Opioid abuse and austerity: Evidence on health service use and mortality in England

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Opioid abuse has become a public health concern among many developed countries, with policymakers searching for strategies to mitigate adverse effects on population health and the wider economy. The United Kingdom has seen dramatic increases in opioid-related mortality following the financial crises in 2008. We examine the impact of spending cuts resulting from government prescribed austerity measures on opioid-related hospitalisations and mortality, thereby expanding on existing evidence suggesting a countercyclical relationship with macroeconomic performance. We take advantage of the variation in spending cuts passed down from central government to local authorities since 2010, with reductions in budgets of up to fifty percent in some areas resulting in the rescaling of vital public services. Longitudinal panel data methods are used to analyse a comprehensive, linked dataset that combines information from spending records, official death registry data and large administrative health care data for 152 local authorities (*i.e.*, unitary authorities and county councils) in England between April 2010 and March 2017. A total of 280,827 people experienced a hospital admission in the English National Health Service because of an opioid overdose and 14,700 people died from opioids across the study period. Local authorities that experienced largest spending cuts also saw largest increases in opioid abuse. Interactions between changes in unemployment and spending items for welfare programmes show evidence about the importance for governments to protect populations from social-risk effects at times of deteriorating macroeconomic performance. Our study carries important lessons for countries aiming to address high rates of opioid abuse, including the United States, Canada and Sweden.

1. Introduction

Opioid abuse and its profound effects on population health is one of the most contentious policy topics in recent years. While opioids are an effective treatment for acute and cancer pain (Nersesyan and Slavin, 2007; Rosenblum et al., 2008), they offer limited pain relief beyond twelve weeks because of built-up tolerance and hyperalgesia (Fields, 2011). Prolonged use often requires higher doses, which can cause dependency and increases the likelihood of an overdose. The United States (US) is at the forefront of the opioid epidemic, recording over one million opioid-related deaths since 1999, and an average of 130 deaths daily (U.S. Department of Health and Human Services, 2019), making it the leading cause of death for those below fifty-years of age (Ruhm, 2018). Across other Organisation for Economic Co-operation and Development (OECD) countries, opioid-related deaths have also risen by an average 20 percent between 2011 and 2016, with particularly large increases observed in Sweden, Lithuania, and England and Wales (OECD, 2019). The global trajectory of opioid abuse has raised concern among national and international institutions, and policymakers are in search for effective strategies to mitigate adverse impacts on public health, societies, and the wider economy (Volkow et al., 2019, European Monitoring Centre For Drugs And Drug Addiction, 2019).

There are several contributing factors to the opioid epidemic. These include a growing and increasingly dynamic illicit drug market (Degenhardt and Hall, 2012), poor knowledge and access to chronic pain management (Katz et al., 2013), and lobbying from pharmaceutical companies leading to higher prescription rates (Kuehn, 2007), especially for synthetic opiates such as tramadol and fentanyl. Indeed,

over-prescribing of opioids for pain relief following surgery, back pain, or in combination with psychological therapies (Hah et al., 2017), is considered a driver of opioid consumption; however, trends of prescription patterns vary widely across OECD countries. For example, in the United Kingdom (UK) opioid prescriptions for non-cancer pain have increased significantly (for example, up to 30-fold in the case of oxycodone) between 2006 and 2017, with a study based on primary care data suggesting that the most used opioid, codeine, reached 2456 prescriptions per 10,000 people in 2017. The study also found that in the first year of opioid initiation, 14.6 percent of prescription recipients became long-term opioid users (Jani et al., 2020). Prescription rates tend to be highly correlated with socio-economic deprivation (Keyes et al., 2014), for example in England (Public Health England, 2019; Mordecai et al., 2018), prescription rates were found to be higher in the north of the country and along coastal regions, which are considered more economically and socially deprived (Schifanella et al., 2020). But it remains unclear whether the availability of opioid medication alone is associated with increases in opioid-related deaths (Powell et al., 2020), considering that at country-level, Germany and the Netherlands report high availability rates despite low overall opioid-related mortality (Verhamme and Bohnen, 2019).

The significant rise in overdoses in some countries falls into a period of sustained economic uncertainty following the 2008 financial crises, and several studies have investigated the relationship between macroeconomic performance and drug abuse (Nagelhout et al., 2017). Deaths of despair coined by Case and Deaton (2015) suggest that economic downturns impact on people's behavioural choices, with an increase in drug abuse and suicides during times of economic hardship. This hypothesis has been supported by evidence from other settings, for example Carpenter et al. (2017) suggest an increase in substance use disorders, involving analgesics by 5 percent, with each percentage-point increase in the state unemployment rate. Similarly, Hollingsworth et al. (2017) found that for opioid abuse, deaths and emergency room visits increased when macroeconomic performance weakens, with a one percent increase in unemployment associated with a 3.6 percent rise in opioid-related deaths and a 7 percent rise in hospital attendances. The underlying narrative of these findings implies that psychological stress inflicted by economic pressure and unemployment raises people's propensity for consuming opioids as a coping mechanism, possibly suggesting the need for functioning safety-nets to offer support to people most affected by economic shocks. However, evidence on the countercyclical relationship between economic performance and opioid abuse mostly relied on observational studies without measures for causality. It is therefore possible that higher rates of opioid abuse in some areas may lead to lower productivity and greater levels of unemployment (Currie et al., 2019).

To study the direction of the relationship between economic drivers and opioid abuse, we focus on a policy of fiscal consolidation to address high levels of sovereign debt encountered in the UK following the financial crises in 2007/08. We take advantage of the variation in spending cuts passed down from central government to local governments since 2010, with budget cuts of up to fifty percent in some areas resulting in the rescaling of vital public services and infrastructure. In light of rises in opioid prescription rates by 34 percent from 568 per 1000 patients to 761 per 1000 patients between 1998 and 2016 in England (Curtis et al., 2019), and an increase in opioid-related deaths to 41 per 1 million population (*i.e.*, increase of 68 percent from 2011 to 2016) (OECD, 2019), we hypothesise that the deterioration of the social safety-net resulted in detrimental impacts on opioid abuse measured through opioid-related utilisation of hospital services and mortality. To our knowledge, this is the first study to investigate the relationship between changes in governmental spending on welfare programmes and opioid abuse, which helps untangle the mechanisms underlying the previously observed association with macroeconomic performance. Our findings suggest that local areas that experienced largest spending cuts also experienced largest increases in opioid abuse across the study

period. Impacts were strongest for reductions in funding for social care services and housing assistance, highlighting the importance of a social safety-net in protecting vulnerable populations from economic shocks. Our findings add to the growing evidence on the impacts of economic performance on population health and can inform the current government on its spending priorities.

The remainder of the paper proceeds as follows: Section two discusses the context of austerity in England and reviews evidence on its adverse impacts. Section three describes the methods and data used for our analyses, section four presents the findings, while section five provides a discussion, policy implication and concluding remarks.

2. Background: austerity in England

A combination of speculative activity in the financial markets and the accumulation of debt through cheap credits culminated in the 2007/08 global financial crisis (Helleiner, 2011; Claessens et al., 2013). Growth of mortgage defaults and the burst of the housing bubble in the US, triggered a chain of events that led to the bankruptcy of major investment banks and negative spill-overs on economies, globally. To avoid economic collapse and boost stability, governments across Europe and North America assigned emergency stimulus packages and bank bailouts, effectively transforming the private sector financial crises into a sovereign debt crisis (Josifidis et al., 2014). In the UK, fiscal support actions under the Labour government included policies such as a reduced value-added tax from 17.5 percent to 15 percent to boost public consumption, and capital injections in banks with a liquidity scheme for buying toxic assets (Office for National Statististics, 2020b). As a consequence, UK national debt increased from 39 percent of GDP prior to the financial crises, to 69 percent of GDP in 2010.

To contain the rise in national debt, the 2010 elected Conservative-led coalition government (*i.e.*, Conservatives and Liberal Democrats) pledged to introduce strict austerity measures (Conservative et al., 2010). These included spending reductions to most government departments, but excluded departments responsible for health, international development, energy and climate change. Largest budget cuts of more than 50 percent in real terms were enforced on local authorities between 2010 and 2015, resulting in rescaling of welfare programmes linked to social care, housing assistance and public health across most local districts in the UK (Gray and Barford, 2018). Since 2010, spending cuts in these areas alone were estimated £30 billion, effectively resulting in a diminishing size of the state, and an erosion of the British welfare-system.

The usefulness of austerity measures at times of macroeconomic downturns has been contested among policymakers and academics (McKee et al., 2012). Proponents argue that austerity leads to a reduction in public-debt as a share of GDP and stimulates economic growth through expansionary contraction by adjusting expectation around taxes and governmental spending (Konzelmann, 2014). Opponents argue that countercyclical spending is required to provide economic stimulus through fiscal expansion, including a reduction of taxes, and spending that translates into job creation (Ban, 2015). While this approach will ultimately result in higher budget deficits, it will increase interest rates and encourage private investments, and governments are recommended to reverse fiscal support once economic performance has strengthened.

There remains much debate about the effectiveness of either approach on improving macroeconomic performance in response to a financial crisis, but undoubtedly, austerity measures are regressive in nature (Hastings et al., 2017; Callan et al., 2011); they therefore carry the greatest burden for the countries' poor, which can lead to widespread inequalities, and causes problems in physical and mental well-being (Rajmil et al., 2020). Across European countries that implemented austerity measures in the years post-2008, either as part of a condition to access financial bailouts prescribed by the International Monetary Fund, European Central Bank and European Commission (*i.e.*, Greece, Ireland, and Portugal), or as a national agenda to consolidate the

fiscal household (*i.e.*, UK), adverse impacts on population health have been reported (Fransham and Dorling, 2018; Quaglio et al., 2013; Stuckler et al., 2017). This includes overall reductions in self-reported health status, rises in the number of mental health problems such as depression and anxiety, increases in suicide rates among the working age population, and higher levels in transmission of infections. Reductions in health care coverage also resulted in higher out-of-pocket expenditure for use of health care services, increased catastrophic spending for health care services among poor households, and triggered a rise in unmet medical needs across some European countries.

Austerity is found to impact health through two mechanisms (Stuckler et al., 2017): first, a social-risk effect that combines adversities from unemployment and poverty with social welfare programmes commonly used to protect against health effects, and second, a health care effect, resulting from spending cuts to health care services. Given that austerity in the UK was mostly directed towards local governments, and health care budgets remained ringfenced, we hypothesise that social-risk effects may have been responsible for the rise in opioid abuse observed in England in the period post-2010. While opioid abuse is correlated with socio-economic deprivation (Petmesidou et al., 2014), austerity measures specifically impacted the benefits available for the unemployed, ultimately increasing the level of poverty (*i.e.*, deprivation) across the country. This included the introduction of tightened rules to qualify for unemployment benefits, or financial sanctions for people failing to provide evidence for active employment seeking behaviour. Funding cuts also led to a reduction in housing assistance, with evidence to suggest a link with increased homelessness (Fransham and Dorling, 2018) and food insecurity (Dowler and Lambie-Mumford, 2015).

The combined effect of measures introduced under austerity in England was exacerbated by the rise in unemployment, in part as a consequence of the financial crises, and in part due to austerity measures aiming to reduce the size of the state with associated cuts to public sector jobs. For instance, more than 820,000 employees in public sector jobs were made redundant between 2010 and 2019 because of governmental spending cuts, with areas in the north of England most affected (Office for National Statistics, 2020a). These job losses came at a time when austerity measures resulted in a rescaling of welfare programmes available to support those becoming unemployed. Without a sufficient safety-net to protect against the adverse social-risk effects resulting from unemployment and poverty on health, it is possible that opioid consumption increased in line with the existing narrative describing the use of opioids as a coping mechanism to deal with psychological stress, which often also manifests in physical pain and discomfort. Using detailed data on important adverse consequences of opioid abuse (*i.e.*, health service use and mortality) and spending trends across local authorities in England from April 2010 to March 2017, we were able to model the direction and degree of this relationship and provide quantitative evidence on the impact of austerity on the trajectory of opioid abuse. Analysis of these contemporaneous changes allowed us to expand on previous research findings that focussed on unemployment as proxy for macroeconomic performance and assess the role of welfare on opioid consumption.

3. Methods

3.1. Data

We studied the impact of governmental spending cuts for 152 local authorities (*i.e.*, unitary authorities and county councils) for each financial year from April 2010 to March 2017. Local authorities in England are funded by grants from central government (>50%), as well as other sources of income, including council tax (~30%) and monies raised through business taxes (~16%) (Wilson, 2020). They have autonomy over their budgets and are responsible for financing public services within the boundaries of a defined catchment area (UKPGA, 2000). These include services with direct impacts on population health via the social-risk effect, such as social care and housing. While local authorities have some degree of flexibility to adjust their streams of income generation, during the study period, local authorities were bound to the 2011 Localism Act, which stipulates that council tax rates may not be raised by more than 2 percent per year without holding a 'referendum'.

All analyses were conducted at the local authority-level because all measures and control variables can be calculated at this level. Our models are based on a total 144 local authorities. Five local authorities were excluded because of missing data, including Bournemouth, Poole, Dorset, Isle of Scilly and the City of London. A further three local authorities were excluded due to inconsistencies in the expenditure data, including Westminster, Kensington & Chelsea and Hammersmith & Fulham. The selected study period was chosen based on the availability of data and relevance of this issue to policymakers aiming to understand the determinants of the recent trajectory of opioid abuse in England. Moreover, the study period captures the entire term of the Conservative-led coalition government, their response to the financial crises and fiscal consolidation policies.

3.2. Public accounts data

Local authority revenue expenditure and financing data is made publicly available by the Ministry of Housing, Communities and Local Government from financial year 2007/2008 (Gov.UK, 2020). It entails detailed information on the annual spending of each local authority in England, total expenditure, and separately for spending items related to education, transport, social care, housing, culture, environment, planning and development, and central services. The same expenditure data had been previously used in a study that investigated the regional variation of austerity measures in the UK (Gray and Barford, 2018). For our analyses, we calculated total net expenditure and the net expenditure for each of the line items, adjusted by population size and expressed per 100,000 population. To account for changes in real terms of expenditure over time, we adjusted our estimates for annual inflation using the GDP deflator with financial year 2010/11 as the baseline year.

We restrict our analysis to the inclusion of three expenditure categories (*i.e.*, social care, housing, and planning and development) based on theoretical and statistical considerations. Social care spending and housing expenditure was believed to be directly linked to social-risk effects resulting from a reduction in welfare at times of rising levels of unemployment. In England, social care expenditure is allocated to long-term care and short-term care for working-age individuals and older people. This includes the allocation of funds to pay carers, assistive technology, and initiatives to tackle social isolations. Additionally, it pays towards the support for working-age adults with a learning disability, and physical support for older people, and also includes metal health support services. Expenditure data for housing relates to any financial help given to tenants (privately renting or through local authority premises) when income falls below a particular threshold. This includes mandatory rent allowances and rent rebates. Moreover, spending also includes the cost of maintaining council housing. Expenditure on planning and development is allocated to economic and community development programs, including spending on planning policy, community development, business support, development and building control, and economic research. Given that this type of expenditure is likely unrelated to social-risk effects and may not serve as protecting factor against the adversities from unemployment, we entered planning and development to test our hypothesis and as an additional check with regards to social-risk effects assumed for social care and housing. Finally, the inclusion of these three expenditure items allowed overcoming multicollinearity when disaggregating the total expenditure.

3.3. Opioid mortality

Opioid mortality data by local authority was provided upon request made to the Office for National Statistics (Office for National Statistics, 2018). The information was collected from death registries and accounts for individuals with a record for death from drug poisoning and where the death certificate mentions the involvement of any opiates (*i.e.*, includes unspecified opioids, but excludes paracetamol compounds). In line with the identification of health service utilisation, ICD-10 codes were used to identify relevant cases annually between 1993/94 and 2016/17. Mortality data was collected based on the death registration date, rather than the day death occurred. In England, deaths should be registered within five days of the date of death, although some exceptions exist, for instance when the cause of death is being investigated by a coroner. We calculated opioid-related mortality based on local authority population statistics expressed per 100,000 population.

3.4. Health service utilisation

To capture the impacts of opioid abuse on the use of public resources and to account for its consequences that would remain unreported when limiting the focus on mortality, we examine opioid-related health care utilisation over time. It is possible that opioid abuse presents as a significant burden for the public health care system (the National Health Service in England, or NHS), leaving the scale of the opioid problem unreported in England when reviewing mortality statistics only. We focussed our analysis on the number of inpatient admissions related to an opioid overdose to hospitals of the NHS, calculated by local authority. We obtained pseudonymised and unidentifiable patient health records from the Hospital Episode Statistics (HES) database. HES is a large administrative health care dataset, containing information on demographics, diagnosis and treatment procedures for all patients interacting with Accident and Emergency departments, requiring inpatient care services, or attended outpatient care services. We selected patients based on diagnoses records according to the International Statistical Classification of Diseases and Related Health Problems, 10th edition (ICD-10) (see Appendix A). The choice of ICD-10 codes followed definitions used by the Office for National Statistics (*i.e.*, a non-governmental department providing statistical services to the UK parliament) and ensured comparability with opioid mortality records. For each local authority, we calculated the total number of inpatient admissions for each financial year from 2010/11 to 2016/17. Similar to opioid-related mortality, the number of hospital admission were adjusted by the population size of each local authority and expressed per 100,000 population.

3.5. Other variables

As a starting point for our study, we aimed to replicate previous work from the US, showing a countercyclical relationship between opioid abuse and macroeconomic performance, commonly measured through unemployment rates. For the study period, we obtained time-varying unemployment rates by local authority from regional labour market statistics provided by the Office for National Statistics (Watson, 2019). Unemployment figures include people who are actively seeking employment within one month prior to the survey and who are considered available to start work within the following two months. The unemployment rate is measured for people aged 16 years or older and captures only economically active populations who are unemployed.

Opioids are a widely used treatment for acute and cancer pain and play an important role in palliative care. To account for the underlying health needs of the population by local authority, and to absorb any effects unrelated to spending cuts, we obtain information for cancer mortality for people below 75 years. Mortality profiles based on death registry ICD-10 codes are collected and made publicly available by Public Health England (*i.e.*, an executive agency of the Department of Health and Social Care in the United Kingdom) (Public Health England, 2020). The information is age-standardised, entailing all cancers (C00 – C97) in persons below 75 years and expressed per 100,000 population.

3.6. Statistical analysis

We first assessed the association between the number of opioid-related mortality, opioid-related hospital admissions and unemployment to replicate previous work from the US, suggesting a significant relationship with macroeconomic performance. We then expand our model to include spending, including overall net expenditure and the expenditure for social care, housing, and planning and development. To investigate factors underlying the relationship between unemployment and opioid abuse, we further expand our model by entering interaction terms, separately for changes in spending items and unemployment. In each case, we use panel data models that take advantage of the longitudinal nature of the linked dataset (Hsiao, 2007), with observations spanning 144 local authorities and seven financial years. To account for unobserved heterogeneity in characteristics of local authorities that are assumed to remain constant across the study period (*i.e.*, such as governance structure, or the size of the catchment area), we applied local authority fixed effects. Since it is possible that the correlation between errors for observations in the same local authority are greater than those from other local authorities, our models used standard errors clustered at local authority-level.

We estimate the following model specification:

$$Y_{lt} = \beta_0 + \beta_1 U_{lt} + \beta_2 S_{lt} + \beta_3 U_{lt} S_{lt} + \eta_t + \delta_t + \varepsilon_{lt} \tag{1}$$

where the dependent variable, Y_{lt} is the number of opioid-related hospital inpatient admissions in the NHS or opioid-related mortality, per 100,000, in local authority l and financial year t. The independent variable, U_{lt} is the local authority unemployment rate in a financial year, and S_{lt} is the total local authority net expenditure or net expenditure for line items social care, housing and planning. Variable $U_{lt} S_{lt}$ is the local authority interaction term between unemployment rate and spending item in a financial year. Considering that both variables are on a continuous scale, the interaction terms allow to investigate the additional impact a change in one variable has on the outcome when holding the other variable constant. For example, it allows calculating the added effect of an increase in unemployment on the outcome measure when expenditure remains fixed at a certain level. The interpretation is based on the sum of the coefficient estimated for unemployment and the coefficient of the interaction term multiplied by a fixed level of expenditure. We include η_t as local authority fixed effect and δ_t as year fixed effect; the normally distributed error ε_{lt} captures unobserved random shocks.

3.7. Sensitivity analysis

To assess the robustness of our analysis, we investigate the temporal relationship between spending changes on drug poisoning and drug misuse for each local authority over the study period. Both datasets where provided by the Office for National Statistics (Office For National Statistics, 2018) and cases had been identified based on the information recorded on the death certificate of the deceased (via ICD-10 codes). According to the Office for National Statistics, death due to drug poisoning included a broad spectrum of substances, such as controlled and non-controlled drugs, prescription medicines (either prescribed to the individual or obtained by other means) and over-the-counter medications. Major causes are from mental and behavioural disorders due to drug use, accidental and intentional poisoning or assault by drugs, medicaments and biological substances. Death due to drug misuse included deaths where the underlying cause is drug abuse, drug dependence, and drug poisoning where any of the substances controlled under the Misuse of Drugs Act 1971 are involved.

Deaths classified as a drug poisoning and/or a drug misuse must have an applicable ICD-code assigned as the underlying cause of death (see Appendix B and C for respective ICD-codes as provided by the Office for National Statistics), and the list of drugs are updated each year. Opioid mortality includes deaths from specific class of drugs (*e.g.*, illegal drug heroin, synthetic opioids, pain medication); while drug poisoning can be deaths from broader types of drugs which also includes opioids. All analyses were performed using STATA SE 16.

4. Results

4.1. Study sample

A total of 280,827 people experienced a hospital admission in the English NHS because of an opioid overdose and 14,700 people died from opioids across 144 local authorities from April 2010 to March 2017. The mean opioid mortality per 100,000 population and financial year was 5.7 (Std. Dev. = 7.4), ranging from 0 to 60.2 across local authorities. The magnitude of mean opioid admissions to the English NHS was significantly larger at 105.5 (Std. Dev. = 137.6), ranging from 3.1 to 1166.8 across local authorities. Table 1 shows descriptive statistics for covariates used in our statistical analysis, including unemployment (mean = 7.0%; Std. Dev. = 2.5%), population size (mean = 231,766; Std. Dev. = 134,380), and total expenditure as well as expenditure for several line items.

Table 1
Characteristics of local authorities on key variables (2010/11–2016/17).

Variables	Mean	Std. D	Min	Max	N
Opioid-related mortality (per 100,000 inhabitants)	5.738	7.409	0	60.230	1043
Opioid-related admissions (per 100,000 inhabitants)	105.505	137.61	3.159	1166.81	1051
Drug misuse mortality (per 100,000 inhabitants)	7.165	8.981	0	69.264	1043
Drug poisoning mortality (per 100,000 inhabitants)	10.917	13.586	0	99.379	1043
Unemployment rate (%)	7.086	2.548	2.431	15.615	1050
Population	231,766.2	134,380.2	2224	1,128,077	1064
Total expenditure (£1000 per 100,000 inhabitants)	315,556.9	348,444.9	95,801.78	1,985,032	1007
Social expenditure (£1000 per 100,000 inhabitants)	90,309.39	105,886.6	29,556.2	54,7440.6	1007
Planning expenditure (£1000 per 100,000 inhabitants)	3658.271	6928.483	23.955	96,719.95	1007
Housing expenditure (£1000 per 100,000 inhabitants)	5293.839	4438.474	0	37,372.05	1007
Cancer mortality (under 75)	143.319	20.225	70.013	207.292	1054

Source: ONS and Ministry of Housing, Communities & Local Government data

4.2. Trends in opioid-related mortality and hospitalisations

Fig. 1 and Fig. 2 show the evolution and the spatial distribution of opioid-related deaths and hospital admissions for the whole of England. While both indicators increased over time, opioid-related mortality saw largest increases across the study period. Moreover, spatial pattern emerged in the evolution of both indicators, with deaths and admissions mostly concentrate in the south east, south west and north west of England.

4.3. Trends in unemployment and expenditure

Across the study period, there has been a decrease in unemployment across England from 8.1% (Std. Dev. = 2.3%) in 2010, to 5.1% (Std. Dev. = 1.5%) in 2016. However, the decrease in unemployment was not evenly distributed across the country (see Fig. 3). While unemployment across areas to the west of London appear to have reduced to levels below the national average, unemployment in areas of the midlands, north west and north east appear to remain above the national average of 7.9%. Visually, the areas with higher unemployment seem to be correlated with areas reporting higher levels of opioids-related deaths and hospital admissions.

Fig. 4 presents the expenditure growth rate from 2010 to 2016, for total expenditure and disaggregated by social care, housing, and planning and development. The darker coloured a local authority, the higher the decrease in expenditure over the study period. All local authorities were affected by reductions in their expenditure as a result of austerity measures introduced in 2010. Largest reductions have been observed in the midlands (−25.7%) and in north and east of England (−22.5% and −26.8%, respectively). Cuts to social care spending where mostly experienced by local authorities situated in the north of England (−14.3%) and along the coastal regions to the south and east of London. Large reduction in housing expenditure were observed in the south west (−58.8%), west midlands (−65.1%) and the north west (−49.6%) of the country.

4.4. Panel data model results

In Table 2 and Table 3, we report the results of our statistical analysis, for opioid-related mortality and hospital admissions, respectively. As specified in equation (1), we estimate longitudinal panel data models with fixed-effects at the local authority-level and year-level.

We find a positive and significant effect of the unemployment rate on opioid mortality (see Table 1, column 1), which appears in line with previous research from the US. A 10-percent increase in unemployment, increases opioid-related deaths by 2.47 per 100,000 population. We then expand our model to incorporate expenditure data (see column 2 and 3), showing a small negative and significant effect for total expenditure (column 2) on opioid-related mortality. An increase in total expenditure by £1,000,000, decreases opioids-related deaths by 0.017 per 100,000 population. In our final model (see column 4 and 5), we interact unemployment and expenditure to assess the role of spending on welfare programmes at times of economic downturns. We find that when holding total expenditure fixed at a low level (*i.e.*, below £225,000,000 per 100,000 inhabitants), a one percent increase in unemployment rate is associated with a statistically significant increase in opioid-related mortality per 100,000 population. However, if expenditure is fixed at a higher level (*i.e.*, above £225,000,000 per 100,000 inhabitants), a one percent increase in unemployment rate is associated with a statistically significant decrease in opioid-related mortality per 100,000 population, suggesting that higher total expenditure compensates for the negative effect of unemployment. Therefore, in areas with low levels of total expenditure, unemployment results in an added effect on the increase of opioid-related mortality. The same relationship was found for expenditure on social care and housing. Interaction effects based on expenditure for planning and development support our
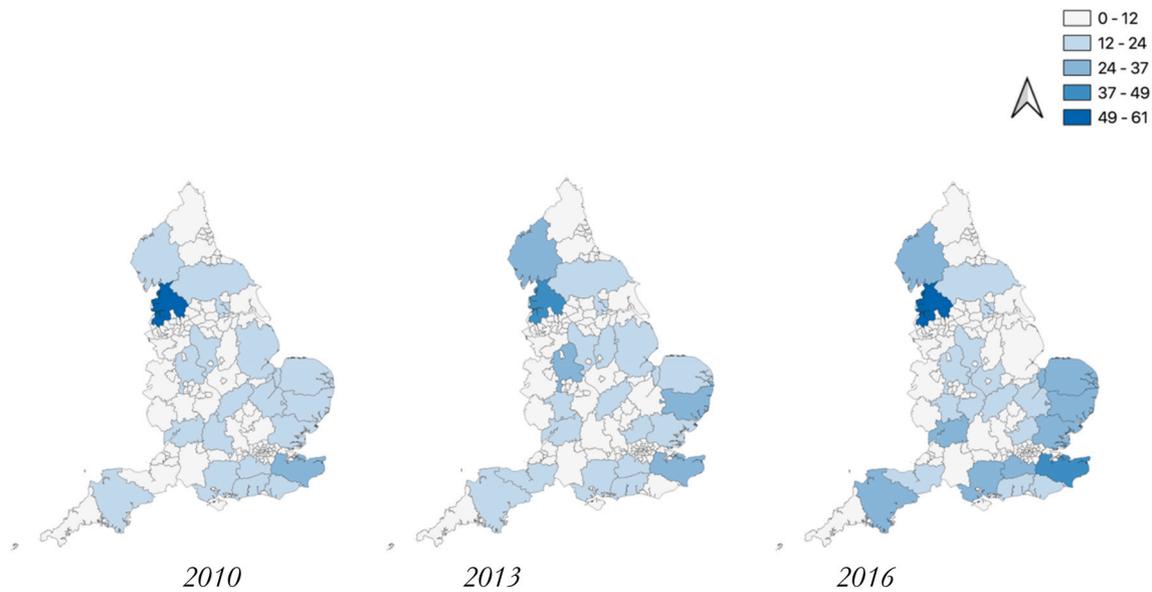
Legend (Fig. 1):
- 0 - 12
- 12 - 24
- 24 - 37
- 37 - 49
- 49 - 61

Fig. 1. Spatial evolution of opioid-related mortality per 100,000 inhabitants in England.

Legend (Fig. 2):
- 0 - 233
- 233 - 467
- 467 - 700
- 700 - 934
- 934 - 1167
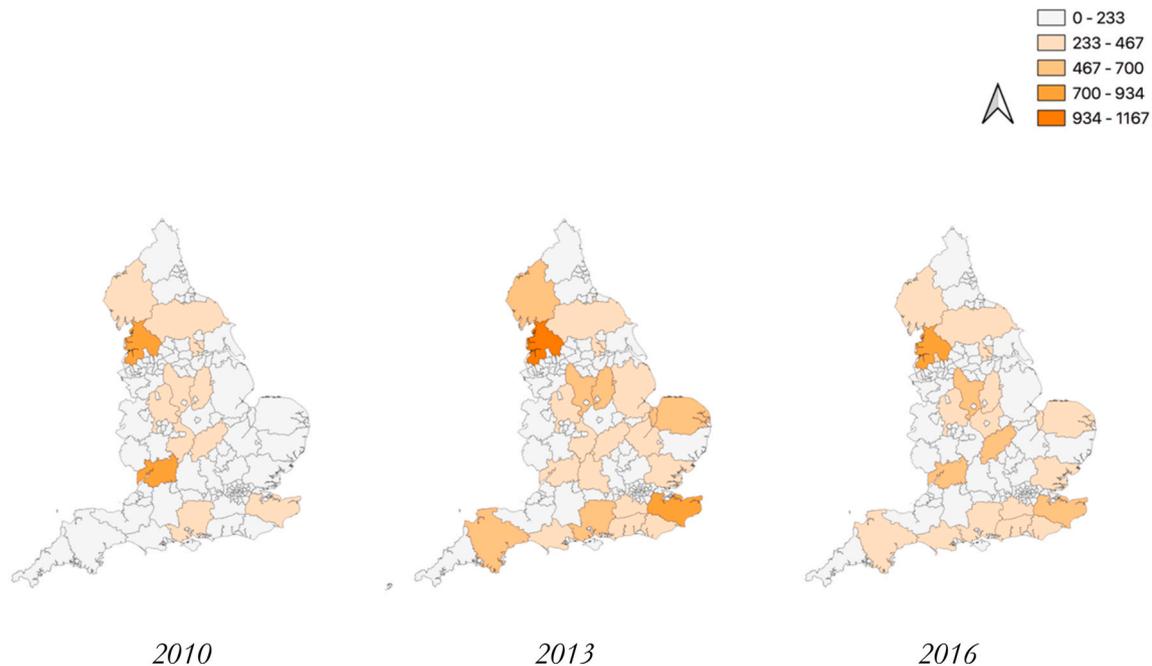
Fig. 2. Spatial evolution of opioid-related hospital admissions per 100,000 inhabitants in England.

hypothesis that this item is unrelated to social-risk effects, considering that for all levels of expenditure, an increase in unemployment, increases opioid-related mortality.

For opioid-related hospital admissions (see Table 3), an increase in total expenditure is associated with a larger reduction in hospital admissions compared with opioid-related mortality. An increase in total expenditure by £1,000,000, decreases opioids-related admissions by 0.4 per 100,000 population. When interacting expenditure with unemployment, only social care expenditure is statistically significant. For low levels of social care expenditure (*i.e.*, below £55,000,000 per 100,000 inhabitants), a one percent increase in unemployment rate is associated with a statistically significant increase in opioid-related hospitalisations per 100,000 population. However, the opposite is holds for high levels of social care expenditure (*i.e.*, above £55,000,000 per 100,000 inhabitants).

Our findings were robust to various model specifications and when entering drug misuse and drug poisoning into the model as dependent variables (see Tables 4 and 5).

5. Discussion

The 2010 Conservative-led austerity programme was introduced to address concerns over rising levels of sovereign debt in the UK. Austerity measures reduced spending to most government departments, with spending cuts of up to 50% in real terms enforced on local authorities (Gray and Barford, 2018), which are responsible for the financing of several welfare programmes. It is possible that rescaling social security programmes carried significant spill-over effects on people's propensity to consume opioids through social-risk effects (Zhou et al., 2018), particularly when such measures had been introduced at times of
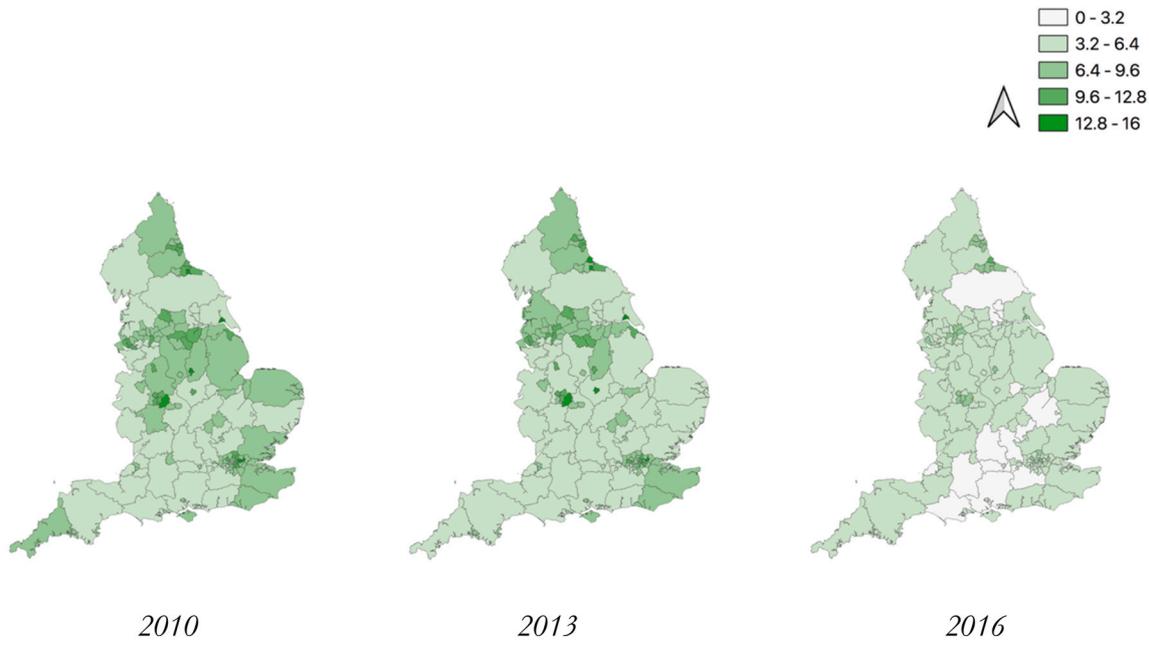
Fig. 3. Spatial evolution of unemployment (%) in England.
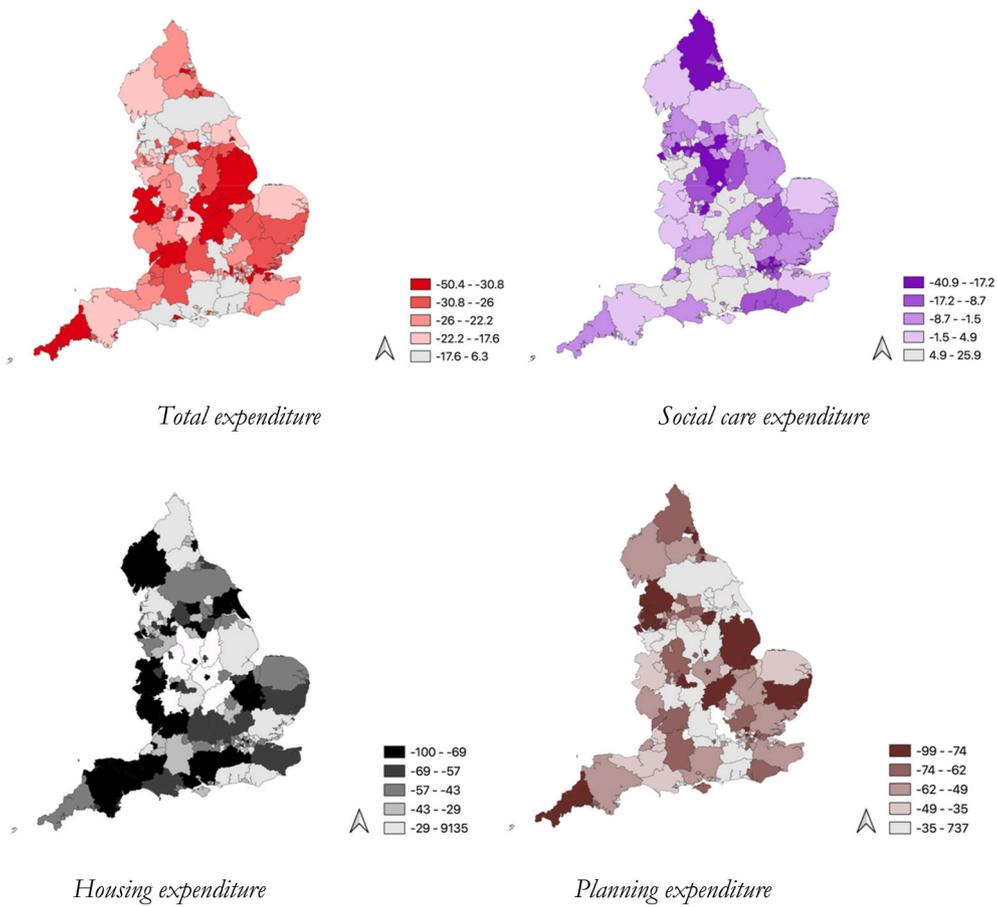
Fig. 4. Spatial evolution of expenditure growth rate (%) in England from 2010 to 2016.

decline in macroeconomic performance. Previous research has highlighted a positive association between economic downturns and opioid abuse but failed to uncover the underlying factors that could drive this relationship (Hollingsworth et al., 2017). In our study, we exploited the variation in spending cuts passed down from central government to local authorities since 2010, which allowed examining the direction and degree of temporal changes between opioid abuse, unemployment and expenditure. We find that reductions in public spending resulted in

Table 2
Panel data models for opioid-related mortality.

Dep. var:	Opioid mortality (per 100,000 inhabitants)				
Models	(1)	(2)	(3)	(4)	(5)
Unemployment rate	0.247**	0.131	0.249**	0.712***	0.603***
	(0.109)	(0.088)	(0.103)	(0.156)	(0.192)
Cancer mortality (under 75)	0.0117	0.00967	0.0126	0.000413	0.00152
	(0.0191)	(0.0173)	(0.0191)	(0.0161)	(0.0170)
Total exp. (100,000 inh.)		−1.69e-05***		2.24e-05***	
		(4.89e-06)		(8.14e-06)	
Social care exp. (100,000 inh.)			−1.37e-06		8.27e-05**
			(2.49e-05)		(3.83e-05)
Planning exp. (100,000 inh.)			−0.000183*		−0.000450**
			(9.96e-05)		(0.000180)
Housing exp. (100,000 inh.)			−0.000131**		0.000211
			(5.78e-05)		(0.000152)
Unemp * Total exp.				−3.20e-06***	
				(7.45e-07)	
Unemp * Social care exp.					−8.81e-06***
					(1.55e-06)
Unemp * Planning exp.					3.66e-05**
					(1.49e-05)
Unemp * Housing exp.					−4.00e-05*
					(2.06e-05)
N	977	977	977	977	977
Nº of local authorities	144	144	144	144	144
Year fixed-effects	Yes	Yes	Yes	Yes	Yes
Local Authority fixed-effects	Yes	Yes	Yes	Yes	Yes
R^2	0.127	0.182	0.152	0.290	0.305
Years	2010–2016	2010–2016	2010–2016	2010–2016	2010–2016

Notes: Columns report the coefficients and the standard errors (clustered at the local authority-level) for each covariate. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 3
Panel data models for opioid-related hospital admissions in the English NHS.

Dep. var:	Opioid-related admissions (per 100,000 inhabitants)				
Models	(1)	(2)	(3)	(4)	(5)
Unemployment rate	0.341	−2.094	0.783	1.687	6.176**
	(1.891)	(1.576)	(1.936)	(3.232)	(3.122)
Cancer mortality (under 75)	0.646	0.603	0.648	0.543	0.505
	(0.477)	(0.455)	(0.480)	(0.432)	(0.433)
Total exp. (100,000 inh.)		−0.000354***		−9.86e-05	
		(0.000123)		(0.000266)	
Social exp. (100,000 inh.)			−0.000274		0.000743
			(0.000621)		(0.000645)
Panning exp. (100,000 inh.)			−0.00221		0.000321
			(0.00153)		(0.00498)
Housing exp. (100,000 inh.)			0.000496		0.00337
			(0.00205)		(0.00406)
Unemp * Total exp.				−2.08e-05	
				(1.66e-05)	
Unemp * Social exp.					−0.000108***
					(3.23e-05)
Unemp * Planning exp.					−0.000191
					(0.000433)
Unemp * Housing exp.					−0.000278
					(0.000430)
N	977	977	977	977	977
Nº of local authorities	144	144	144	144	144
Year fixed-effects	Yes	Yes	Yes	Yes	Yes
Local authority fixed-effects	Yes	Yes	Yes	Yes	Yes
S.E.	robust	robust	robust	robust	robust
R^2	0.148	0.209	0.154	0.221	0.213
Years	2010–2016	2010–2016	2010–2016	2010–2016	2010–2016

Notes: Columns report the coefficients and the standard errors (clustered at the local authority-level) for each covariate. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

detrimental impacts on opioid abuse in England, measured through opioid-related utilisation of hospital services and mortality. Findings suggest that spending cuts in social care and housing assistance predict increases in opioid abuse, particularly when interacted with changes in unemployment. Finally, our analysis highlighted that expenditure on social care and housing can protect against the adverse effect of rising

unemployment on opioid-related hospitalisation and mortality.

While there is growing evidence that austerity may not be a useful tool to accelerate economic recovery (Arie, 2018), the policy caused a significant rise in UK poverty levels, with up to 130,000 preventable deaths (Hochlaf et al., 2019), and spill-over effects on political movements, such as voting pattern in favour of Brexit (Fetzer, 2019). The

Table 4
Sensitivity analysis: Panel data models for drug misuse mortality.

Dep. Var:	Drug Misuse (per 100,000 inhabitants)				
Models	(1)	(2)	(3)	(4)	(5)
Unemployment rate	0.273**	0.113	0.275**	0.812***	0.773***
	(0.123)	(0.0963)	(0.114)	(0.178)	(0.232)
Cancer mortality (under 75)	0.0211	0.0183	0.0247	0.00712	0.0111
	(0.0230)	(0.0198)	(0.0228)	(0.0179)	(0.0186)
Total Exp. (100,000 inh.)		−2.33e-05***		2.40e-05**	
		(6.60e-06)		(9.68e-06)	
Social Exp. (100,000 inh.)			−1.55e-05		9.12e-05**
			(2.21e-05)		(3.59e-05)
Panning Exp. (100,000 inh.)			−0.000176		−0.000396*
			(0.000106)		(0.000216)
Housing Exp. (100,000 inh.)			−0.000163**		0.000270
			(7.56e-05)		(0.000174)
Unemp * Total Exp.				−3.85e-06***	
				(8.26e-07)	
Unemp * Social Exp.					−1.12e-05***
					(1.71e-06)
Unemp * Planning Exp.					3.36e-05*
					(1.76e-05)
Unemp * Housing Exp.					−5.05e-05*
					(2.59e-05)
N	977	977	977	977	977
N° of local authorities	144	144	144	144	144
Year fixed-effects	Yes	Yes	Yes	Yes	Yes
Local authorities fixed-effects	Yes	Yes	Yes	Yes	Yes
R²	0.159	0.240	0.183	0.361	0.373
Years	2010–2016	2010–2016	2010–2016	2010–2016	2010–2016

Notes: Columns report the coefficients and the standard errors (clustered at the local authority-level) for each covariate. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 5
Sensitivity analysis: Panel data models for drug poisoning mortality.

Dep. Var:	Drug Poisoning (per 100,000 inhabitants)				
Models	(1)	(2)	(3)	(4)	(5)
Unemployment rate	0.431**	0.211	0.450***	1.034***	1.083***
	(0.178)	(0.137)	(0.159)	(0.239)	(0.313)
Cancer mortality (under 75)	0.0251	0.0212	0.0305	0.00813	0.0145
	(0.0327)	(0.0278)	(0.0326)	(0.0243)	(0.0251)
Total Exp. (100,000 inh.)		−3.20e-05***		2.36e-05**	
		(8.78e-06)		(1.10e-05)	
Social Exp. (100,000 inh.)			−3.24e-05		0.000103***
			(2.58e-05)		(3.25e-05)
Panning Exp. (100,000 inh.)			−0.000325**		−0.000820***
			(0.000155)		(0.000283)
Housing Exp. (100,000 inh.)			−0.000215*		0.000421*
			(0.000122)		(0.000235)
Unemp * Total Exp.				−4.53e-06***	
				(1.04e-06)	
Unemp * Social Exp.					−1.40e-05***
					(2.08e-06)
Unemp * Planning Exp.					6.65e-05**
					(2.55e-05)
Unemp * Housing Exp.					−7.82e-05**
					(3.66e-05)
N	977	977	977	977	977
N° of local authorities	144	144	144	144	144
Year fixed-effects	Yes	Yes	Yes	Yes	Yes
Local authorities fixed-effects	Yes	Yes	Yes	Yes	Yes
R²	0.166	0.253	0.198	0.349	0.373
Years	2010–2016	2010–2016	2010–2016	2010–2016	2010–2016

Notes: Columns report the coefficients and the standard errors (clustered at the local authority-level) for each covariate. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

impact of austerity is felt particularly strongly by people with lower socio-economic standing due to the policies regressive nature, with funding cut disproportionately for persons living in the most deprived areas in England compared with those in the least deprived areas (*i.e.*, 31 percent per capita versus 16 percent per capita, respectively (Harris et al., 2019)). Historically, a strong welfare state protected vulnerable populations by providing a social safety-net, for instance through housing assistance, unemployment benefits, or social care services. However, ten years of Conservative-led governing diminished the size of the state and caused a rescaling of many public services.

Adverse effects of austerity measures on health have been widely reported in the literature (Macdonald and Morgan, 2020; Stuckler et al., 2017). This includes increases in mental health problems and suicides among working age populations (Cummins, 2018), but also physical

ailments such as a rise in infections. Some of these impacts are likely the result of health care effects, whereby spending cuts reduce resources for health systems with subsequent decrease in the supply of health care services. These effects have been observed in countries where austerity was prescribed to access financial bailouts during the financial crises, including Italy and Greece (Petmesidou et al., 2014; Serapioni and Hespanha, 2019). Our findings provide evidence on the second pathway in which austerity can impact health, the social-risk effects, because spending on health care services remained ringfenced under UK government policy.

We show that local authorities with largest reductions in social care spending also observed largest increases in opioid abuse. Since the introduction of austerity measures in 2010, local authorities had to limit social care services for people with most severe care needs (Hastings et al., 2015), leading to about half a million fewer adults receiving services in the four years after the policy came into place. Particularly, lower intensity services such as counselling or providing support for people at risk of abuse or neglect saw budget reductions, which had served as an important mechanism to help prevent people's needs from deteriorating. It is likely that the reduced availability of such services to the most vulnerable of society accelerated mental health problems that manifested into physical health problems, with possible effects on people's propensity to medicate using pain relivers such as opioids. However, the reduced availability of social care services in a local authority also often requires informal care givers to fill the void. There are about 5.3 million unpaid care givers in the UK who often are family members, friends or neighbours, with almost half of them living in poverty (Aldridge and Hughes, 2016). Providing informal care can be taxing, imposing physical and mental strain on individuals. It is therefore possible that opioid consumption increases with a rise in the number of informal care workers, particularly when linked to high levels of deprivation, which was found to correlate with opioid abuse.

The second social-risk effect found in our study relates to a reduction in local authority spending for housing. Local authorities are the main supplier of social housing to people who cannot afford their own accommodation in the UK. Local housing allowances are being paid to individuals to support with rental payments but spending cuts have resulted in a real term reduction of housing allowance rates (Goering and Whitehead, 2017), requiring people to pay the difference between housing benefit and rent. Pressure on social housing means that the number of affordable homes has not aligned with changes in demand over time, causing peoples homelessness when they cannot afford to pay the shortfall in rent. Indeed, homelessness has soared in the UK since austerity measures were introduced in 2010, with official figures rising four-fold to 4751 in 2017 (Independence Educational Publishers, 2020). We find that local authorities that reported highest reductions in housing assistance experienced largest increases in opioid abuse across the study period. This finding aligns with work from the US (Yamamoto et al., 2019), which identified homelessness as a key determinant for opioid abuse.

Based on our study findings, we argue that a reliable safety-net can help mediate some of the adverse effects resulting from declines in macroeconomic performance, including job loss, job insecurity, and loss of income. Compared with countries such as the US, welfare programmes in England remain comprehensive despite the severe budget cuts of the past decade. This could explain the difference in the size of association observed between temporal changes in unemployment and opioid-related hospitalisations and mortality across previous studies. The lack of a comprehensive social safety-net may also be one of the reasons why the overall rate of opioid abuse remains above the rates observed in England. Countries with strong social welfare systems report consistently low levels of opioid abuse even in the aftermath of the financial crises, which could explain why the widespread availability of opioids in countries like Germany and the Netherlands is not correlated with high mortality rates. Indeed, recent research has focussed on supply-side factors that determine opioid abuse. This includes the

impact of expanding prescription drug insurance for older people under the Medicare Prescription Drug Benefit Program in 2006 on opioid-related deaths (Powell et al., 2020), or expansion of Medicaid under the Affordable Care Act (Meinhofer and Witman, 2018). Even though these findings provide important insights into the trajectory of opioid utilisation in the US, in England access to the NHS has remained universal and free at the point of access, making it unlikely that changes in coverage can explain the rise in opioid abuse. However, the supply of opioid medication through prescriptions has increased three-fold in England between 1998 and 2015, though the slope of the prescription rate has flattened in recent years (Curtis et al., 2019). At the same time, the strength of prescribed opioid medication has increased, risking dependencies in patients receiving treatment for acute and cancer pain, and highlighting the need for a diligent pain management system in place to avoid opioid abuse (Stannard, 2013). However, fundamental differences in the way health care systems are organised may make it difficult to generalise our study findings to other settings.

5.1. Strengths and limitations

This study has limitations. First, we use panel data models to examine the association between temporal changes in opioid abuse, unemployment and local authority spending. This specification accounts for some of the unobserved variation in local authority characteristics. We were able to adjust for time-invariant effects on outcomes but were not able to fully discount time-invariant factors that may have affected opioid abuse during the study period. The econometric specification aligns with previous studies investigating the impact of macroeconomic performance on opioid outcomes (Hollingsworth et al., 2017), though we were able to use data at a more granular level. Because funding cuts affected all local authorities in England, this eliminated the possibility for causal inference by constructing a natural control group. To overcome this concern, our models included spending across items believed to be unrelated to social-risk effects. Even though we find statistically significant associations for spending on social care and housing, no such association was found for spending items considered unrelated to social-risk effects (*i.e.*, planning and development). Our findings were robust to changes in model specification. Moreover, sensitivity analysis showed that possible endogeneity concerns resulting from an unobservable relationship in the allocation of government funding on outcomes were unfounded (see Appendix D), and that overall expenditure changes and outcome variables were negatively correlated (see bivariate scatter plot in Appendix E). An event-study to assess the identification assumption was performed, suggesting no significant difference across treated and control authorities prior to the introduction of austerity measures.

Second, we relied on accuracy and timeliness of mortality statistics based on the ICD-10 classification. Delayed submission of death records could have been incorrectly assigned to a given financial year, despite of occurring in the previous financial year. Residual errors resulting from registration delays could appear when a person deceased close to the end of the financial year, which might have impacted on our estimations particularly for local authorities with few opioid cases. Moreover, it remains unclear whether all opioid cases have been classified as per cause of death, particularly in instances when multiple substances had been consumed prior to a person's death. Officen for National Statistics data fails to provide information on whether the opioid was legitimately obtained on prescription or obtained illicitly. We further relied on a standardised approach to toxicological testing, including the types of substances tested for and their contribution to a death. Though, according to the Royal College of Anaesthetists, there appears to be variation across coronal system and over time (Royal College of Anaesthetists, 2020). To address concerns about accuracy of death registration, we expanded our analysis to also focus on hospital admissions linked to opioid abuse. HES recording is generally considered to be of high quality, especially when recording of conditions is linked to

financial incentives or hospital reimbursement. While it is possible that our focus on hospital inpatients misses some patients treated in Accident and Emergency departments and who were immediately discharged, our regression estimates for mortality statistics and hospital admissions appear consistent throughout.

5.2. Conclusion

Our study provides important insights into the underlying determinants for the countercyclical relationship between macroeconomic performance and opioid abuse observed in previous studies. We suggest that more and targeted spending on the social sector, policies that address systematic inequalities, and improved macroeconomic conditions are critical in curtailing the opioid epidemic. Our findings come at a time of significant uncertainty, including potential adverse economic effects across Europe because of the decision by the UK government to leave the European Union (Roman-Urrestarazu et al., 2019), but also economic and social uncertainties resulting from the Covid-19 pandemic. It is possible that rising levels of unemployment could see a further surge in opioid-related hospitalisations and mortality. Moreover, many governments including the UK have introduced stability programmes to support the economy since March 2020, financed through borrowing which has led to substantial increases in national debt, exceeding increases observed during the 2007/08 financial crisis. Since our findings add to evidence on the detrimental impact austerity had on population health, poverty, inequality, and economic recovery, policymakers should learn from these experiences and abstain from introducing austerity measures to reduce national debt at the expense of local authorities, or welfare programmes. It is the duty of governments to consider the wider impacts of their fiscal policies, ensuring not only economic recovery but protecting the poor and vulnerable from social-risk effects.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2021.114511.

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