics. Relative to Scotland, there was a trend towards later start and finish times of drinking occasions in England and Wales, and the proportion of drinking occasions involving pre-loading also increased. However, there was no measurable change in the proportion of occasions involving post-loading, no evidence of increased variation in occasion finish times, and no increase in the proportion of over 25s' or full time employees' drinking occasions starting after 11pm. We also did not find measurable effects of the Act on drinking speed, occasion duration or alcohol consumption in the occasion. Our results go some way towards explaining why previous authors have not observed the expected major public health effects of the Act on alcohol consumption or harm. Given our results which only indicated small changes in the timing of occasions, we would only expect a possible (small) shift of acute problems and social disorder later into the night.

A possible reason for the lack of effect on proximal outcomes is that the Licensing Act 2003 may have only had limited impact on actual trading hours due to earlier liberalisation processes and the existing wide-spread availability of late-night drinking opportunities prior to the Act.[10] Although the international literature suggests that extending trading hours increases alcohol-related harm, our evidence, in agreement with other evaluations from the UK, suggest that the specific nature of regulatory changes is important.[3,4,8,10–12]

The Alcovision survey provides unique data on changes in drinking occasion characteristics over time, allowing us to evaluate proximal impacts of the Act on drinking occasions. A further strength is the availability of data from Scotland, where a similar policy was not implemented until several years later, as a control time series. However, our evaluation of effects relies on the assumption that correlations between both time series do not differ over time and remained constant before and after the introduction of the Act (with the exception of effects as a result of the introduction itself). The Alcovision data was collected using in-street quota sampling, which has known limitations.[30] A further limitation of our analysis, and prior evaluations, is the lack of data on the changes to premise serving hours experienced by consumers following the Act. We therefore cannot quantify the link between the magnitude of changes in availability and the outcomes studied. We were also unable to evaluate similar legislation introduced in Scotland in 2009 (Licensing (Scotland) Act 2005). Although Alcovision continued to collect data after 2008, a break in the data series between 2008 and 2009 to switch from in-street to online sampling means we did not have access to comparable pre-intervention data to allow a robust evaluation. Finally, we did not include as an

outcome measure the proportion of occasions that involved drinking after 11pm including occasions starting earlier in the day, which would have more comprehensively captured late-night drinking.

Despite the Licensing Act 2003 deregulating trading hours in England and Wales, this study has found that the Act had only limited effects on the characteristics of drinking occasions. Future research should evaluate changes in alcohol availability by collecting local data on changes in trading hours, to permit quantification of the direct effects of the policy. It should also collect data on drinking occasions, to validate our unique analysis in additional contexts and develop understanding of how changes in availability affect characteristics of drinking occasions, consumption and harm. More broadly, policy-makers should state clear intentions and a theory of change for policy measures. This would facilitate the inclusion of proximal outcomes in policy evaluations, informing the refinement of ineffective policies.

Declaration of interests

Acknowledgements

Data accessibility statement

The Alcovision survey is a commercial product and therefore cannot be made publically accessible.

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8.2   Supplementary material

Main analyses

Table 1. Supplementary table for all drinkers

Start time						
Step change				**Slope change**		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	0·04	-0·08 - 0·16	0·49	0·00	0·00 - 0·01	0·41
Scotland	-0·02	-0·19 - 0·15	0·85	-0·01	-0·02 - 0·00	0·02
Differences	0·05	-0·15 - 0·26	0·61	0·01	0·00 - 0·02	0·00

Finish time						
Step change				**Slope change**		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	0·19	0·06 - 0·32	0·00	0·00	0·00 - 0·01	0·23
Scotland	0·19	-0·09 - 0·48	0·18	-0·03	-0·04 - -0·01	0·00
Differences	-0·01	-0·29 - 0·26	0·92	0·03	0·02 - 0·04	0·00

Finish time – standard deviation						
Step change				**Slope change**		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	0·08	0·00 - 0·17	0·04	0·01	0·00 - 0·01	0·00
Scotland	-0·11	-0·33 - 0·12	0·34	0·00	-0·01 - 0·01	0·47
Differences	0·18	-0·04 - 0·41	0·10	0·01	0·00 - 0·02	0·08

Proportion of pre-loading occasions						
Step change				**Slope change**		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	0·01	0·00 - 0·01	0·00	0·00	0·00 - 0·00	0·01
Scotland	-0·02	-0·03 - 0·00	0·01	0·00	-0·00 - 0·00	0·54
Differences	0·02	0·01 - 0·03	0·00	0·00	-0·00 - 0·00	0·22

Proportion of post-loading occasions						
Step change				**Slope change**		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	0·00	-0·00 - 0·00	0·52	0·00	-0·00 - 0·00	0·13
Scotland	0·00	-0·01 - 0·01	0·75	0·00	-0·00 - 0·00	0·19
Differences	0·00	0·00 - 0·01	0·53	0·00	-0·00 - 0·00	0·61

Proportion of late drinking occasions

Step change				Slope change		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	0·00	0·00 - 0·00	0·03	0·00	-0·00 - 0·00	0·99
Scotland	0·00	0·00 - 0·01	0·06	0·00	-0·00 - 0·00	0·64
Differences	0·00	-0·01 - 0·00	0·43	0·00	-0·00 - 0·00	0·65

Drinking speed (units/ hr)

Step change				Slope change		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	-0·05	-0·19 - 0·09	0·51	0·00	-0·01 - 0·00	0·18
Scotland	-0·43	-0·70 - -0·17	0·00	0·02	0·01 - 0·03	0·00
Differences	0·38	0·11 - 0·66	0·01	-0·02	-0·03 - -0·01	0·00

On-trade consumption

Step change				Slope change		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	0·13	-0·03 - 0·30	0·11	0·00	-0·01 - 0·01	0·77
Scotland	0·02	-0·58 - 0·62	0·95	0·00	-0·02 - 0·03	0·89
Differences	0·11	-0·47 - 0·70	0·70	0·00	-0·03 - 0·02	0·82

Off-trade consumption

Step change				Slope change		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	0·12	-0·10 - 0·33	0·29	0·00	-0·01 - 0·01	0·97
Scotland	0·01	-0·29 - 0·30	0·97	-0·01	-0·02 - 0·00	0·14
Differences	0·08	-0·36 - 0·51	0·72	0·01	0·00 - 0·03	0·15

Differences = Differenced series created by subtracting the Scotland series from the England and Wales series. B = regression coefficient. P = p-value. All outcome measures are monthly series of weighted drinking occasion characteristics. Start time, finish time, drinking speed, on-trade consumption and off-trade consumption are monthly averages. Finish time – standard deviation is monthly weighted standard deviations of occasion finish times. Pre-loading occasions are when alcohol is consumed in the off-trade (e.g. at home) and then the on-trade (e.g. a pub) and vice versa for post-loading occasions. Proportion of pre-loading occasions is the monthly weighted number of pre-loading occasions as a proportion of the weighted number of total occasions that month. Proportion of post-loading occasions and late drinking occasions are calculated in the same way. Late drinking occasions are defined as occasions starting after midnight. Drinkers are those who consumed at least one alcoholic beverage during the diary week.

Subgroup analyses

Table 2. Supplementary table for on-trade or mixed drinking occasions among under 25 year olds

Start time						
Step change				**Slope change**		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	-0·06	-0·29 - 0·17	0·61	0·01	0·00 - 0·02	0·05
Scotland	0·28	-0·19 - 0·75	0·24	0·00	-0·02 - 0·02	0·72
Differences	-0·33	-0·81 - 0·14	0·17	0·01	-0·01 - 0·03	0·21

Finish time						
Step change				**Slope change**		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	0·23	-0·02 - 0·47	0·07	0·01	0·00 - 0·02	0·02
Scotland	0·57	0·01 - 1·12	0·05	-0·02	-0·04 - 0·01	0·18
Differences	-0·34	-0·92 - 0·24	0·25	0·03	0·00 - 0·05	0·03

Differences = Differenced series created by subtracting the Scotland series from the England and Wales series. B = regression coefficient. P = p-value. All outcome measures are monthly series of weighted drinking occasion characteristics. Start time and finish time are monthly averages. On-trade or mixed drinking occasions are those which included at least one drink in the on-trade (e.g. at a pub).

Table 3. Supplementary table for on-trade or mixed drinking occasions at the weekend

Start time						
Step change				**Slope change**		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	0·14	-0·05 - 0·33	0·15	0·01	0·00 - 0·02	0·05
Scotland	0·07	-0·23 - 0·37	0·66	0·00	-0·01 - 0·01	0·76
Differences	0·07	-0·34 - 0·47	0·74	0·01	-0·01 - 0·03	0·23

Finish time						
Step change				**Slope change**		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	0·53	0·29 - 0·76	0·00	0·00	-0·01 - 0·01	0·48
Scotland	0·21	-0·29 - 0·70	0·40	-0·01	-0·03 - 0·01	0·59
Differences	0·30	-0·21 - 0·82	0·24	0·01	-0·01 - 0·03	0·44

Differences = Differenced series created by subtracting the Scotland series from the England and Wales series. B = regression coefficient. P = p-value. All outcome measures are monthly series of weighted drinking occasion characteristics. Start time and finish time are monthly averages. On-trade or mixed drinking occasions are those which included at least one drink in the on-trade (e.g. at a pub). Weekend days are Friday and Saturday.

Table 4. Supplementary table for on-trade or mixed drinking occasions

Start time						
Step change				**Slope change**		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	0·08	-0·12 - 0·27	0·44	0·01	0·00 - 0·02	0·04
Scotland	0·24	-0·01 - 0·50	0·06	-0·01	-0·02 - 0·00	0·11
Differences	-0·22	-0·62 - 0·18	0·28	0·02	0·00 - 0·03	0·02

Finish time						
Step change				**Slope change**		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	0·37	0·14 - 0·59	0·00	0·01	0·00 - 0·01	0·24
Scotland	0·47	0·13 - 0·80	0·01	-0·02	-0·03 - 0·00	0·02
Differences	-0·21	-0·67 - 0·26	0·38	0·02	0·01 - 0·04	0·01

Drinking speed (units/ hr)						
Step change				**Slope change**		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	-0·24	-0·45 - -0·03	0·03	0·00	-0·01 - 0·01	0·65
Scotland	-0·37	-0·73 - -0·01	0·04	0·00	-0·01 - 0·02	0·58
Differences	-0·19	-0·56 - 0·18	0·31	0·00	-0·01 - 0·02	0·73

Differences = Differenced series created by subtracting the Scotland series from the England and Wales series. B = regression coefficient. P = p-value. All outcome measures are monthly series of weighted drinking occasion characteristics. Start time, finish time and drinking speed are monthly averages. On-trade or mixed drinking occasions are those which included at least one drink in the on-trade (e.g. at a pub).

Table 5. Supplementary table for off-trade drinking occasions at the weekend

Finish time						
Step change				**Slope change**		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	0·11	-0·05 - 0·26	0·16	0·01	0·00 - 0·01	0·09
Scotland	-0·01	-0·49 - 0·46	0·96	-0·03	-0·05 - -0·01	0·00
Differences	0·15	-0·19 - 0·5	0·38	0·02	0·01 - 0·03	0·00

Differences = Differenced series created by subtracting the Scotland series from the England and Wales series. B = regression coefficient. P = p-value. All outcome measures are monthly series of weighted drinking occasion characteristics. Finish time is monthly averages. Off-trade drinking occasions are those which took place solely in off-trade venues (e.g. at home). Weekend days are Friday and Saturday.

Table 6. Supplementary table for drinking occasions among under 25 year olds

Proportion of pre-loading occasions						
Step change				**Slope change**		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	0·01	0·00 - 0·02	0·17	0·00	-0·00 - 0·00	0·06
Scotland	-0·01	-0·05 - 0·02	0·46	0·00	-0·00 - 0·00	0·25
Differences	0·02	-0·01 - 0·06	0·23	0·00	-0·00 - 0·00	0·08

Differences = Differenced series created by subtracting the Scotland series from the England and Wales series. B = regression coefficient. P = p-value. Pre-loading occasions are when alcohol is consumed in the off-trade (e.g. at home) and then the on-trade (e.g. a pub). Proportion of pre-loading occasions is the monthly weighted number of pre-loading occasions as a proportion of the weighted number of total occasions that month.

Table 7. Supplementary table for drinking occasions at the weekend

Proportion of pre-loading occasions						
Step change				**Slope change**		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	0·00	0·00 - 0·01	0·11	0·00	-0·00 - 0·00	0·13
Scotland	-0·02	-0·04 - 0·00	0·01	0·00	-0·00 - 0·00	1.00
Differences	0·03	0·01 - 0·04	0·00	0·00	-0·00 - 0·00	0·67

Differences = Differenced series created by subtracting the Scotland series from the England and Wales series. B = regression coefficient. P = p-value. Pre-loading occasions are when alcohol is consumed in the off-trade (e.g. at home) and then the on-trade (e.g. a pub). Proportion of pre-loading occasions is the monthly weighted number of pre-loading occasions as a proportion of the weighted number of total occasions that month. Weekend days are Friday and Saturday.

Table 8. Supplementary table for drinking occasions among over 25 year olds

Proportion of late drinking occasions						
Step change				**Slope change**		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	0·00	-0·00 - 0·00	0·08	0·00	-0·00 - 0·00	0·99
Scotland	0·00	0·00 - 0·01	0·17	0·00	-0·00 - 0·00	0·48
Differences	0·00	-0·01 - 0·00	0·63	0·00	-0·00 - 0·00	0·50

Differences = Differenced series created by subtracting the Scotland series from the England and Wales series. B = regression coefficient. P = p-value. Late drinking occasions are defined as occasions starting after midnight. Proportion of late drinking occasions is the monthly weighted number of late drinking occasions as a proportion of the weighted number of total occasions that month.

Table 9. Supplementary table for drinking occasions among those in full-time employment at the weekend and during the week

Proportion of late drinking occasions at the weekend						
Step change				**Slope change**		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	0·00	-0·00 - 0·00	0·46	0·00	-0·00 - 0·00	0·35
Scotland	0·00	0·00 - 0·01	0·05	0·00	-0·00 - 0·00	0·50
Differences	0·00	-0·01 - 0·00	0·04	0·00	-0·00 - 0·00	0·84

Proportion of late drinking occasions during the week						
Step change				**Slope change**		
	B	**95% Confidence interval**	**P**	**B**	**95% Confidence interval**	**P**
England & Wales	0·00	0·00 - 0·01	0·06	0·00	-0·00 - 0·00	0·24
Scotland	0·00	0·00 - 0·00	0·05	0·00	-0·00 - 0·00	0·12
Differences	0·00	0·00 - 0·01	0·51	0·00	-0·00 - 0·00	0·82

Differences = Differenced series created by subtracting the Scotland series from the England and Wales series. B = regression coefficient. P = p-value. Late drinking occasions are defined as occasions starting after midnight. Proportion of late drinking occasions is the monthly weighted number of late drinking occasions as a proportion of the weighted number of total occasions that month. Full-time employment was self-reported as working 30+ hours per week. Weekend days are Friday and Saturday.

9   Discussion

The work in this thesis demonstrates that theories of practice provide a useful framework for research into drinking context, consumption and harm. The thesis contributes to the literature through four papers published in peer-reviewed journals (43,96,122,127). This final discussion chapter starts with a summary of the main findings. Then, it reflects on applying a novel quantitative occasion- and practice-based approach and the strengths and limitations of the presented research. Finally, it highlights recommendations for prevention policy and future research in this area.

9.1   Main thesis findings

9.1.1   Description and synthesis of existing event-level literature

The first two studies presented in this thesis are comprehensive reviews of the existing event-level literature studying associations between contextual characteristics of drinking occasions, consumption, and acute harms. The mapping review found a large evidence base (278 papers) but much of this literature focused on student and young adult populations in the United States (43). This limits the generalisability of findings to other population groups.

The systematic review focused on studies that included measures of acute alcohol related harm (95 papers) and narratively synthesised their findings (96). This review found that a large number of contextual characteristics are directly associated with acute harm outcomes in the existing literature (96). Drinking at the weekend, in licensed premises and alongside illicit drug use are consistently associated with a range of acute harms. This suggests that considering contextual characteristics may be important for public health efforts to prevent alcohol-related harms. Only a few studies tested for more complex relationships between contextual characteristics and acute harms, such as the effects of combinations of contextual characteristics.

Although the literature reviewed in these two papers considers a broad range of contextual characteristics of drinking occasions, few studies include a broad set of characteristics. Instead, studies commonly focus on psychological factors (e.g. stress/mood), day of the week and time of day. Researchers pay less attention to some characteristics such as the duration of occasions or features of the drinking environment (e.g. loud music). This suggests that researchers do not have a clear conceptual framework for which contextual characteristics are most relevant and how to measure or analyse them. This is reflected in the literature as few studies stated their theoretical perspective.

9.1.2 Decision tree models of alcohol consumption

The decision tree study found that the heaviest drinking occasions (across all age-sex groups) are long and involve drinking spirits as doubles (122). For 18-35 year olds, they also involve drinking wine. In their heaviest drinking occasions, men and 18-35 year olds consume higher mean number of units than women or other age groups. In contrast, there is minimal variation across age-sex groups in mean consumption in the lightest drinking occasions.

Since long drinking occasions were very strongly associated with heavy consumption, I conducted a secondary analysis to explore predictors of long occasions. Drinking in both on- and off-trade venues within a single occasion (such as in a pub and then at home), starting the occasion earlier in the day, and drinking with friends are associated with drinking for longer. These findings suggest that temporal and material elements of drinking occasions are particularly important. However, the dataset I used was more limited in measuring meanings and competencies so my analysis may have missed important relationships with consumption in these areas. For instance, the dataset did not include measures of managing intoxication levels, toasting, or 'downing' drinks, which have been identified as important in the qualitative literature (31,39,128).

Finally, I found that contextual characteristics explained a large proportion of the variance in alcohol consumption and had important effects in combination (e.g. long drinking occasions that *also* involved drinking spirits as doubles were associated with heavy consumption).

9.1.3 Evaluation of the Licensing Act 2003

The final paper presented in this thesis is a context-focused evaluation of the Licensing Act 2003, which extended alcohol trading hours in England and Wales (127). Based on prior literature and expert opinion, my *a priori* hypotheses were that occasions would become longer and occur later at night, with more variation in occasion finish times, increases in pre-drinking, and increases in within-occasion consumption.

This study found limited evidence in support of the hypothesised effects. The Act had small effects on the timing of drinking occasions - shifting occasions slightly later at night in England and Wales relative to Scotland. There was a small increase in the proportion of occasions involving pre-drinking but no evidence of changes in: post-loading, variation in occasion finish times, late-night drinking or alcohol consumption. Overall, the findings suggest that the Licensing Act 2003 had only limited effects on the characteristics of drinking occasions, which may explain why previous evaluations struggled to find clear effects on consumption and harm.

9.2   Reflections on a novel practice-based approach to quantitative alcohol research

My thesis aimed to advance alcohol epidemiology and policy evaluation research by applying a novel quantitative occasion- and practice-based approach. This section reflects on how I applied this approach in each study. In particular, it highlights the complexity of quantitative practice-based research due to the large number of inter-related relevant factors (elements), and the need to take a pragmatic approach both theoretically and methodologically.

9.2.1   Reviews of the existing literature

The first step towards developing practice-based alcohol epidemiology and policy analysis was to review the existing literature. I focused on studies using event-level methods as these are well suited to collecting data on drinking practices (94,95). Event-level methods ask participants about their drinking within a particular occasion and can collect detailed contextual information (79,80,86,104). This thesis has a focus on the contextual characteristics of such drinking occasions as I conceptualise these as elements of drinking practices.

I wanted to comprehensively consider the existing literature, so I decided to take a broad approach to selecting contextual characteristics of interest. I identified contextual characteristics during search strategy development and within the results of a scoping search (43). During this process, I noticed that similar concepts are labelled differently across theoretical traditions. For example, the psychological literature focuses on constructs such as intentions or affect, which I classify as elements of meaning from a practice-based perspective (9,45,129). The compatibility of different theoretical frameworks is a contentious area of debate, and Shove has argued that psychological perspectives based on behavioural choices and sociological practice-based perspectives are like 'chalk and cheese' (130). Shove argues that behavioural models conceptualise contextual characteristics as external factors that cause *choices* while theories of practice place context as an endogenous feature of practices, concluding that these perspectives are irreconcilable because they lead to different problem definitions (i.e. the issue that research and policy is aiming to address) (130,131).

However, for my thesis, it was helpful to take a pragmatic approach and draw on the findings of previous research in other theoretical traditions, especially since a practice-based approach is not well established in alcohol research. The findings of prior studies reflect real-world associations between contexts, consumption, and harm that can tell us something about drinking practices despite not applying a practice-based approach. For example, if positive affect is associated with increased alcohol consumption relative to negative affect that suggests that practices including meanings of happiness or enjoyment also involve heavier alcohol consumption. It is challenging to map concepts studied from a

different theoretical perspective to the types of elements used by Shove *et al.* but it is necessary to attempt this to build on prior research, given that the different theories clearly examine overlapping phenomena.

I also used a practice-based approach to consider the findings of my reviews (43,96). By thinking through the key elements of practice (meanings, materials, competencies and temporalities) I was able to identify gaps in the existing literature. For example, few studies focused on alcohol consumption by drinking companions or the evolution of drinking occasions over their duration. Furthermore, my practice-based approach emphasises the inter-relationships between contextual characteristics. Sensitised by this approach, I noticed that most studies focus on just one or two contextual characteristics and few studies test for mediated, moderated, or combined effects of context (43,96). The studies in the existing literature therefore offer limited insight into the inter-relationships between different aspects of drinking contexts, consumption, and acute alcohol-related harm.

9.2.2 Epidemiological analysis

In my mapping review, I found that the existing event-level literature lacks studies including a broad set of contextual characteristics and focuses on student populations in the United States (43). I therefore designed an analysis using data from the Alcovision survey to examine the relationships between a wide range of contextual characteristics and alcohol consumption in a general adult population sample (122). This approach also facilitated studying the combined effects of contexts, which are emphasised in theories of practice since elements combine to form practices (7,9).

My epidemiological study aimed to:

a) identify combinations of contextual characteristics that are strongly associated with light and heavy consumption within drinking occasions and should therefore be included in future analyses

b) assess whether accounting for contextual characteristics (individually and in combination) improves the prediction of alcohol consumption at the occasion-level

c) critically interpret the findings and make recommendations for future research and prevention policy.

I used a novel data mining method (decision tree modelling) to address these aims as this allowed me to include a large number of both categorical and continuous predictors, to estimate the contribution of each contextual characteristic to predicting consumption, and to generate combinations of characteristics that are associated with lower or higher levels of consumption (126). Theories of practice see the elements of drinking occasions as being fundamentally inter-related, which does not

align with the assumption that predictors are independent in a regression model (132). Using decision tree modelling addresses some of the limitations of traditional regression models for studying drinking practices by accounting for complex and systematic inter-relationships between contextual characteristics (126). Furthermore, it is difficult to account for complex inter-relationships in regression models as interaction effects should be pre-specified and it is not methodologically rigorous to include all possible interaction effects (132,133).

This analysis used drinking occasions as the unit of analysis, which allowed me to explore combinations of contextual characteristics. However, one limitation of this approach was that the outcome measures were features of individual occasions (consumption and duration). This means that I did not assess elements that are associated with the frequency of drinking occasions. For example, there may be more alcohol consumption at the weekend as this is when more occasions occur (63,134). My analysis would not identify this as it focuses on whether having a particular contextual characteristic is associated with *heavier* consumption during the occasion. Future work could consider the frequency of drinking occasions as this is also important from a public health perspective.

By using a wide range of predictors, I was able to identify that the contextual factors most commonly studied in the existing literature do not align with the contexts most strongly associated with alcohol consumption levels in this analysis. For instance, only 8.6% of the papers included in the mapping review studied the duration of drinking occasions (43). This may reflect a gap between the most salient contextual characteristics for researchers and those that explain the greatest variance in alcohol consumption within drinking occasions. To give a further example, some academics may expect that occasions with an all-male group would involve heavier consumption, but this did not feature prominently in the decision tree results. This demonstrates the value of using an empirical approach with a broad range of measures rather than relying on cultural salience only. However, further work is needed to understand the causal relationships between contextual characteristics of drinking occasions, alcohol consumption and subsequent alcohol-related harm. It may be that culturally salient factors are the drivers of occasion duration and thereby of consumption. This hypothesis has some face validity, as drinking with friends and in multiple venues are culturally salient factors that were associated with longer drinking occasions in this study.

This study produced complex results as I analysed data with a high degree of multi-dimensionality. It was not practical to interpret the results comprehensively, which speaks to the trade-off between accounting for the complexity inherent to theories of practice and providing a more reductive summary. Some practice theorists may argue that this tension is a fundamental problem with quantitative research (as discussed in chapter four) (52,60), because quantitative methods aim to reduce data to a more interpretable form, which could be considered overly reductive (65,69). However, some

level of simplification is required in *all* research to produce comprehensible findings, and the important question is to what extent this is appropriate for a given research project aiming to answer a given question (65,69).

9.2.3 Policy analysis

My thesis also aimed to apply a practice-based approach to alcohol policy analysis. I chose to evaluate the effects of the Licensing Act 2003 on the contextual characteristics of drinking occasions in England and Wales (127). This policy is well suited to practice-based evaluation because it is not clear why the prior evaluation literature did not find evidence for the expected substantial impacts on alcohol harms. My application of theories of practice conceptualised alcohol consumption as taking place within multiple distinct types of drinking practices. This approach has potential for policy evaluation as it can explore heterogeneous effects of interventions on these different practices (7). It can also consider the effects of interventions on practices with specific elements (or contextual characteristics) such as taking place in licensed venues. I used this approach to provide insight into the mechanisms of effect of the Licensing Act 2003 by exploring the effects on drinking occasions that are on the hypothesised causal pathway to distal outcomes such as consumption and alcohol-related harm (7).

The findings of this study provide insight into the effects of the Act, help to explain previous mixed findings, and inform future research and policy regulating alcohol availability. It found that the Act had only limited effects on the characteristics of drinking occasions which may explain why previous evaluations did not find clear evidence of the expected increases in consumption and harm (135–137). For example, my study tested the hypotheses that occasions finished later at night after the Licensing Act 2003 was implemented but that they started at a similar time and the rate of alcohol consumption per hour stayed the same. If these hypotheses were supported, this would have resulted in heavier alcohol consumption within occasions, which is linked to increased risk of violence (96,138,139). However, these hypotheses were not supported by my analysis, which suggests that this pathway from the Licensing Act 2003 to increased alcohol consumption and violence did not occur.

As previously discussed, using a practice-based approach led to a set of hypotheses that covered several different characteristics of drinking occasions. While this added value to the study, I found it challenging to design the analysis. Testing my hypotheses required a complex study design that involved running many different models. Furthermore, my hypotheses were focused on changes in individual contextual characteristics (or elements of practice) rather than considering practices themselves as the unit of analysis. This was partially due to the nature of the prior evaluation literature. Previous evaluations largely focused on consumption and harm outcomes and did not explore changes in contextual characteristics or drinking practices. However, some authors hypothesised mechanisms of

effect relating to contextual characteristics such as increased pre-drinking or later finish times of occasions (35,140–144). These authors did not hypothesise effects on drinking practices because this theoretical framework has not been widely adopted in public health research. This may change in future as there is increasing interest in applying theories of practice in public health (7,9,10,22,53–58). Furthermore, future practice-based evaluations could be improved by the inclusion of a qualitative aspect to explore how drinkers (practitioners) feel their drinking practices have changed. This would support the development of practice-based hypotheses.

9.2.4 Reflections on using theories of practice for alcohol epidemiology and policy analysis

Overall, using a practice-based approach delivered many of the benefits that I anticipated when planning my thesis. I have explored heterogeneity of drinking practices within Great Britain, decentred individuals in my analyses, and systematically considered the relationships between contextual characteristics of drinking occasions, alcohol consumption, and acute harm. Shove *et al.* give a clear schema of practices which has been useful for applied quantitative alcohol research (9). My findings have shed light on the results of prior evaluations of the Licensing Act 2003, suggesting that the Act had limited effects on drinking occasions (127). I also found that accounting for contextual characteristics and their joint effects substantially improves the prediction of alcohol consumption in drinking occasions relative to demographic factors. In particular, the heaviest drinking occasions were long, involved drinking spirits as doubles, and drinking wine (122). These findings identify promising targets for occasion-specific intervention development.

I have applied theories of practice to quantitative alcohol research using a large-scale survey dataset. Chudzikowski *et al.* have emphasised the flexibility of practice theory, arguing that it lends itself to interpretive qualitative research but can also be used to conduct 'multi-dimensional exploratory analyses of large-scale survey datasets' (145,146). However, this thesis demonstrates that practice-based quantitative research is not limited to exploratory analyses as I also used it to test hypothesised mechanisms of effect for the Licensing Act 2003 on drinking occasions. As discussed in the previous section, developing these hypotheses was challenging and future work may benefit from incorporating qualitative exploration to identify the practices that make up everyday life.

In applying a quantitative approach, I was able to consider a wide range of contextual factors across practices-as-performance (drinking occasions). In comparison to the qualitative literature, my decision tree paper included a wider range of contextual characteristics, particularly relating to material elements such as drink type and venue type (122). On the other hand, it was challenging to consider meanings and competencies and these aspects of drinking occasions are less commonly measured in quantitative studies. Future quantitative and qualitative practice-based research would benefit from further thinking

on how to study each of these aspects of drinking occasions in conjunction and consider how meanings are connected to material elements. A good example of this is a qualitative study by Aresi *et al.* which explores the meaning and functions of different nightlife settings among Italian young adults (39).

Theories of practice are an example of a grand sociological theory - outlining an ambitious and comprehensive framework for understanding the social world - which require substantial work for empirical research applications (145). Alternative theoretical approaches for alcohol epidemiology and policy analysis include micro-theories from other disciplines such as psychology. Micro-theories aim to explain smaller or more specific social phenomena. For example, routine activity theory relies on a rational choice model and posits that crime (which can be an alcohol-related harm) occurs when there is a potential offender, suitable target and no capable guardian (147). People are theorised to rationally weigh up the benefits and risks of committing a crime to inform their behaviour. This suggests clear hypotheses, for example: regular police patrols will reduce criminal activity by increasing the risk to criminals. Another possible theoretical approach is motivational models, which were used by papers included in my mapping review (43). These models clearly define the construct of interest – motives – which facilitates measurement and hypothesis development (148,149). However, this thesis intended to consider alcohol consumption as part of multiple distinct activities in order to improve our understanding of their associations with consumption and harm and of heterogeneous intervention effects. Micro-theories are not well suited to this broad level of enquiry.

Applying a grand sociological theory shaped the emphasis of my research questions on the structure of relationships between contextual characteristics of drinking occasions, alcohol consumption, and alcohol related harms. For instance, my systematic review explored the importance of direct effects of contextual characteristics on acute harms and my epidemiological study explored whether contextual characteristics combine to influence alcohol consumption. This may be a result of applying a theory that considers the structure of the social world rather than focusing on the effect(s) of a specific construct. This is a benefit of applying a grand sociological theory, as it is important for scientific progress to develop and test structural hypotheses (150–153).

9.3   Strengths

This thesis includes the first studies applying theories of practice to quantitative alcohol policy evaluation and exploring the relationships between context, consumption and alcohol-related harms. The first two studies reviewed the large and heterogeneous existing literature, providing a thorough overview of previous research in the area. The findings of these reviews informed the design of primary research to fill gaps in the literature. For example, the decision tree modelling study presented in chapter 7 considered the relationships between a wide range of contextual characteristics and alcohol

consumption, since most previous studies consider one or two factors only. These reviews also used a detailed systematic search strategy that successfully identified studies across a range of research traditions and topics (43,96).

This thesis includes policy evaluation and epidemiological studies using advanced quantitative data analysis methods. The policy analysis study was the first explicitly context-focused evaluation of a major intervention - the Licensing Act 2003. This study used a controlled interrupted time series design with data from Scotland providing the control. The epidemiological study used innovative data mining methods which made it possible to conduct the first study using a broad set of drinking occasion characteristics to predict alcohol consumption. The analyses in this study were stratified by age and sex groups, which protects against confounding by the differences in drinking behaviour and alcohol consumption between these groups (22). The study also used linear regression models with clustered standard errors, to account for the nesting of drinking occasions within survey participants and avoid artificially low error values.

Both studies used data from Kantar Alcovision, which includes detailed information about drinking occasions – from the reason for the occasion to the type of drinking companions. This survey recruited a large sample of the general population, with around 30,000 participants per year. Much of the existing literature in this area uses student or other young adult samples, so it was valuable to analyse data from a wider population and this also improves the generalisability of my findings (43).

The findings of this thesis can inform future research and prevention policy. It has identified dominant approaches, research gaps and areas for further review in the existing literature. It has also identified potential intervention targets that are associated with acute harms and alcohol consumption. The evaluation of the Licensing Act 2003 can partially explain the lack of detrimental public health effects of the Act and provides insight into conducting occasion-based policy analysis.

9.4   Limitations

The main limitations of the literature reviews are that they were primarily conducted by a single reviewer and did not synthesise the findings of papers using consumption outcomes. To mitigate the first limitation, a colleague independently re-assessed twenty papers for inclusion, which demonstrated good reliability. The second limitation is due to the change in focus of the epidemiological study from harm to consumption outcomes. Towards the beginning of the PhD, I chose to focus on mapping the full literature and then synthesising the findings using harm outcomes in order to identify research gaps and inform my planned primary research linking contextual characteristics to acute harm outcomes. This left time available within my study period for conducting policy evaluation and epidemiological

studies. However, given the change in focus to consumption outcomes, narrative synthesis of previous findings on the relationships between contextual characteristics and alcohol consumption could have informed hypothesis development for the epidemiological study.

Furthermore, there are some important limitations of the Alcovision survey data which was used for the policy analysis and epidemiological studies (22). Since it is a market research dataset, the measures are designed for this purpose rather than practice-based scientific research. This is primarily a limitation for the decision tree analysis as there are some areas where data were not available for analysis, particularly competencies within drinking practices. The measures used for drinking motivations did not align with standard approaches (i.e. the Drinking Motives Questionnaire) and did not include drinking to cope (22,154). This study was therefore not able to fully assess the importance of competency elements and may have been missing other factors associated with heavy drinking such as drinking to cope.

There were some other key limitations of using data from Kantar Alcovision that affected my PhD studies, as discussed in detail in chapters 7 and 8. Participants were selected using a quota sampling approach in-street from 2001 – 2008 and from an online panel from 2009 – 2016. This sampling method is non-random which led to concerns about the validity of matching the data with national harm data. I was therefore unable to contribute to the literature on the direct relationships between contextual characteristics of drinking occasions and acute harm outcomes. Furthermore, the change in sampling method from in-street to online in 2009 was accompanied by changes to the survey questions. These changes resulted in larger than expected discontinuities in the time series that I tried to resolve in collaboration with colleagues. Unfortunately, we were not able to resolve these issues using data harmonisation, re-weighting, or propensity score matching, which meant that I could not evaluate the Licensing Act (Scotland) 2005.

9.5 Recommendations for future research and prevention policy

9.5.1 Future research

Use an explicit theoretical framework

The existing event-level quantitative literature lacks systematically applied occasion-based theoretical frameworks (43). This leads to few studies considering a broad set of contextual characteristics and a literature that focuses on some characteristics (e.g. stress or mood) and pays less attention to others (e.g. the duration of drinking occasions) without a clear rationale for these choices. Future studies should prioritise development and application of explicit theoretical frameworks and the work

presented in this thesis demonstrates that using a practice-based approach provides a useful structure for identifying and understanding the research area, developing promising research questions and interpreting research findings.

Elements of practice

The findings of this thesis can inform the selection of contextual characteristics to include in future research. I have identified the contextual characteristics (conceptualised as elements of practice) that have been studied or neglected in the existing literature and modelled the relationships between contexts and alcohol consumption in drinking occasions. The decision tree analysis indicates which contextual characteristics are most strongly associated with alcohol consumption and should therefore be included in future studies (122). The characteristics most strongly associated with heavy consumption were long drinking occasions, drinking spirits as doubles and drinking wine. These characteristics are not the most commonly studied in the existing literature – the duration of drinking occasions was included in just 8.6% of papers (43).

From a practice-based perspective, research in this area should study a wide range of contextual characteristics to develop a full understanding of the elements involved in drinking practices. Shove *et al.* conceptualise elements in three main types – meanings (e.g. having fun), materials (e.g. a pub) and competences (e.g. buying a round) (9). Drawing on previous work by Ally *et al.* (22) and Meier *et al.* (7) I have included temporalities based on Southerton's five understandings of time – periodicity (e.g. every Sunday), duration (e.g. three hours long), tempo (e.g. visiting three pubs per hour on a pub crawl), sequence (e.g. having a glass of wine once the kids are in bed), synchronisation (e.g. drinking while watching football) (63). The importance of temporalities in my decision tree analysis supports the inclusion of these elements in theoretical frameworks for practice-based alcohol research. Future work in this area may benefit from further theoretical development and from drawing on other forms of theories of practice to guide variable selection and conceptualisation.

The existing quantitative literature particularly lacks studies of competencies and wider aspects of temporalities than the day of the week. These are promising areas for future research. For example, researchers could consider how drinking occasions change over their duration or the role of managing intoxication levels in drinking occasions (31,39,43,128). Future quantitative research should pay greater attention to temporalities - including duration - and to developing new methods for measuring competences (9,43,63).

Collecting data on drinking occasions

Future quantitative occasion-based alcohol research requires more thought on which characteristics to include and how to measure them (43). My findings show that the existing literature in this area studies

a wide range of contextual characteristics but that the choice of contextual characteristics to examine often lacks clear justification (43). This literature also lacks consistent methodology, using a heterogeneous set of study designs and few validated measures.

Furthermore, the mapping review found that most of the literature in this area uses consumption rather than acute harm outcomes. I followed this up with my systematic review and found substantial evidence that contextual characteristics are directly associated with acute alcohol-related harms. I was not able to contribute primary research to this literature in my thesis due to limitations of the available data. Future event-level data collection should include measures of understudied acute harms such as harms to others which is increasingly recognised as an important area of research (96,155). Collecting data on harms alongside data on drinking occasions would facilitate study of direct effects as well as those mediated by consumption.

Overall, the relationships between contextual characteristics of drinking occasions, consumption, and acute harm are complex. Future research should use theoretical frameworks to inform areas of study and the development of appropriate measures.

Future directions

Contemporary authors have argued that applying theories of practice to public health research has the potential to deliver insights into health inequalities (7,10). A practice-based approach shifts the focus from individuals with 'unhealthy' lifestyles to practices – routinized behaviours carried and performed by groups of people. Public health researchers may be able to understand the distribution and patterning of health outcomes in populations through studying the practices that people in different social groups are exposed to and may become 'carriers' of (7,10). This approach could be applied to a range of population subgroups such as young people or those using alcohol treatment services in order to understand the range of practices that different groups of people are 'carriers' of and how this influences their health outcomes.

Practice-based research can also improve our understanding of how drinking culture has changed over time and provide a framework for international comparisons. Shove *et al.* have paid particular attention to using theories of practice to account for processes of change (9). This is an area that could be developed further. There are currently some active projects in the Sheffield Alcohol Research Group building on work by Ally *et al.* (22) which aim to explore change in British drinking culture over time and to understand reductions in young peoples' alcohol consumption.

This area of research could also extend to consider broader issues such as what a desirable drinking culture would be and what level of alcohol-related harm is acceptable as a result of our drinking practices. Policymakers have a long history of seeking to change drinking cultures, but it is less clear

what an acceptable culture requiring no further intervention would look like. Developing clear thinking in this area could help to identify the aims of policy and to judge policy options.

9.5.2 Prevention policy

This thesis has identified targets for prevention policy. My systematic review highlights contextual characteristics that are consistently associated with acute harm outcomes (e.g. drinking at the weekend, in licensed premises, and alongside illicit drug use) (96). These findings can inform interventions that modify drinking environments. For instance, promoting food being available at the weekend in licensed venues. My epidemiological study also identifies contextual characteristics (individually and in combination) that are associated with heavy vs light drinking occasions (122). In the paper, we suggest that prevention campaigns could encourage shorter versions of existing drinking practices as we find longer occasions are associated with heavy alcohol consumption. We also suggest that excluding intoxicated individuals from licensed premises would disrupt very long mixed-location practices and likely reduce consumption. In the language of theories of practice, this would inhibit the material elements of visiting multiple on-trade venues being combined with heavy alcohol consumption (156,157).

My evaluation of the Licensing Act 2003 also has implications for prevention policy (127). This study demonstrates the importance of policymakers being clear in their stated intentions for policy measures, with an *a priori* theory of change, and that commissioned evaluations track proximal outcomes along the causal pathway rather than only distal outcomes. This recommendation is in line with recent Medical Research Council guidance on process evaluation of complex interventions (113). This guidance considers the planning, design, conduct, analysis and reporting of process evaluations and argues that 'a clear description of the intended intervention, how it will be implemented, and how it is expected to work' should have been developed prior to evaluation (113). This evaluation approach may require more primary data collection but would enable evaluators to readily identify policy measures that fail to have the desired effects or where there are unintended consequences, and pinpoint where in the causal chain things have deviated from expectations (113,158). This may allow ineffective policies to be refined or revoked.

More broadly, there are contemporary debates around developing interventions from a practice-based perspective. There is some disagreement on whether theories of practice lead to fundamentally different interventions than conventional approaches (7,10,159,160). For example, Fraser argues that theories of practice lead to interventions that fail to adequately decentre the individual – such as promoting yoga to address women drinking to relax after a stressful day rather than tackling the 'institutionally perpetuated gender imbalances in domestic labour and income inequality' (7,159).

However, theories of practice can consider the importance of wider factors such as gender-based inequalities, within the framework of a 'flat ontology' where these factors are produced by constellations of practice (7,9,51,60). In my thesis, I have focused on drinking practices only, which limits the recommendations that I make to targeting drinking occasions. This is more due to the secondary dataset used and the practical constraints of collecting large amounts of primary data than an inherent limitation of using a practice-based approach. Future studies examining the gendered intersections between work, family, and health-related practices could provide new insights into the gender imbalances referred to by Fraser.

I have argued that theories of practice address the limitations of individualistic theoretical perspectives and have potential for developing public health interventions (10,15,41). In this thesis, I have recommended interventions including making food more available in licensed premises and more stringently excluding drunk people from licensed premises (96). These recommendations are not substantially different from previous approaches, which Blue *et al.* argue is typical of practice-based interventions (10). Theories of practice do not provide clear guidelines that produce novel types of public health interventions, instead changing the way that we conceptualise the social world and supporting the development of more *effective and targeted* interventions based on an understanding of social practices (7,10). For example, theories of practice have been applied in energy studies to develop and evaluate interventions that reconfigure elements of practice, influence relationships between practices, and provide infrastructure (material elements) that can be incorporated into desired practices (10,160–162).

9.6 Conclusions

This thesis has used theories of practice to develop event-level alcohol epidemiology and policy analysis. I have shown that applying a novel quantitative practice- and occasion-based approach facilitates conceptualising drinking occasions, identifying important research questions, and systematically interpreting research findings in alcohol epidemiology and policy analysis. The existing quantitative event-level literature studying associations between contextual characteristics and alcohol consumption/ acute alcohol-related harm is large and heterogeneous. Most studies focus on student populations, consumption outcomes, and consider a limited range of contextual characteristics. In this thesis, I used novel methods to identify risky drinking contexts for future research efforts and prevention efforts to target such as long drinking occasions, drinking spirits as doubles and drinking concurrently with illicit drug use. I also found that it is important to consider combinations of contextual characteristics, and direct effects on acute harm outcomes. Overall, I have advanced work in my field, paving the way for future applications of theories of practice in alcohol research and practice.

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Appendix A – Changes to papers in response to examiners comments

Chapter five

- I have included the following new text in the methods section:
  "We included search terms based on informal discussion with expert stakeholders."

  "Citation and reference list searching were not undertaken."

- The 'Exposure' section now reads:
  "Contextual characteristics were organised into six categories developed using the results of the scoping search"

  I have also moved the description of the six categories out of the methods and into the results section.

- I have clarified which were the eight reviews that were excluded from the mapping review in a footnote.

- I have added the following new text:
  "Analysis is focused on study characteristics and contextual characteristics that were reported in at least five papers in order to identify where there is a body of literature."

Chapter six

- I have included the following in the discussion for this paper:
  "It is important to note that this review considered only direct effects of contextual characteristics on acute harms, and did not include studies with consumption outcomes only. The effects of contextual characteristics on alcohol consumption levels may suggest alternative intervention targets and their importance for alcohol-related harm may be greater. The policy recommendations of this study should therefore be considered alongside wider literature in this area."

- I have included the following new text in the methods section:
  "We included search terms based on informal discussion with expert stakeholders."

  "Citation and reference list searching were not undertaken."

- I have included the following in the 'Analysis and reporting' subsection:

"We have developed the following contextual characteristic categories for ease of interpretation, based on the areas covered by the included papers: people, place, timing, psychological states, drink type and other."

- I have included new supplementary tables: S4, S5, and S6.

Chapter seven

- I have added new descriptive information to Table S1 and included the following information in the results section:
  "Across the six models by age-sex groups, there are 45.5 leaves on average per model. The number of occasions per leaf ranges from 10 to 823, with an average of 167.1 occasions per leaf. This wide range is due to the different sample sizes for each age-sex group, as these groups differ in size in the Great British population and young adults are also over-sampled in the Alcovision survey."

- I have included a new section with the heading 'additional discussion' at the end of this paper.

- I have included the following in the discussion:
  "Weekend drinking may have characteristics that are associated with longer occasions, such as drinking in both the on- and off-trade, with friends, and starting earlier in the day."

Chapter eight

- I have clarified that 'late-night drinking' refers to occasions that started after 11pm in the Outcome measures section, in Table 1, and in the Discussion. I have also clarified in the discussion that we did not explicitly address occasions that started early but continued late into the night in our analyses.