

Implementation of minimum unit pricing for alcohol in Scotland and subsequent rates of hospital-admitted self-harm: controlled interrupted time series analysis

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ABSTRACT

Background: Harmful alcohol use is a major modifiable risk factor for self-harm. We aimed to examine associations between minimum unit pricing for alcohol, introduced in Scotland in 2018, and rates of hospital-admitted self-harm.

Methods: Data were obtained from Public Health Scotland and English Hospital Episode Statistics. Interrupted time series (ITS) analysis compared pre- and post-intervention self-harm admission rates per 100 000 population, including controlled comparisons with England.

Results: The before-after slope reduction in Scotland corresponded to -5.6 (95% CI -7.5 to -3.7) admissions per quarter, per 100 000 population, over the intervention period. Using controlled ITS, a greater slope reduction was observed in Scotland relative to England: -3.5 , CI -6.4 to -0.6 . No differences in slope change were observed when examining only pre-pandemic study quarters. Findings were consistent with a possible postintervention rate reduction in the two most deprived population quintiles, while no between-nation slope difference was observed in the three least deprived quintiles.

Conclusions: Findings were consistent with possible postintervention reductions in hospital-admitted self-harm in Scotland compared to England, with reductions concentrated in more deprived populations. Population-level alcohol pricing policies may contribute to reducing self-harm frequency, although causal interpretation is limited by the observational, quasi-experimental study design and differing between-nation pre-intervention trajectories.

Keywords: alcohol; mental health; population-based and preventative services

Introduction

Reducing rates of self-harm and suicide are public health priorities in the UK and globally.^{1–3} Self-harm is strongly associated with suicide, therefore, addressing risks of self-harm is a key mechanism for preventing suicide. There are ~120 to 200 hospital-admitted self-harm episodes per 100 000 population annually in England.^{4,5} Rates of hospital-admitted self-harm are markedly higher among people living in deprived neighbourhoods.⁶ Alcohol is involved in over half of self-harm hospital presentations and a third of these

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patients are identified as having alcohol misuse problems.⁷ Suicide is around ten times more prevalent in people with alcohol dependence than in the general population.⁸ Therefore, there is a strong rationale for implementing measures to reduce alcohol affordability to lower rates of self-harm, decrease the medical severity of self-harm episodes, and prevent suicide.

The 10-Year Health Plan for England and the Scottish Suicide Prevention Strategy both set out preventative action as a key priority^{2,9} while England's cross-sector suicide prevention strategy aims to reduce access to means of suicide and address risk factors at the population level.¹

In May 2018, Scotland introduced minimum unit pricing (MUP) for alcohol sold to the public. MUP policy sets a legal minimum price per unit of alcohol, preventing alcohol from being sold below that price. The minimum price was originally set at £0.50 and increased to £0.65 in September 2024.¹⁰ While taxation and some restrictions apply to retailers in England—for example, bans on encouraging irresponsible drinking and below-cost sales—England has not implemented MUP. Scottish MUP was associated with decreased alcohol sales,¹¹ as well as reductions in deaths and hospitalizations attributable to alcohol consumption in Scotland,¹¹ with larger reductions observed in more deprived populations.¹² No previous research has specifically examined MUP and self-harm or suicide, although restrictive alcohol policies more broadly have been linked to lower suicide rates and smaller proportions of suicide deaths attributable to alcohol.¹³

Possible mechanisms of the relationship between less affordable alcohol and decreased suicidal behaviour include reducing the number of people in the population who move into harmful drinking and lowering volumes consumed and intoxication levels. Those in the 'harmful drinking' category have higher risks of self-harm and repeated suicidal behaviour¹⁴ via heightened psychological distress.¹⁵ This can exacerbate exposure to and impacts of adverse life events, social withdrawal and marginalization, which can also increase self-harm risk.^{16,17} Reducing affordability of alcohol may lower the number of people experiencing intoxication, a group at greater risk of moving from self-harm ideation to action^{15,18} and of more medically serious self-harm.¹⁹

Examining impacts of population-level health interventions requires consideration of co-occurring interventions and societal influences.²⁰ Rates of primary-care-recorded self-harm were impacted by the COVID-19 pandemic and its associated 'stay at home' orders and restrictions on healthcare availability.²¹ Given that England and Scotland both experienced the pandemic, yet only Scotland implemented MUP for alcohol, England provides an appropriate control population for this policy intervention.

We aimed to examine the potential impact of the MUP policy implementation in Scotland on hospital-admitted self-harm rates, including those involving acute alcohol use, compared to those in England using interrupted time series (ITS) analyses. Our specific objectives were to conduct:

- i. a single (uncontrolled) ITS of hospital-admitted self-harm in Scotland from quarter Q2 2015 to Q4 2024
- ii. a single ITS of hospital-admitted self-harm involving alcohol in Scotland
- iii. a controlled ITS of hospital-admitted self-harm in Scotland, using England as a control nation (Q2 2015 to Q1 2023)

Methods

The study protocol was registered at <https://osf.io/6hxxkg/overview>. The Strengthening the Reporting of Observational Studies in Epidemiology Statement guidelines for reporting observational studies were followed.²² Further details of the methodology are provided in the supplement.

Data sources

Data were obtained via publicly available data repositories and supplemented with freedom of information requests to NHS England and Public Health Scotland (PHS) made by the first author. Data from Q1 2015 to the latest available calendar quarter were sought.

Outcomes and covariates

Our primary study outcome was hospital admission where self-harm was recorded. The secondary outcome was self-harm with diagnostic codes relating to acute alcohol use recorded for the same admission (available in Scotland only). We focused on acute alcohol codes, rather than a broader set of codes relating to chronic alcohol misuse, to capture self-harm involving alcohol intoxication. This definition more closely reflected the potential mechanisms of the relationship between alcohol use and self-harm that we outlined. Additionally, the impacts of MUP on admissions for chronic alcohol use have been widely studied.^{11,12}

Models were stratified by the following covariates:

- Area-level deprivation, obtained from the Scottish Index of Multiple Deprivation (SIMD) and the English IMD, is a composite measure based on the following domains: income, employment, education/skills, health, crime, housing and geographical access to services (Scotland) or living environment (England).
- Sex: male or female.

Statistical analysis

Rates of hospital-admitted self-harm per 100 000 population were calculated for each quarter (Q) from Q2 2015 to Q4 2024; 13 data points prior to the intervention and 26 postintervention. Controlled analyses involving England were conducted on the Q2 2015 to Q1 2023 time series due to changes in diagnostic recording methods in England from 2023 (see Supplement: 'Methods' and Table S1). No power calculation was conducted; consistent with methodological guidance for ITS analyses, we included several years of quarterly observations before and after the intervention to allow estimation of baseline trends, seasonal variation, and changes in level and slope.²³ Crude rates were calculated for each nation before and after the intervention.

Before-after uncontrolled interrupted time series

Our approach used the framework set out in Bernal 2018,²⁰ including conducting both single and controlled ITS. A single group ITS was conducted for Scotland's hospital-admitted self-harm rates using ITSA²⁴ in Stata V19.5. Generalized linear models with Newey-West standard errors were used to estimate level and slope change following the intervention start date of Q3 2018.

Controlled interrupted time series

To minimize potential confounding from secular trends, seasonal variation, and external events occurring at similar times to the intervention, we applied a control group to the ITS.²⁰ Differences in rate differences between Scotland and England at the start of the intervention (level change) and over the course of the postintervention period (slope change) were estimated. Preintervention differences in level and slope in the intervention and control group were examined to assess similarity of the two nations and inform the interpretation of the results. Similarity strengthens the assumption that any divergence after the intervention was likely due to the intervention rather than pre-existing differences. Subgroup differences were examined using stratified analyses. For both single and controlled ITS analyses, postestimation tests were conducted to check whether the models correctly accounted for autocorrelation and the appropriate lag was specified.

Confounding

Uncontrolled and controlled analyses were adjusted for government restrictions related to the COVID-19 pandemic. We incorporated the Oxford COVID-19 Government Response Tracker (OxCGRT) Stringency Index, a composite measure of nine non-pharmaceutical infection containment measure indicators such as school and workplace closures, travel restrictions and public health messaging.²⁵

Sensitivity analyses

We restricted our study period to the pre-COVID-19 quarters and set the median point in the preintervention time series as a pseudo-interruption for the sensitivity analyses.²⁶

Results

Crude pre-post rate comparisons

The rate of hospital-admitted self-harm during the study period Q2 2015 to Q1 2023 was higher in Scotland (218 admissions per 100 000 population) than in England (190) (Table 1). The crude pre-post comparisons are for descriptive, contextual purposes rather than for suggesting associations with the study intervention. Simple pre-post comparisons suggested there was a small increase in hospital-admitted self-harm in Scotland following the intervention, in contrast to a modest reduction in England: the preintervention rate in Scotland was 215 (CI 213 to 217) compared to 221 (CI 218 to 222) postintervention, a rate ratio (RR) of 1.03 (CI 1.01 to 1.04). In England, a decrease was observed: preintervention 200 (CI 199 to 200) vs. postintervention 184 (183 to 184), RR 0.92 (CI 0.916 to 0.924). The small overall postintervention increase that was observed in Scotland was not seen in the most deprived quintile or among men, where an increase was observed (Table 1).

Before-after uncontrolled interrupted time series: Self-harm

In Scotland, the rate of hospital-admitted self-harm was stable prior to the start of the intervention (slope change 1.3, CI -0.4 to 2.9). Following an initial increase (level change 38.4, CI 15.1 to 61.6) the rate reduced over the study period (slope change -5.8, CI -7.8 to -3.9). After adjusting for the COVID-19 stringency index, the level and slope change remained broadly similar: 27.4 (CI 5.6 to 49.3) and -5.6 (CI -7.5 to -3.7), respectively, (Fig. S1).

Post-intervention level changes were non-significant. The adjusted slope change decreased as the area-level deprivation increased: the slope change was -1.7 (-2.6 to -0.8) in the least deprived quintile and -11.2 (-14.8 to -7.5) in the most deprived (Fig. S2 in Supplement). The decrease was similar in males (slope change -5.2, CI -6.9 to -3.6) and females (-6.0, CI -8.4 to -3.7).

Before-after uncontrolled interrupted time series: Self-harm involving alcohol

During the study period, 27.6% (78 per 100 000 population) of hospital-admitted self-harm episodes in Scotland were coded as involving alcohol. There was no significant rate change in hospital-admitted self-harm involving alcohol

Table 1 Simple pre-post comparisons of hospital-admitted self-harm rates during preintervention and postintervention study quarters, Scotland and England.

	Rate per 100 000 population (95% CI), no. of hospital-admitted self-harm episodes			
	Preintervention study period, Q2 2015 to Q2 2018: Scotland	Postintervention study period, Q3 2018 to Q1 2023: Scotland	Preintervention study period, Q2 2015 to Q2 2018: England	Postintervention study period, Q3 2018 to Q1 2023: England
Overall	215 (213 to 217), 37 526	221 (218 to 222), 56 669	200 (199 to 200), 359 227	184 (183 to 184), 493 496
Area-level deprivation				
Quintile 1 (least deprived)	82 (79 to 85), 2827	96 (93 to 98), 4817	126 (125 to 127), 42 865	121 (120 to 122), 62 820
Quintile 2	127 (123 to 131), 4354	136 (133 to 139), 6827	148 (146 to 149), 50 853	138 (137 to 139), 72 930
Quintile 3	179 (174 to 183), 6264	188 (184 to 192), 9685	186 (185 to 188), 64 985	168 (166 to 169), 90 780
Quintile 4	264 (259 to 269), 9454	269 (265 to 273), 14,217	237 (236 to 239), 84 065	209 (207 to 210), 114 450
Quintile 5 (most deprived)	386 (380 to 392), 14 080	379 (374 to 385), 20 381	332 (330 to 333), 115 737	288 (287 to 290), 153 990
Sex				
Female	248 (245 to 251), 22 300	263 (260 to 266), 34 797	250 (249 to 251), 228 994	237 (237 to 238), 325 456
Male	180 (177 to 248), 15 226	175 (173 to 177), 21 872	161 (160 to 162), 142 113	141 (140 to 141), 185 117

Table 2 Difference-in-difference level and slope change estimates in rates of hospital-admitted self-harm, adjusted for COVID-19 Stringency Index, following alcohol MUP implementation in Scotland, compared to England as a control nation, Q2 2015 to Q1 2023.

	Difference in level change in Scotland (compared to England) (95% CI)	Difference in slope change in Scotland (compared to England) (95% CI)
Overall	4.7 (−23.6 to 32.9)	−3.5 (−6.4 to −0.6)
Area-level deprivation		
Quintile 1 (least deprived)	2.7 (−11.8 to 17.2)	0.4 (−1.2 to 2.0)
Quintile 2	−0.9 (−19.7 to 18.0)	−0.7 (−2.7 to 1.3)
Quintile 3	16.0 (−10.3 to 42.3)	−1.0 (−3.6 to 1.7)
Quintile 4	12.0 (−24.9 to 48.8)	−5.3 (−9.2 to −1.4)
Quintile 5 (most deprived)	11.9 (CI −47.0 to 70.7)	−7.7 (CI −13.3 to −2.0)
Sex		
Female	−0.2 (CI −34.3 to 33.8)	−3.8 (−7.3 to −0.2)
Male	9.7 (−15.1 to 34.4)	−3.2 (−5.7 to −0.7)

during the preintervention study period in Scotland (adjusted rate −0.6, CI −1.3 to 1.0). There was a level increase immediately following the intervention (11.2, CI 3.1 to 19.4) followed by a slope decrease of −1.1 (CI −1.9 to −0.3) (Fig. S3).

The slope reduction was similar in males and females: in males −1.4 (CI −2.3 to −0.5) and −0.8 in females (CI −1.6 to −0.2). The reduction in rates was only observed in the two most deprived quintiles: quintile 4 slope change −1.7 (CI −2.9 to −0.4) and quintile 5 was −1.8 (CI −3.4 to −0.3) (Fig. S4).

Controlled interrupted time series

Prior to the intervention, there were no differences in level change (−9.6 per 100 000 per quarter, CI −23.9 to 4.8) between Scotland and England. The pre-intervention trend

in Scotland suggested a non-significant slope increase of 1.3 (−0.4 to 3.0) per 100 000 per quarter, while the rate in England was decreasing by around 1.7 (−3.4 to −0.11). The difference between these pre-intervention trends was 3.0 (0.6 to 5.4), indicating that the two nations were following significantly different trajectories before the intervention. Following the intervention, there was no difference in level change between the two nations (4.7, −23.6 to 32.9) (Table 2). However, there was a difference in slope change (−3.5, CI −6.4 to −0.6) (Fig. 1). These findings are broadly similar to analyses based on data up to Q4 2024 (Fig. S5) and unadjusted analyses (Fig. S6).

Stratification by area-level deprivation quintile indicated that MUP was associated with a between-nation rate difference in the most deprived quintile over the postintervention

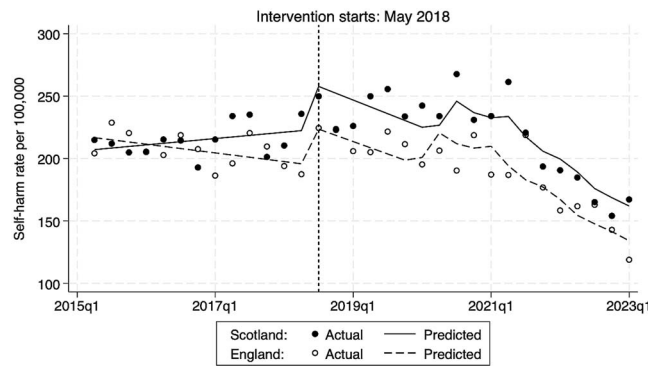


Figure 1 Scotland vs. England, adjusted for COVID-19 Stringency Index, Q2 2015 to Q1 2023.

study period: slope change -7.7 (CI -13.3 to -2.0). This association was also observed in the second most deprived quintile: between nation slope difference -5.3 (CI -9.2 to -1.4) (Fig. 2). In contrast, there was no significant between-nation slope difference in admission rates in the three least deprived quintiles.

The baseline self-harm admission rate was lower in males compared with females (Fig. S7). Postintervention decreases in slope change (but not level change) were observed in both females and males: slope change -3.8 (CI -7.3 to -0.2) in females and -3.2 (CI -5.7 to -0.7) in males (Table 2).

Sensitivity analyses

Restricting the study quarters to those occurring before the COVID-19 pandemic, there were no postintervention differences in level (-12.4 , CI -61.6 to 36.8) or slope change (1.0 , CI -13.8 to 15.7) between England and Scotland (Fig. S8).

As an additional sensitivity analysis, the median point in the preintervention time series was set as a pseudo-intervention date (Q4 2016) and interruptions to the outcome trend were tested. Results from the single ITS using data from Scotland suggested a significant postintervention slope change of -3.0 (CI -5.0 to -1.1) (Fig. S9). Using the same pseudo-interruption date, controlled ITS using England as a comparison population resulted in no significant slope change: -0.4 (CI -5.9 to 5.2) (Fig. S10).

Discussion

Main findings of this study

Before-after analyses of Scottish data suggested that there was, an immediate increase in admissions following the introduction of alcohol MUP, with a subsequent sustained and statistically significant decline over time. This postintervention downward trend corresponded to a quarterly reduction of ~ 4 – 5 admissions per 100 000 population and was robust

to adjustment for the COVID-19 stringency index. Substantially steeper declines were observed in more deprived areas. For hospital-admitted self-harm involving alcohol, findings were consistent with no preintervention trend, an immediate postintervention increase and a subsequent decline that was evident only in the two most deprived quintiles, though causal interpretation was limited by the absence of a control population in this analysis.

Controlled ITS analyses comparing Scotland with England indicated a greater postintervention reduction in trends in Scotland relative to England. This between-nation difference in slope was essentially only observed in the two most deprived quintiles. However, causal interpretation is constrained by the observational, quasi-experimental study design, the differing pre-intervention slope trajectories and the absence of a postintervention slope difference during the pre-pandemic study quarters.

What is already known on this topic

Evidence suggests restrictive alcohol policies are associated with reduced suicide rates in addition to lower proportions of suicide deaths involving alcohol.^{13,27} Considering policies addressing alcohol pricing specifically, much of the evidence suggests restrictive pricing is associated with reductions in suicide deaths.²⁷ However, conclusions are constrained by risks of bias within the studies. There is also evidence that effects are not uniform across groups. For example, some studies observed reductions in suicide deaths only in males.²⁷

In 2025, the UK Government produced the first clinical guidance for alcohol treatment, aiming to facilitate better care for people with alcohol use disorder and harmful drinking, including among people with co-occurring mental health conditions.²⁸ However, there are concerns that there has been little progress in addressing harmful alcohol use in recent years and that inequalities have continued to widen.²⁹ Population level approaches such as minimum unit alcohol pricing are a promising addition to clinical approaches.

What this study adds

Based on the assumption that the observed changes were causally related to MUP, our findings have important implications for the continuation of alcohol pricing limits in nations where such interventions are already in place. In nations where no such interventions have been implemented, our findings may contribute to evidence for debates about introducing new policies. While existing evidence pointed to reductions in alcohol-related hospital admissions and deaths,^{11,12} this is the first study to examine impacts on hospital-admitted self-harm and suggests benefits of MUP may stretch beyond physical health and extend to mental health.

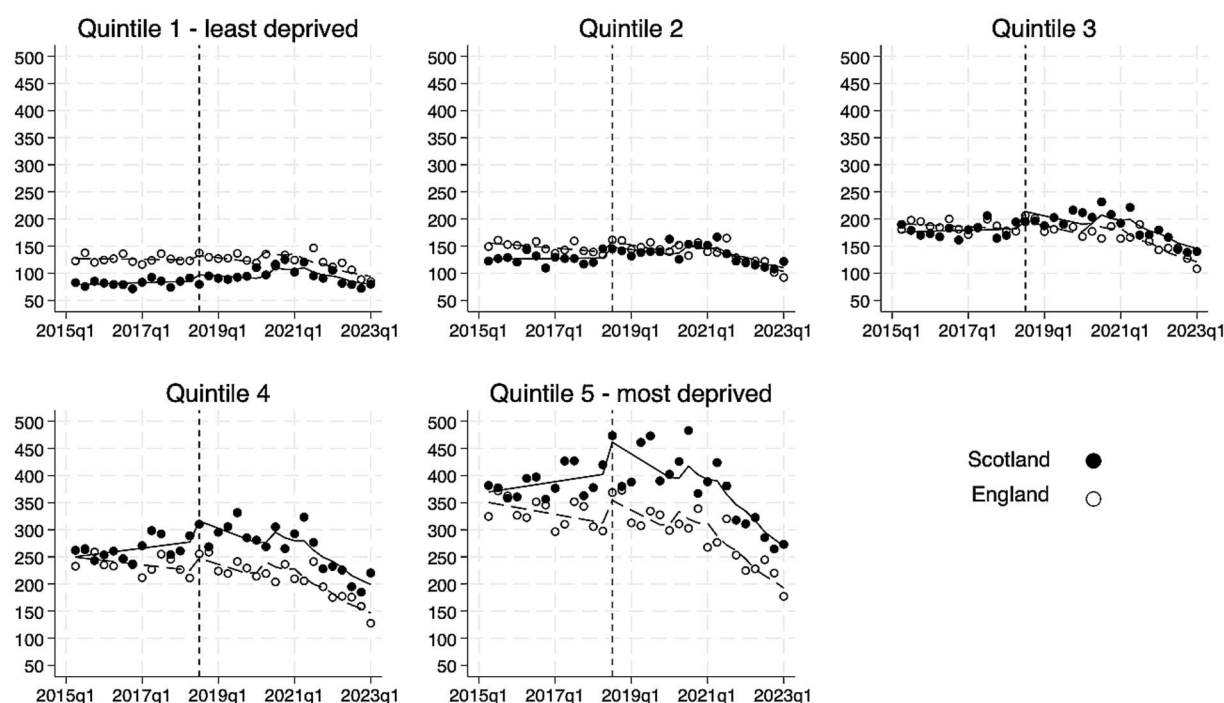


Figure 2 Scotland vs. England, adjusted for COVID-19 Stringency Index, Q2 2015 to Q1 2023, by deprivation quintile.

Our findings were consistent with larger self-harm reductions in individuals living in areas with higher levels of deprivation, in line with studies examining impacts of alcohol MUP on alcohol-related deaths and hospitalisations,¹² and on cancer incidence and mortality.³⁰ These findings may be driven by the relatively low price per unit, set at £0.50 for the quarters included in our study.

MUP may be an important component of national approaches to reducing self-harm, particularly in more deprived populations. The 2024 increase in MUP to £0.65 per unit may increase the proportion of the population that may be influenced by the policy. Our findings are consistent with a beneficial impact of MUP on self-harm outcomes over time, and they add to a broader body of evidence suggesting that population-level alcohol pricing policies may contribute to reducing the frequency of in suicidal behaviour. However, findings based on the pre-pandemic study quarters, and the differing preintervention trends between the study nations, constrain the causal attribution of our findings to the intervention and suggest that other factors may have played a role. Future research should examine differential impacts in ethnic and age groups, effects of the MUP increase and impacts on suicide rates.

Limitations of this study

A key strength of this study is the use of population-level hospital admission data from two nations over an extended

study period, allowing comparison of temporal trends in hospital-admitted self-harm before and after the policy implementation. The use of England as a control nation helped to account for population factors such as the COVID-19 pandemic and other contemporaneous societal influences that were experienced in both the control and exposed nation. Stratified analyses by sex and area-level deprivation enabled exploration of potential differential effects across population subgroups. We incorporated recommended sensitivity analyses to test for changes in trends using a pseudo-intervention date.

Several limitations should be considered when interpreting the findings. The COVID-19 stringency index included in the analyses reflected UK-wide restrictions and did not capture differences in the timing or nature of lockdowns and other societal restrictions imposed between Scotland and England or regionally within each nation. Although adjustment for this index did not materially alter the main findings, residual confounding related to pandemic-related service disruption or behavioural change may remain. Consistent with this, sensitivity analyses restricted to the pre-pandemic period found no postintervention differences in level or slope between Scotland and England, indicating that findings may be sensitive to the inclusion of pandemic-affected periods. Changes in admission thresholds arising from the COVID-19 pandemic may have differed between Scotland and England, potentially influencing observed trends in hospital admissions.

The definitions of ‘hospital admission’ differed slightly between Scotland and England, which may affect the comparability of absolute rates of hospital-admitted self-harm. However, such differences are likely to have remained relatively stable over time and are therefore less likely to bias estimates of changes in trends. Findings from controlled ITS should be interpreted in the context of the preintervention differences between Scotland and England, with the rate in Scotland increasing relative to England, where the rate was stable.²⁶ Data on the use of alcohol at the time of hospital-admitted self-harm were not reliably available in England. Findings from single, before-after ITS on self-harm involving alcohol use were consistent with a possible reduction following the intervention. However, because this analysis could not be conducted within the controlled ITS framework, these findings should be regarded as supportive rather than indicative of causal evidence linking the intervention to observed changes in self-harm frequency.

The Scottish Government increased the MUP threshold to £0.65 per unit in September 2024.³¹ The largest price increases were for high-strength cider and low-cost spirits such as supermarket brand vodka. This took the minimum price of a 70 cL bottle of 40% ABV spirit from £14.00 to £18.20 and a 2-litre bottle of high-strength (7.5% ABV) cider from £7.50 to £9.75. The real-terms value of the minimum unit price of £0.50, introduced in 2018, would not have been constant over our study period due to effects of inflation. Some evidence suggested that the initial minimum price was too low.³² While the increased threshold of £0.65 per unit occurred in September 2024, fewer products would have been affected by the policy, and to a lesser degree, in the preceding years proximal to this increase.³¹ Therefore, our findings are potentially a conservative estimate of the impact on hospital-admitted self-harm particularly in the two most deprived quintiles.

Additional limitations include the restricted age stratifications available from data providers, which limited age-specific analyses. We conducted prespecified subgroup analyses to explore heterogeneity in the purported intervention effects. Subgroup findings should be interpreted cautiously and considered supportive rather than definitive evidence of differential effects. Hospital admission data capture self-harm episodes with higher clinical need and associated with greater mortality risks, and do not reflect all self-harming behaviour that occurs in the population. Due to data availability, deviations from our registered protocol were necessary including omitting Wales as a control nation and excluding suicide as an outcome measure. Finally, we could not assess potential differences by ethnic group due to the absence of available data, which should be addressed in future research.

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Author contributions

R.D., A.J., L.M., and R.T.W. developed the concept for the study, which was refined by S.S. and all authors. The study design was shaped by a Population Mental Health Consortium policy roundtable. S.S. led the study, requested and obtained the data, conducted the data analysis, and wrote the first draft of the paper. R.T.W., J.D.-M., R.D., N.K., L.M., J.S., and A.J. contributed towards interpretation, conclusions, implications, and editing subsequent drafts of the paper. S.S. is the guarantor.

Supplementary data

Supplementary data is available at *Journal of Public Health* online.

Conflict of interest. N.K. is a member of the Department of Health and Social Care (England) National Suicide Prevention Advisory Group. He has chaired and contributed to various committees for the National Institute for Health and Care Excellence (NICE) developing guidelines for suicide prevention, depression, and the management of self-harm. He is supported by the Mersey Care NHS Foundation Trust as well as the University of Manchester.

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Data availability

The data used in this study can be requested from Public Health Scotland and NHS England. Due to ongoing analysis of the study data by the research team, the statistical code used in this study will be made available upon request within 24 months following the publication date. Requests should be made to the corresponding author.

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