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Modelling the longer-term health and health inequality impacts of changes in alcohol consumption during the COVID-19 pandemic in England

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ABSTRACT

Background

Alcohol consumption changed substantially during the COVID-19 pandemic for many people. This study quantified how these changes in drinking varied across the population and their potential longer-term impact on health and health inequalities.

Methods

We analysed data from the Alcohol Toolkit Study to estimate how alcohol consumption changed during the pandemic (April 2020- November 2021) and how these changes varied with age, sex, drinking level and socioeconomic position. We combined these estimates with a range of alternative scenarios of future alcohol consumption and used the Sheffield Alcohol Policy Model to assess the long-term health and health inequality impacts of these changes.

Results

Alcohol consumption in 2020-21 increased in heavier drinkers but fell in moderate drinkers. If alcohol consumption returns to pre-pandemic levels in 2022 we estimate a total of 42,677 additional hospital admissions and 1,830 deaths over 20 years due to these changes. If consumption remains at 2021 levels in the long-term these figures rise to 355,832 and 12,849 respectively. In all scenarios the biggest increase in harm occurs in the most deprived 20% of the population.

Conclusions

Pandemic-era changes in alcohol consumption are likely to have a significant negative impact on public health and health inequalities, even under optimistic assumptions about future drinking.

INTRODUCTION

The health and social impacts of the global COVID-19 pandemic have been enormous, with an estimated 14.9 million deaths globally (1) and an estimated economic cost of $10 trillion (2). In England, national 'lockdowns' were in place in March-June and November-December 2020 and January-March 2021 with a wide range of national and local restrictions in place at other times, including the closure of pubs, restaurants and nightclubs (3). One consequence of these restrictions has been a major change in the ways in which people purchase alcoholic drinks and the settings and contexts in which they drink them.

Alcohol consumption is associated with a wide range of negative health effects and previous analyses have estimated that it was responsible for 10,700 deaths and 640,000 hospital admissions, at a cost to the NHS of £2.7bn in England in 2019 (4). The pandemic has placed unprecedented strain on healthcare services, but it is unclear to what extent changes in alcohol consumption during the course of the pandemic may have contributed to this.

Initial data has proved concerning, with a 19.3% increase in deaths from causes that are wholly-attributable to alcohol in England in 2020 compared to 2019, and a further 6.9% increase in 2021 (5). These figures may reflect changes in people's willingness or ability to access both healthcare and specialist alcohol treatments services during the pandemic as well as the direct impact of changes in alcohol consumption on health (6). However, they do not capture either the effects of changes in drinking on health conditions for which alcohol is not the only potential cause or risk factor, such as injuries and cardiovascular diseases. Further, epidemiological evidence suggests that changes in alcohol consumption can take many years to feed through into changes in risk for some chronic health conditions, particularly for cancers (7). As a result the short-term increases in alcohol-related deaths that we have observed will not reflect the full impact of recent changes in drinking, which are likely to take well over a decade to be fully realised. It also remains unclear to what extent changes in drinking behaviour may persist in the longer term, as public health restrictions are relaxed, pubs, restaurants and nightclubs re-open and levels of socialising begin to increase back towards pre-pandemic levels.

In order to explore these wider impacts of changes in alcohol consumption in England during the pandemic and their potential longer-term implications, we analysed detailed survey data to understand how changes in drinking varied across different groups in the population. We then used the Sheffield Alcohol Policy Model (v4.1)(8), a widely-used epidemiological policy appraisal tool, to estimate the future health outcomes associated with these changes, under a range of alternative scenarios about their future persistence.

METHODS

Alcohol consumption during the pandemic

The combination of 'stay-at-home' orders, a ban on all socialising with other households and the closure of all pubs, restaurants and nightclubs during the first and subsequent lockdowns in 2020-21 represented an unprecedented shock to the ways that people in England buy and consume alcohol. Unsurprisingly alcohol sales in the off-trade (shops) increased substantially, while sales fell in the on-trade (pubs, bars, restaurants and nightclubs) (9). Taxation data from Her Majesty's Revenue and Customs (HMRC) suggests that the net effect of these changes were a modest increase in overall alcohol sales (10), however this does not tell us whether different population subgroups changed their drinking in different ways.

In order to understand these subgroup-level difference in drinking behaviour, we analysed data from the Alcohol Toolkit Study (ATS) collected between April 2018 and November 2021. The ATS is a monthly survey of around 1,700 adults in England, designed to be representative of the general population, which has been running since 2014 (11) and that collects data on individual characteristics including age, sex and social grade (based on occupation), as well as asking respondents to complete the Alcohol Use Disorders Identification Test (AUDIT) (12). Previous studies have identified a notable rise in people scoring 5+ on AUDIT-C in the initial months of the COVID-19 pandemic (13,14). Figure S1 in the Supporting Information updates these analyses and shows that the proportion of the adult population screening positive for risky drinking has remained at elevated levels throughout the pandemic period (April 2020 – November 2021).

In order to quantify the associations between changes in drinking behaviour and individual characteristics, we fitted Ordinary Least Squares regression models. As there was little evidence in the data of a clear trend in mean consumption or AUDIT scores *during* the pandemic period itself, we pooled data for the 19 monthly waves available during the pandemic period and compared it to pooled data for the equivalent period 2 years prior (April 2018 – November 2019) to control for any seasonality in drinking patterns. See the Supporting Information for full details of these models, including a sensitivity analysis demonstrating that the selection of pre-pandemic period does not affect our findings. Figure 1 provides a summary of the key model coefficients. Across all population subgroups, lower risk drinkers (AUDIT score of <5) reduced their drinking during the pandemic, while risky drinkers (AUDIT score of 5+) increased theirs. This polarisation was greater among men than women, with male lower risk drinkers seeing bigger reductions in consumption and male risky drinkers seeing bigger increases. Older drinkers reduced their drinking by less than younger drinkers if they were drinking at lower-risk levels pre-pandemic and increased it by more if they were drinking more heavily. Lower risk drinkers in the highest socioeconomic group reduced their drinking by more than those in other groups. Among risky drinkers the socioeconomic pattern is more mixed,

with the biggest increases in drinking seen among the highest, middle and lowest socioeconomic groups.

Figure 1 about here

Future alcohol consumption

Whilst the ATS data allows us to quantify changes in alcohol consumption during the first two years of the pandemic, modelling the long-term impacts of these changes on health also requires some assumptions about how these changes in drinking behaviour may persist. Drinking has been shifting from the on-trade to the off-trade for several decades (15), so the enforced shift towards home drinking in the past two years could simply become an accelerated conclusion to that trend. Alternatively, as the on-trade reopens more fully, people may retain their new home drinking habits while also adding back some of the on-trade consumption they have missed during the pandemic.

We held a workshop with stakeholders in NHS England and the Office for Health Improvement and Disparities (OHID) to identify a set of plausible alternative scenarios. This led to 5 alternative possible future drinking trajectories, including one identified as the most plausible or 'main scenario'. These alternatives are, illustrated in Figure 2 and described below from approximately 'best case' to 'worst case':

- **Immediate rebound**: All drinkers return to their pre-pandemic levels of drinking from 2022
- **Main scenario**: Lower risk drinkers (those drinking within the current UK low-risk drinking guidelines) return to their pre-pandemic levels of drinking from 2022 while heavier drinkers remain at their pandemic levels for a further 5 years before gradually returning to pre-pandemic levels over the following 5 years
- **No rebound**: All drinkers continue to drink at the same level as during the pandemic period
- **Lower risk-only rebound**: Lower risk drinkers return to their pre-pandemic levels from 2022 onwards, while heavier drinkers remain at the same level as during the pandemic
- **Increasing consumption**: From 2022 onwards, all drinkers who reduced their drinking during the pandemic return to pre-pandemic levels. Drinkers who increased their drinking during the pandemic increase it further, reflecting lost on-trade consumption being added back into people's drinking habits. This further increase takes the form of the smaller value of: i) either the same increase again as was seen between 2019 and 2020, or ii) the total volume of on-trade consumption pre-pandemic.

Figure 2 about here

Future health outcomes

Finally, we use the Sheffield Alcohol Policy Model (SAPM) to estimate the health outcomes associated with these alcohol consumption trajectories. SAPM is a complex epidemiological model which has been widely used to prospectively appraise the potential impact of a wide range of alcohol policies including Minimum Unit Pricing and the delivery of Identification and Brief Advice (16,17). SAPM was also used to inform the most recent revision of the UK Chief Medical Officers' low risk drinking guidelines (18) and the latest revision of the Australian drinking guidelines (19).

A comprehensive description of the modelling methodology used in SAPM can be found elsewhere (8,20). Briefly, the model consists of two, interlinked components: one model linking policy to changes in alcohol consumption and a second, epidemiological model linking changes in consumption to changes in health harms. For the present analysis we used only the latter model. In this model, changes in alcohol consumption are linked to changes in risks of mortality and morbidity of 45 different alcohol-related health conditions, using data on current prevalence of each condition and epidemiological evidence linking alcohol consumption levels to harm (21) and accounting for delays between changes in drinking and changes in risk (7).

The model is stratified throughout by age, sex and deprivation (measured as quintiles of the Index of Multiple Deprivation (IMD) – a small area-based composite measure of socioeconomic deprivation), allowing the impact of a policy on different subgroups in the population to be examined in detail.

The baseline year for all model runs is 2019. For all of the individuals in the model, alcohol consumption in 2020 and 2021 (i.e. the pandemic period) is modelled by using the results of the regressions fitted on the ATS data to give predicted pre-pandemic and pandemic period consumption according to each individual's baseline drinking and sociodemographic characteristics, then adjusting their observed baseline consumption level (i.e. the volume of alcohol consumption recorded in the HSE) by the ratio between the two. So if the regression model predicts that pandemic consumption will be 5% higher than pre-pandemic levels according to their individual characteristics, then we assume their consumption increases by 5% in 2020 and remains at this level in 2021. In the absence of a robust mapping between social grade and the Index of Multiple Deprivation, we assume that the five categories in each map directly onto each other. All modelled scenarios are compared to a counterfactual in which alcohol consumption remains at 2019 levels for all population groups. Results are analysed for the period from 2019-2039 as evidence suggests that 20 years is the time horizon required for the full impacts of a change in alcohol consumption to feed through into changes in risks of harm (7). As this paper presents the results of computer modelling for a prospective impact appraisal of changes in alcohol consumption, rather than exploratory or confirmatory statistical analyses, no pre-registration was undertaken.

RESULTS

Population-level impacts

The overall cumulative number of additional hospital admissions and deaths between 2019 and 2039 under each modelled scenario compared to a counterfactual where consumption remained at 2019 levels throughout are shown in Table 1. These show that in our main scenario we would expect 207,597 additional alcohol-attributable hospital admissions over these 20 years compared to the counterfactual, a 1.7% increase. Over the same period we also estimate an additional 7,153 alcohol-attributable deaths, a 5.7% increase.

Even under the most optimistic scenario, where alcohol consumption rebounds to 2019 levels immediately in 2022, we would expect 42,677 additional hospital admissions (+0.3%) and 1,830 additional deaths (+1.5%) as a result of changes in alcohol consumption during the pandemic period. Meanwhile, under the most pessimistic scenario, where alcohol consumption rises again as COVID restrictions are relaxed further and on-trade consumption increases again, we estimate an additional 972,382 alcohol-attributable hospital admissions (+7.9%) and 25,192 additional deaths (+20.1%).

Table 1 about here

Inequality impacts

Modelled estimates of future changes in alcohol-attributable hospital admissions for each scenario, separated into IMD quintiles are shown in Figure 3 and in Table S2 in the Supporting Information. Across all scenarios, the biggest increases in harm are in the highest, middle and lowest quintile, particularly the most deprived group. In the main scenario, of the 207,597 additional hospital admissions, 74,002 (35.6%) come from the most deprived 20% of the population. This pattern is similar across all scenarios, with the most deprived quintile suffering disproportionately larger increases in admission rates. However, alcohol-related hospital admissions were already very unequal before the impacts of the pandemic struck, with 56% more admissions in the most deprived compared to the least deprived group. As a result, even though the most deprived group experience the largest *absolute* increase in harms in all scenarios, the least deprived and middle quintiles see larger *relative* increases in most scenarios.

Figure 3 about here

DISCUSSION

Main finding of this study

Our analyses show that alcohol consumption in England has increased since the start of the pandemic and that there is little to suggest a subsequent fall in drinking back to pre-pandemic levels.

This increase has not been uniform across the population, with lower risk drinkers consuming less, on average, while heavier drinkers drank more. The biggest increases were seen among men, older drinkers, and those from the highest socioeconomic groups. In modelling the longer-term impact of these changes, our results show that, under a range of plausible assumptions about future drinking, these increases will lead to significantly more alcohol-attributable hospital admissions and deaths. Even under the most optimistic scenario, where alcohol consumption returned to pre-pandemic levels from 2022, we would still expect around 43,000 additional hospital admissions and 1,800 additional deaths as a result of pandemic-era changes in drinking. Under more pessimistic assumptions these figures could reach as high as 970,000 and 25,200 respectively. In all scenarios these additional harms will fall disproportionately on heavier drinkers and those in the most deprived areas, who already suffer the highest rates of alcohol-attributable harm.

What is already known on this topic

To our knowledge only one other study has sought to model the longer-term health impacts of pandemic-era changes in drinking. This used a microsimulation model to explore the impact of three alternative future alcohol consumption scenarios compared to drinking remaining at 2019 levels (22). Due to the fact that this study used a smaller set of health conditions and differences in the scenarios they modelled, a direct comparison of results is not possible, however the overall findings are very similar with substantial increases in disease incidence and mortality even under the most optimistic scenarios.

What this study adds

The pandemic arrived at a time when, in spite of stable per capita alcohol consumption (23), rates of alcohol-related harm in England had been rising since 2012 (5), alongside stalls in life expectancy and increasing levels of alcohol-related and overall health inequality (24). During this period alcohol taxes have been cut substantially in real-terms and are currently at their lowest level in over 40 years (4,25) with the affordability of alcohol consequently at record high levels (26). At the same time funding for specialist alcohol and drug treatment services has been cut by 27%, leading to fewer people engaging with and completing treatment (27). The extent to which the short-term impacts of the pandemic on alcohol consumption and related harm persist in the coming years are therefore a major public health concern. To date there is little sign of rates of risky drinking returning to pre-pandemic levels (28) and preliminary mortality data for 2022 suggests alcohol-specific deaths may have risen further (29). This data, alongside the results of our study, suggest that further policy action may be required to prevent a substantial increase in alcohol-attributable harm over the coming decade.

The development of future policy, both to address the immediate increases in alcohol harms and also to pre-empt similar increases should there be future pandemic events, could be significantly aided by further research to understand the precise drivers of increased alcohol consumption and harm during the COVID pandemic. In particular, understanding which groups within society experienced changes in which alcohol-related harms would significantly add to our understanding of the inequality impacts of the pandemic. Further research to understand the full impact of moving alcohol treatment services online during the first lockdown and the extent to which this had potentially positive and negative impacts on different groups may also help to improve the accessibility of specialist treatment and ensure vulnerable groups are adequately protected in future public health crises.

Limitations of this study

The modelling presented here draws on evidence from a wide range of sources and the underlying model, SAPM, has been used extensively, both within the UK and internationally, to address key alcohol policy questions. However, as with any modelling study, there are a number of limitations to acknowledge and alongside which the results of this analysis should be considered. Firstly, data on changes in drinking behaviour during the pandemic is limited and imperfect. Whilst there have been many surveys, particularly during the initial lockdown, which asked about changes in drinking behaviour, these were generally methodologically weak and of limited value (9), although the finding of a polarisation in drinking behaviour between moderate and heavier drinkers has been observed consistently across multiple studies (30).

The Alcohol Toolkit Study is more robust than many other sources, being a regular, representative sample which has been collected for several years before the pandemic struck. However it has its own limitations. These include a change in the way the data was collected (from face-to-face to telephone interviews) when the pandemic began in March 2020, although previous analysis have not found any impact of this change (13,14) and the fact that the questions on alcohol consumption (the AUDIT) ask about alcohol consumption “in the past 6 months”, rather than explicitly asking about ‘current’ or ‘recent’ drinking, which may lead the data to understate the scale of short-term changes in drinking.

The counterfactual assumption used in our analysis is that all else – including alcohol consumption - remains equal in the absence of pandemic-related changes in drinking. As such we do not attempt to simulate future alcohol consumption dynamics on the basis of historical trends in alcohol consumption. At a population level, alcohol consumption in England has remained broadly stable for the past decade (23) and recent modelling work that does incorporate historical dynamics of alcohol

consumption to look at the impacts of pandemic-era changes in drinking in Scotland has found similar results to the present study (31). As such it seems likely that the effects of our assumed counterfactual are close to those that would be obtained from a more dynamic modelling approach.

Our analysis of changes in alcohol consumption using data from the Alcohol Toolkit Study has been linked to alcohol consumption and harm data used in SAPM by assuming that the gradient across socioeconomic groups as measured by an occupation-based classification can be mapped to the gradient across IMD groups. As occupation is an individual-level measure, while IMD is a small-area level measure, this equivalence is unlikely to hold true in all cases, although different measures of socioeconomic position are strongly correlated (32). The extent to which this assumption might affect our results is unclear, as both individual- and area-level factors may influence individuals alcohol consumption and health in diverse and complex ways. However, while an alternative approach to this mapping may alter the 'w-shaped' pattern observed in model outcomes (with higher impacts in quintiles 1, 3 and 5), the underlying finding that the additional harms associated with pandemic-era changes in drinking are likely to increase health inequalities is unlikely to change as this is driven primarily by the existing socioeconomic gradients in harms, rather than the gradient in changes in consumption. This can be observed by the fact that the highest socioeconomic group sees a larger estimated increase in alcohol consumption than the lowest group in our study, but a smaller increase in alcohol-attributable harms.

There are also many aspects of the epidemiological evidence relating alcohol consumption to risks of harm which remain uncertain. The largest of these is the disputed evidence that lower risk drinking reduces the risk of some cardiovascular health conditions. In SAPM we take this evidence on face value and include these cardioprotective effects in our modelling, in line with other sources (33,34). However, numerous studies have called the existence of these effects into question (e.g. (35–37)). The impact of this assumption on the findings of the present study are unclear. Removing protective effects would significantly increase our estimate of the *total* burden of alcohol on health, but its impact on the modelling presented here is harder to calculate. In previous sensitivity analyses we have shown that removing protective effects makes relatively little difference to analysis of policy effectiveness (38).

Finally, the modelling approach used in SAPM cannot fully capture the complexity of the relationship between alcohol consumption and health among those individuals with alcohol dependence. Dependent drinkers are missing or underrepresented from many data sources, including epidemiological studies and it is therefore unlikely that we have fully captured the extent to which the drinking of dependent drinkers may have changed during the pandemic, or the potential health

consequences of this. There are also other, critical factors for this population which are beyond the scope of our modelling, including access to specialist alcohol treatment services. Official data has shown that alcohol-specific deaths in England were 27.4% higher in 2021 than in 2019 (5). This rise may, in part, reflect increases in drinking among heavier drinkers, but it may also reflect the consequence of disruption to or unavailability of specialist services during lockdowns as these services moved largely or entirely online. There are also likely to be other COVID-related impacts which may have a major effect on very heavy drinkers, including the health consequences, with COVID having more serious outcomes for those in poorer health, and the wider economic impacts. As such, the modelling analysis presented here may represent an underestimate of the full impact of the pandemic on alcohol-related health.

Conclusion

The findings of this study show that the pandemic has had a significant negative impact on alcohol consumption which is likely to lead to elevated levels of alcohol-related harm for many years to come. These come at a time when the NHS is facing unprecedented pressure in the aftermath of the COVID-19 pandemic and will be felt most acutely by the most vulnerable groups in society.

Data availability

The Alcohol Toolkit Study data analysed in this paper is available from the corresponding author on reasonable request. Much of the data used within the Sheffield Alcohol Policy Model (e.g. alcohol consumption data, hospital episode statistics and mortality data has been accessed under license and cannot be shared, although this data is available to researchers directly from the data owners (e.g. the UK Data Archive, NHS England and the Office for National Statistics)).

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REFERENCES

1. World Health Organization. Global excess deaths associated with COVID-19, January 2020 - December 2021 [Internet]. [cited 2022 May 23]. Available from: https://www.who.int/data/stories/global-excess-deaths-associated-with-covid-19-january-2020-december-2021

2. What is the economic cost of covid-19? The Economist [Internet]. [cited 2022 May 23]; Available from: https://www.economist.com/finance-and-economics/2021/01/09/what-is-the-economic-cost-of-covid-19

3. Institute for Government. UK coronavirus policy timeline. 2021 [cited 2022 Jan 3]. Timeline of UK government coronavirus lockdowns and restrictions. Available from: https://www.instituteforgovernment.org.uk/charts/uk-government-coronavirus-lockdowns

4. Angus C, Henney M. Modelling the impact of alcohol duty policies since 2012 in England & Scotland [Internet]. University of Sheffield; 2019. Available from: https://www.sheffield.ac.uk/media/13068/download

5. Office for National Statistics. Alcohol-specific deaths in the UK 2021 [Internet]. 2022 [cited 2022 Dec 14]. Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/alcoholspecificdeathsintheuk/2021registrations

6. Holmes J, Angus C. Alcohol deaths rise sharply in England and Wales. BMJ. 2021 Mar 5;372:n607.

7. Holmes J, Meier PS, Booth A, Guo Y, Brennan A. The temporal relationship between per capita alcohol consumption and harm: a systematic review of time lag specifications in aggregate time series analyses. Drug and alcohol dependence. 2012 Jun 1;123(1–3):7–14.

8. Brennan A, Meier P, Purshouse R, Rafia R, Meng Y, Hill-Macmanus D, et al. The Sheffield Alcohol Policy Model - a mathematical description. Health economics. 2014 Sep 30;24(10).

9. Public Health England. Monitoring alcohol consumption and harm during the COVID-19 pandemic [Internet]. London: Public Health England; 2021. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1002627/Alcohol_and_COVID_report.pdf

10. Angus C. What has 2020 done to the UK's alcohol consumption? [Internet]. IAS. 2020 [cited 2022 May 23]. Available from: https://www.ias.org.uk/2020/12/02/what-has-2020-done-to-the-uks-alcohol-consumption/

11. Beard E, Brown J, West R, Acton C, Brennan A, Drummond C, et al. Protocol for a national monthly survey of alcohol use in England with 6-month follow-up: 'The Alcohol Toolkit Study'. BMC Public Health. 2015 Mar 7;15(1):230.

12. Babor TF, Higgins-Biddle JC, Saunders JB, Monteiro, M.G. AUDIT: the Alcohol Use Disorders Identification Test : guidelines for use in primary health care [Internet]. Geneva: World Health Organization; 2001 [cited 2022 Jan 3]. Report No.: WHO/MSD/MSB/01.6a. Available from: https://apps.who.int/iris/handle/10665/67205

13. Jackson SE, Garnett C, Shahab L, Oldham M, Brown J. Association of the COVID-19 lockdown with smoking, drinking and attempts to quit in England: an analysis of 2019–20 data. Addiction. 2021;116(5):1233–44.

14. Jackson SE, Beard E, Angus C, Field M, Brown J. Moderators of changes in smoking, drinking and quitting behaviour associated with the first COVID-19 lockdown in England. Addiction [Internet]. 2021;117(3). Available from: http://onlinelibrary.wiley.com/doi/abs/10.1111/add.15656

15. Richardson E, Giles L. Monitoring and Evaluating Scotland's Alcohol Strategy: monitoring Report 2021 [Internet]. Edinburgh: Public Health Scotland; 2021. Available from: https://www.publichealthscotland.scot/media/8090/mesas-monitoring-report-2021.pdf

16. Holmes J, Meng Y, Meier PS, Brennan A, Angus C, Campbell-Burton A, et al. Effects of minimum unit pricing for alcohol on different income and socioeconomic groups: a modelling study. The Lancet. 2014 May 10;383(9929):1655–64.

17. Angus C, Gillespie D, Ally A, Brennan A. Modelling the impact of Minimum Unit Price and Identification and Brief Advice policies using the Sheffield Alcohol Policy Model Version 3 [Internet]. University of Sheffield; 2015. Available from: https://www.sheffield.ac.uk/media/13079/download

18. Holmes J, Angus C, Buykx B Penny, Ally A, Stone T, Meier P, et al. Mortality and morbidity risks from alcohol consumption in the UK: Analyses using the Sheffield Alcohol Policy Model (v.2.7) to inform the UK Chief Medical Officers' review of the UK lower risk drinking guidelines: Final report [Internet]. Sheffield: University of Sheffield; 2016. Available from: https://www.sheffield.ac.uk/media/13072/download?attachment

19. Angus C, Henney M, Meier P, Brennan A, Holmes J. Analyses using an Australian adaptation of the Sheffield Alcohol Policy Model (v2.7) to inform the development of new alcohol guidelines: Final report. Sheffield: University of Sheffield; 2019 p. 57.

20. Meier PS, Holmes J, Angus C, Ally AK, Meng Y, Brennan A. Estimated Effects of Different Alcohol Taxation and Price Policies on Health Inequalities: A Mathematical Modelling Study. Basu S, editor. PLOS Medicine. 2016 Feb 23;13(2):e1001963.

21. Angus C, Henney M, Webster L, Gillespie D. Alcohol-attributable diseases and dose-response curves for the Sheffield Alcohol Policy Model version 4.0. 2019 Aug 21 [cited 2022 Jan 3]; Available from: https://figshare.shef.ac.uk/articles/journal_contribution/Alcohol-attributable_diseases_and_dose-response_curves_for_the_Sheffield_Alcohol_Policy_Model_version_4_0/6819689/2

22. Boniface S, Card-Gowers J, Martin A, Retat L, Webber L, Burton R, et al. The COVID hangover: addressing long-term health impacts of changes in alcohol consumption during the pandemic [Internet]. Institute of Alcohol Studies; 2022 Jul. Available from: https://www.ias.org.uk/wp-content/uploads/2022/07/The-COVID-Hangover-report-July-2022.pdf

23. British Beer and Pub Association. Statistical Handbook 2022. London; 2022.

24. Angus C, Pryce R, Holmes J, de Vocht F, Hickman M, Meier P, et al. Assessing the contribution of alcohol-specific causes to socio-economic inequalities in mortality in England and Wales 2001–16. Addiction. 2020;115(12):2268–79.

25. HM Revenue & Customs. GOV.UK. [cited 2022 Nov 11]. Alcohol Bulletin. Available from: https://www.gov.uk/government/statistics/alcohol-bulletin

26. NHS Digital. NDRS. 2022 [cited 2023 Mar 7]. Statistics on Alcohol, England 2021. Available from: https://digital.nhs.uk/data-and-information/publications/statistical/statistics-on-alcohol/2021

27. Roscoe S, Pryce R, Buykx P, Gavens L, Meier PS. Is disinvestment from alcohol and drug treatment services associated with treatment access, completions and related harm? An analysis of English expenditure and outcomes data. Drug and Alcohol Review. 2022 Jan;41(1):54–61.

28. UCL Tobacco & Alcohol Research Group. Monthly Tracking KPI - Graphs - Alcohol in England [Internet]. [cited 2023 May 9]. Available from: https://www.alcoholinengland.info/graphs/monthly-tracking-kpi

29. Office for National Statistics. Deaths registered summary statistics, England and Wales [Internet]. 2023 [cited 2023 May 9]. Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/datasets/deathsregisteredsummarystatisticsenglandandwales

30. Acuff SF, Strickland JC, Tucker JA, Murphy JG. Changes in alcohol use during COVID-19 and associations with contextual and individual difference variables: A systematic review and meta-analysis. Psychol Addict Behav. 2022 Feb;36(1):1–19.

31. Angus C, Morris D, Leeming G, Kai Le Chen R, Wilson L, Stevely A, et al. New modelling of alcohol pricing policies, alcohol consumption and harm in Scotland: An adaptation of the Sheffield Tobacco and Alcohol Policy Model [Internet]. Sheffield: University of Sheffield; 2023 Sep. Available from: doi.org/10.15131/shef.data.21931386

32. Beard E, Brown J, West R, Kaner E, Meier P, Michie S. Associations between socio-economic factors and alcohol consumption: A population survey of adults in England | PLOS ONE. PLOS ONE [Internet]. 2019 Feb 4 [cited 2023 Dec 12]; Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0209442

33. Rehm J, Gmel Sr GE, Gmel G, Hasan OSM, Imtiaz S, Popova S, et al. The relationship between different dimensions of alcohol use and the burden of disease—an update. Addiction. 2017;112(6):968–1001.

34. Griswold MG, Fullman N, Hawley C, Arian N, Zimsen SRM, Tymeson HD, et al. Alcohol use and burden for 195 countries and territories, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. The Lancet. 2018 Sep 22;392(10152):1015–35.

35. Fekjær HO. Alcohol—a universal preventive agent? A critical analysis. Addiction. 2013;108(12):2051–7.

36. Naimi TS, Stockwell T, Zhao J, Xuan Z, Dangardt F, Saitz R, et al. Selection biases in observational studies affect associations between 'moderate' alcohol consumption and mortality. Addiction. 2017;112(2):207–14.

37. Stockwell T, Zhao J, Panwar S, Roemer A, Naimi T, Chikritzhs T. Do "Moderate" Drinkers Have Reduced Mortality Risk? A Systematic Review and Meta-Analysis of Alcohol Consumption and All-Cause Mortality. J Stud Alcohol Drugs. 2016 Mar 1;77(2):185–98.

38. Angus C, Holmes J, Pryce R, Meier PS, Brennan A. Model-based appraisal of the comparative impact of Minimum Unit Pricing and taxation policies in Scotland: An adaptation of the Sheffield Alcohol Policy Model version 3 [Internet]. University of Sheffield; 2016. Available from: https://www.sheffield.ac.uk/media/13073/download

Table 1 - Cumulative changes in health outcomes over 20 years compared to counterfactual

	Counterfactual	Scenario	Difference	% Difference
Admissions				
Immediate rebound	12,289,237	12,331,915	42,677	0.30%
Main scenario		12,496,835	207,597	1.70%
No rebound		12,645,070	355,832	2.90%
Lower risk-only rebound		12,689,435	400,198	3.30%
Increasing consumption		13,261,620	972,382	7.90%
Deaths				
Immediate rebound	125,581	127,411	1,830	1.50%
Main scenario		132,734	7,153	5.70%
No rebound		138,430	12,849	10.20%
Lower risk-only rebound		137,296	11,715	9.30%
Increasing consumption		150,773	25,192	20.10%