Enhancing opportunities to reduce escalation to substance use disorders through early engagement: a retrospective observational data linkage study of primary and secondary care in Wales

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ABSTRACT

Introduction Substance misuse (SM) remains a challenging public health concern despite substantial evidence from traditional research methods for effective interventions. Studies which used whole population linked data are scarce but may be useful in informing early identification and prevention of escalation. We examined the type and timing of healthcare service contacts in those presenting with SM-related issues in Wales to describe sociodemographic characteristics and quantify the frequency of pre-and-post index SM healthcare contacts as potential opportunities for preventative interventions. We defined the index as the first SM-related record in healthcare settings.

Methods We conducted a whole population cohort study on 168 774 persons aged at least 10 years whose index SM contact with health services was between 1 January 2010 and 31 December 2019. We examined their records both prospectively and retrospectively for 2 years from the index SM event date.

Results Inpatient admission (36.0%) and primary care (30.0%) were the main points of first SM-related contact. Median age was 39 years; the majority were males (62.3%) of white ethnicity (71.0%). One in four lived in the most deprived areas. The majority (60.3%) had alcohol as the problem substance at baseline. Approximately 38.0% (63 520) of the cohort had at least a second SM-related event within 24 months postindex SM event, indicating potential missed opportunities for referral to relevant SM specialist treatment services. Inpatient admissions increased by 71.0% after the index SM date (ISMD) compared with pre-ISMD (84 237 and 49 327, respectively). Injury, poisoning and digestive disorders were the most frequent reasons for admissions. However, admissions relating to mental disorders more than tripled after the ISMD (8421 admissions from 2696 patients—a 212.0% increase). Similar increases were found in emergency and GP contacts. Around 1.0% had their first SM record captured at death.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ In Wales, the scale of substance misuse and the characteristics of the individuals are usually estimated from the substance misuse treatment services dataset. However, this dataset includes only those who had a referral, assessment or received treatment for substance misuse.

WHAT THIS STUDY ADDS

⇒ This cohort, assembled from five national administrative linked datasets, presents a more complete picture of substance misuse problems in Wales, including describing for the first time the type and timing of healthcare usage before and after their index SM record. In highlighting that the cohort is frequent healthcare service users, the study shows that opportunities exist to implement some level of preventative interventions. The study also indicates that individuals are not being signposted to appropriate SM services.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Substance misuse and harm reduction strategies should include holistic active preventative interventions within healthcare settings. Consultations with healthcare professionals should include questions about substance use, and opt-out referral to substance misuse services should be made on presentation to healthcare with substance misuse-related reasons.

Conclusion Individuals with SM records are frequent attendees to healthcare services, particularly after their index SM event. Healthcare contacts represent vital opportunities to engage those with SM issues early to reduce harm and potential escalation of use and refer to specialist treatment and support.

INTRODUCTION

Despite being preventable, substance misuse (SM) is among the leading causes of morbidity, all-cause premature mortality as well as mortality due to suicides globally.[1] SM—defined as harmful or hazardous use of psychoactive substances, including alcohol and illicit drugs[2]—and associated disorders have been recognised as a growing public health problem, causing or contributing to poorer health, crime, violence, injuries and reduced quality of life, risk of suicide and premature deaths.[1 3] Globally, it is estimated that in 2021, there were around 296 million people who used drugs and an estimated 400 million living with alcohol use disorders.[1 4]

In 2022 in the UK, 10 048 (17 per 100 000) people died from alcohol-specific causes, the highest number on record and 32.8% higher than in 2019. In England and Wales alone, there were 4907 drug poisoning deaths (84.4 deaths per million people), of which 63.7% were identified as drug misuse deaths, and since 2012, the age-standardised mortality rate for deaths related to drug poisoning has risen every year.[5 6]

Alcohol is related to at least 200 medical conditions and is a common reason for both hospital inpatient and urgent admissions across various clinical specialties.[7 8] Such attendances may represent opportunities for earlier evidence-based interventions to reduce the risk of future presentation with complications from ongoing alcohol misuse. Similarly, people who use illicit drugs are admitted to the emergency department or hospital approximately seven times more often than the general population.[9] A study on the impact of frequent attenders on a UK emergency department indicated that individuals with substance use disorder (SUD) are among frequent attenders, as well as a strong association between an increase in the number of visits and an increase in the likelihood of 2-year mortality,[10 11] thus providing a potential opportunity for intervention. Specifically, alcohol-related liver disease (ARLD) is just one example of a preventable disease directly associated with SUD, in this case, related to excessive alcohol consumption. Being mostly asymptomatic in the early stages, ARLD often presents late when the prognosis is already poor, with subsequent interventions making limited impact.[7] Compared with individuals with viral hepatitis, those with ARLD are twelve times more likely to present late[7] and more likely to present at an emergency department (ED).[7 8] Once cirrhosis develops among individuals who misuse alcohol, the prognosis is typically poor, with approximately a 25% survival rate at 5 years and 9% at 15 years.[12] Nonetheless, abstaining from alcohol remains a critical factor in improving outcomes and survival for those with liver damage, due to the human liver's recovery potential.[13] Due to these health risks, preventing problematic drinking from escalating is a key public health preventative approach in reducing the burden of alcohol-related diseases.

SM is also highly comorbid with some mental health disorders, especially anxiety, depression, personality disorders and post-traumatic stress disorder.[14] These comorbidities can complicate SM treatment and recovery from both the SM and co-occurring mental health conditions. Additionally, SM contributes significantly to intimate partner violence, family violence, overdose and suicide and other accidental injury deaths (eg, related to weapons, motor vehicles and drowning).[15–18] Furthermore, the ethical obligation to address SM effectively also aligns with a strong economic imperative. In England, for example, SM and associated disorders are estimated to cost at least £19 billion each year in healthcare costs, lost productivity and criminal justice costs.[19] At the same time, investment in SM treatment services has fallen by at least 17% since 2014; unmet need is growing while the workforce is declining in both number and quality.[20]

In Wales, as in other UK nations, estimates of the number of people with SM are typically based on the number of people seen within specialist SM treatment services. For example, between April 2022 and March 2023, 15 538 individuals (0.6% of the adult population) completed assessments within specialist SM treatment services in Wales.[21 22] However, this estimate is not representative of all individuals experiencing health harms related to substance use. Substantial stigma exists around SM, and as such, there is widely embedded resistance to contacting or engaging with specialist treatment services.[23] As such, contact with healthcare services provides an opportunity for engaging with support. Hospital admissions are a commonly used indicator to assess the harms from SM, which is likely to be reflective of harms accrued from repeated patterns of substance use.

Therefore, the identification of early opportunities for intervention is key to reducing the burden of SM on both the individual and society at large. Undoubtedly, earlier engagement, improving assessment of additional needs and understanding where individuals are coming into contact with any services, not just those within treatment, are important ways that linked data can aid policymakers in making evidence-based policy design and prioritisation.

Early identification followed by evidence-based behavioural and medication-assisted treatments has been shown to significantly reduce SM and related harms.[24] Also, the introduction of Alcohol Care Teams, for example, in some acute UK hospitals, showed early positive results in reducing acute hospital admissions, readmissions and mortality and improved the quality and efficiency of alcohol care.[25] However, despite this knowledge and evidence, our understanding of the progression of individuals with SM history through the healthcare system is fragmented. Where studies are available, they often lack detailed linked assessment of prehealthcare and posthealthcare contacts and associated demographic and clinical factors, limiting the understanding of opportunities for early intervention. There is a need for population-wide SM studies examining the type and reasons for contacts across all health services, before and after the index SM healthcare event.

Few studies have used linked data on whole populations to assess the prevalence of SUD in health services and to identify the potential for the early identification and offer of interventions that can prevent an escalation in the severity of SM. We used whole population health data in Wales to examine the type and timing of health service contacts in persons who present with health problems related to SM. We described the sociodemographic characteristics of persons with SM and quantified the frequency of healthcare contacts before and after an index treatment episode to identify opportunities for preventative interventions.

MATERIALS AND METHODS
Study setting, design and data sources
We used a whole population retrospective cohort study using routine administrative health data held by the Secure Anonymised Information Linkage (SAIL) Databank at Swansea University, Wales. SAIL is a repository of health, social and educational data containing linked, anonymised, individual-level data covering the whole of Wales.[26–28] We used the following datasets:

Welsh Longitudinal General Practice (WLGP)
A primary care dataset containing all attendance and clinical information for all general practice (GP) interactions, including patients' symptoms, investigations, diagnoses, prescribed medication and referrals to tertiary care.[29]

Primary care data are available for approximately 86% of the GPs in Wales, while secondary care data are available for 100% of the Welsh population.

Patient Episode Dataset for Wales (PEDW)
A secondary care database containing all inpatient and day case activities undertaken in the National Health Service (NHS) Wales plus data on Welsh residents treated in English hospitals.[29]

Outpatient Database for Wales (OPDW)
A secondary care database containing attendance information for all hospital outpatient appointments.[29]

Emergency Department Dataset (EDDS)
A database containing all attendances and clinical information for all ED attendances.[29]

Substance Misuse Dataset (SMDS)
The Welsh National Database for Substance Misuse captures data relating to all individuals, both young persons and adults, presenting for SM treatment in Wales.[29]

Welsh Demographic Service Dataset (WDSD)
A register of all individuals registered with a Welsh General Practice includes individuals' anonymised address and GP history.[29]

Annual District Death Extract (ADDE)
A register of all deaths relating to Welsh residents, including those who died outside of Wales, derived from the UK Office for National Statistics (ONS) deaths register.[29]

All the contributors had equal access to all the databases and tables used to create the study population.

Formation of the base cohort
The base cohort consisted of individuals aged 10+ years with an index (ie, first time) health service event indicating acute drug or alcohol harm, presenting to GP (WLGP), inpatient services (PEDW), accidents and emergency (EDDS), SM treatment services (referral) or who died from SM (ADDE) between 1 January 2010 and 31 December 2019. An individual was included in the study if they were recorded as either having a referral to SM treatment services (SMDS) or if their primary care (WLGP), secondary care (PEDW and EDDS) or mortality (ADDE) records contained previously validated Read Codes version 2 (in WLGP) or International Classification of Diseases version 10 (ICD-10) codes (in PEDW, EDDS and ADDE) related to alcohol or drug misuse (online supplemental materials).[30–32] ADDE records were included where SM was either the underlying or contributory cause of death.

To ensure an individual's SM event was truly their index event, we undertook a minimum 5-year retrospective search on each individual's records in all the datasets up to 1 January 2005. This resulted in the exclusion of all individuals who have had a previous SM event in the 5 years prior to the start of the cohort selection period (ie, 1 January 2010). The choice of 5 years was arbitrary and in sync with the earliest available robust data in one of the datasets used, namely the SMDS. In this study, therefore, *an index SM event was defined as an individual's first SM-related record within the aforementioned health services databases between 2010 and 2019, having not had any previous record(s) in at least 5 years prior to their index SM record.*

Records were extracted separately from each dataset and subsequently merged into one file to obtain the earliest (ie, index) SM date.

The cohort was stratified by the primary type of index substance recorded, categorised as: alcohol, opioids, stimulants, cannabinoids or 'drugs-other'. The 'drugs-other' category included prescription drugs, benzodiazepines, hallucinogens and solvents. It is important to note that the category 'cannabinoids' includes synthetic cannabinoid receptor agonist drugs. Figure 1 shows a flowchart of how the base cohort was formed and the data linkage.

Subsequently, each individual's healthcare records were searched retrospectively for 730 days (ie, 2 years) from the date of the index SM event back to 1 January 2008 to extract the dates and reason for contact with healthcare services. Similarly, their records were searched prospectively until death or 730 days, whichever came first. We defined a 'contact' as any recorded attendance or encounter with health services found in the WLGP,
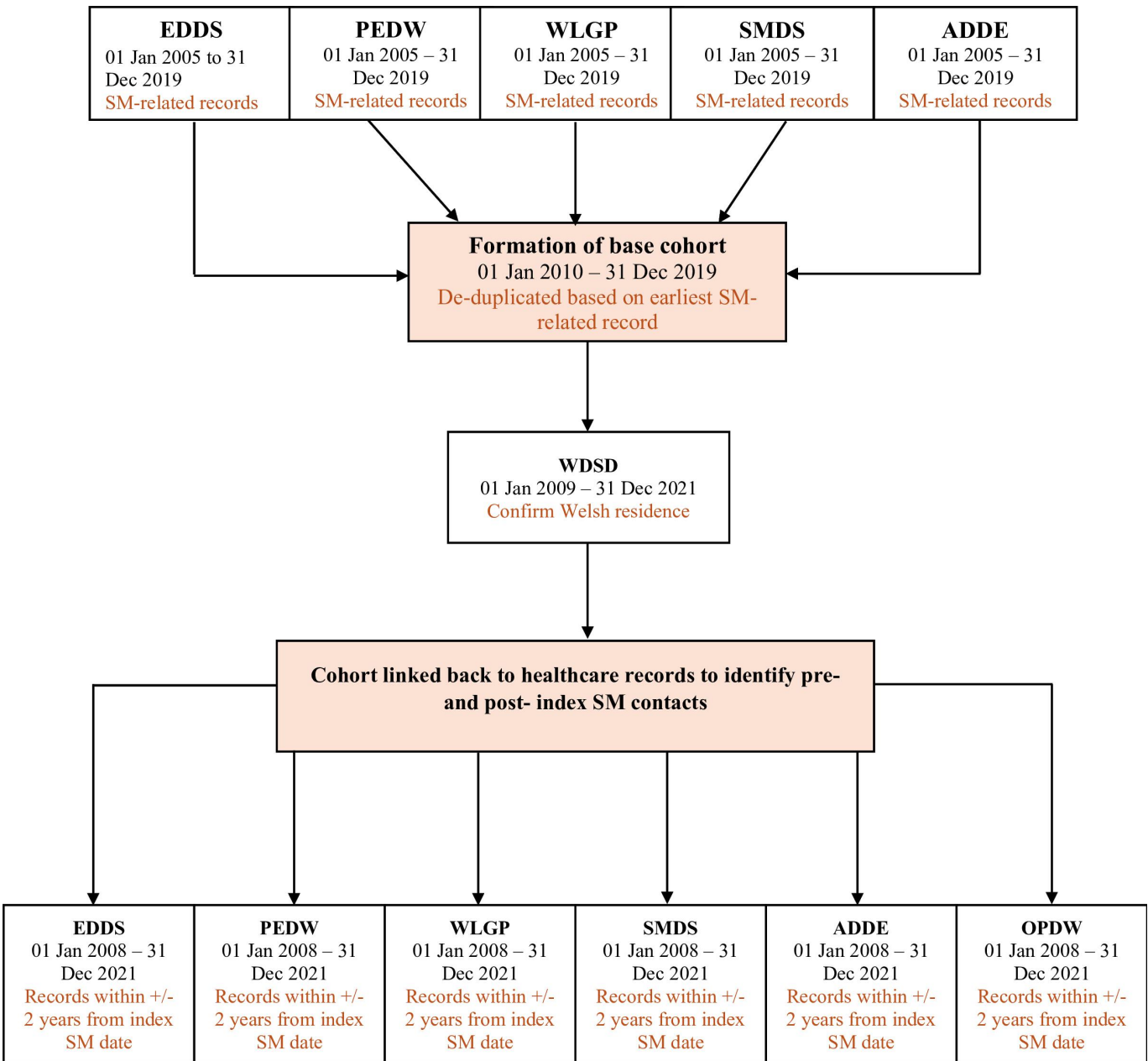
Figure 1 Formation of the base cohort and data linkage flowchart. ADDE, Annual District Death Extract; EDDS, Emergency Department Dataset; OPDW, Outpatient Database for Wales; PEDW, Patient Episode Dataset for Wales; SM, substance misuse; SMDS, Substance Misuse Dataset; WDSD, Welsh Demographic Service Dataset; WLGP, Welsh Longitudinal General Practice.

PEDW, OPDW or EDDS databases using validated Read and ICD-10 codes (online supplemental materials).

Opportunities for intervention

Potential opportunities for intervention (eg, brief intervention and/or SM service referral) were defined as any GP consultation, inpatient admission, ED or outpatient attendance in the 2 years postindex SM event. For each health services contact in this period, we extracted the contact date, the reason for contact (using the Read and ICD-10 codes) and where applicable, the specialty of attendance (eg, secondary care).

Health services contact definitions

For GP contacts, we extracted only the records where an intervention, such as brief advice or SM service referral, could have been possible. Hence, only the consultation records with the following meeting descriptions were included: 'seen by general practitioner', 'seen in GP surgery', 'computer link consultation' and 'telephone encounter.'

We defined a unique hospital admission as a 'continuous inpatient spell' following standard methods,[29] representing an individual's journey from admission to discharge. PEDW contains both primary and secondary

ICD-10 diagnostic codes for each hospital admission. We excluded day-case visits, regular day and night attenders.

Measures

We extracted six demographic and geographical variables (age, sex, ethnicity, level of deprivation, rural/urban residence and substance type) at baseline (ie, index SM date). These were validated (and/or complemented where missing) using information from WDSD.

We used quintiles of the Welsh Index of Multiple Deprivation (WIMD) 2014 as a measure of area-based deprivation at Lower layer Super Output Area level, which represents approximately 1500 individuals or 650 households per area.[33] The WIMD scores are ranked to produce quintiles, with one representing the most deprived 20% and five for the least deprived 20% of areas.

Statistical analysis

We analysed the reason and timing of contacts and performed a longitudinal analysis comparing contacts before and after the index SM event. We also examined each person's journey in the health service from the index SM event to the next SM-related contact, a possible indicator of how referrals to SM treatment services work in practice. Ideally, inpatient admission or ED attendance for SM-related events should be followed by a referral to the SM treatment service.

Continuous variables were expressed as medians with IQRs. Categorical variables were summarised as n (%) in each category. The Wilcoxon rank sum test, Pearson's χ^2 test and Fisher's exact test were applied where appropriate. The Kaplan-Meier curve was used to analyse the time between the index date (SM event) and the first healthcare contact post-SM event, excluding those whose index SM event was identified from the mortality records (ie, ONS deaths).

We described the characteristics of the cohort using individual characteristics (eg, age, sex and ethnicity) and other key variables such as deprivation levels and rural and urban residence. Each person's index SM health service setting was compared with their next SM setting to highlight the current referral pathways to SM treatment services. The number of unique persons and the number of SM-related health services contacts (including the median number) prior to index SM event was compared with the number after index SM event. Finally, we described and reported the top 10 reasons for health services contact before and after the index SM event.

All analyses were undertaken within SAIL Databank's trusted research environment using DataBase 2 - Structural Language Query (DB2-SQL) (www.ibm.com/analytics/db2) and R (V.4.0.5) for Windows (https://www.r-project.org/).

Ethical approval

SAIL's Information Governance Review Panel granted ethical approval to conduct this research using anonymised data (project number 1451).

RESULTS

The characteristics of the cohort are summarised in table 1 (full details are contained in online supplemental appendix table 1). We identified 168 774 individuals in Wales who had an index SM event (~6.0% of the national population aged 10+ years[21] within the study period). Of these, 62.8% (106 016) were male. At the time of their index SM event, the median age was 39 years, with 26.8% (45 268) <25 years old and 14.0% (23 565) 65+ years old. The majority of the cohort were of white ethnicity (71.0% (119 459)) and residents in urban areas (66.0% (111 960)). 25.0% (42 862) of the cohort lived in the most deprived WIMD 2014 quintile, and only 12.0% (20 759) were from the least deprived quintile. Overall, 66.0% of the cohort had their index events in PEDW (ie, inpatient records, 36.0%, (60 455)) and WLGP records (30.0%, (50 670)). A relatively consistent number of individuals had an index SM event in each year of the study (highest in 2014, (11.0% (18 200)]) and lowest in 2012, (9.3% (15 731)). <1.0% (1242) of the cohort were dead at the index (ie, their first SM event record was only recorded at their death), while 13.0% (22 396) died during the study period.

Alcohol was the primary substance of index SM, with 60.3% (101 768) of the cohort and a median age of 46 years old at index SM event, mainly presenting at inpatients (42.0%) and GP (33.0%). The youngest median age (21 years) was found for individuals with cannabinoids (11 909 (7.1%)) as the index substance type. The highest percentage (64.0%) of those with stimulants (3.5%, (5872)) as the index substance was in individuals aged 18–24 years (29.0%) and 25–34 years (35.0%), and more than half (53.0%) were identified from the SM treatment service dataset. Over the study period, the number of SM-related contacts decreased overall, while the unique number of individuals remained relatively stable, as shown in online supplemental appendix figure 1.

Of the cohort, 37.9% (63,520) had at least a second SM-related event within 24 months postindex event. Of these, only 33.4% (21 677) presented in specialist SM services, with the remaining majority 66.6% (41 843) representing in primary, secondary or ED for care. Figure 2 shows the pathway between the healthcare setting of the index SM event and subsequent SM event for both alcohol and 'drugs-other'. The pathways for opioids, stimulants and cannabinoids can be found in online supplemental appendix figure 2.

Opportunities for intervention

GP: frequency and reasons for contacts

In the 2 years leading up to the index SM date (ISMD), 23.0% (38 593) of the cohort had contact with their GP. This increased to 30.0% (50 121) in the 2 years following the ISMD. Similarly, the overall number of GP contacts increased from 127 806 before to 173 104 after, with a median of six contacts in both periods. Contacts preceding and prior to the index SM event are shown

Table 1 Characteristics of the cohort at index substance misuse (SM), 2010–2019 (Abridged Table)

	Whole cohort (n=168 774)*	Alcohol (n=101 768)*	Opioid (n=11 296)*	Cannabinoid (n=11 909)*	Stimulant (n=5872)*	Drugs—Other (n=31 831)*	Unknown (n=6098)*	P value†
Age at first SM	39 (24, 55)	46 (28, 60)	35 (25, 49)	22 (17, 32)	27 (21, 35)	31 (21, 48)	31 (22, 44)	<0.001
Sex								<0.001
Male	106 016 (63%)	65 516 (64%)	5536 (49%)	8884 (75%)	4230 (72%)	17 906 (56%)	3944 (65%)	
Ethnicity								<0.001
White	119 459 (71%)	70 124 (69%)	8610 (76%)	9417 (79%)	4854 (83%)	21 412 (67%)	5042 (83%)	
Other	3611 (2.1%)	1657 (1.6%)	347 (3.1%)	389 (3.3%)	155 (2.6%)	905 (2.8%)	158 (2.6%)	
Missing	45 704 (27%)	29 987 (29%)	2339 (21%)	2103 (18%)	863 (15%)	9514 (30%)	898 (15%)	
Area morphology								<0.001
Rural	40 416 (24%)	25 681 (25%)	2536 (22%)	2851 (24%)	1277 (22%)	6544 (21%)	1527 (25%)	
Urban	111 960 (66.0%)	66 618 (65%)	7413 (66%)	7934 (67%)	4049 (69%)	22 022 (69%)	3924 (64%)	
Missing	16 398 (9.7%)	9469 (9.3%)	1347 (12%)	1124 (9.4%)	546 (9.3%)	3265 (10%)	647 (11%)	
Deprivation quintile (WIMD 2014)								<0.001
1—most deprived	42 862 (25%)	23 655 (23%)	3322 (29%)	3681 (31%)	1700 (29%)	8830 (28%)	1674 (27%)	
2	36 015 (21%)	21 633 (21%)	2340 (21%)	2621 (22%)	1324 (23%)	6790 (21%)	1307 (21%)	
3	28 755 (17%)	17 831 (18%)	1805 (16%)	1982 (17%)	929 (16%)	5281 (17%)	927 (15%)	
4	23 985 (14%)	15 370 (15%)	1427 (13%)	1483 (12%)	767 (13%)	4073 (13%)	865 (14%)	
5—least deprived	20 759 (12%)	13 810 (14%)	1055 (9.3%)	1018 (8.5%)	606 (10%)	3592 (11%)	678 (11%)	
Missing	16 398 (9.7%)	9469 (9.3%)	1347 (12%)	1124 (9.4%)	546 (9.3%)	3265 (10%)	647 (11%)	
Where identified—dataset								<0.001
SM treatment service (SMDS)	33 005 (20%)	13 390 (13%)	2583 (23%)	5846 (49%)	3116 (53%)	2021 (6.3%)	6049 (99%)	
General Medical Practice (WLGP)	50 670 (30%)	33 513 (33%)	1976 (17%)	3184 (27%)	911 (16%)	11 047 (35%)	39 (0.6%)	
Accident & Emergency (EDDS)	23 402 (14%)	10 846 (11%)	330 (2.9%)	21 (0.2%)	39 (0.7%)	12 165 (38%)	1 (<0.1%)	
Inpatient hospitalisation (PEDW)	60 455 (36%)	43 250 (42%)	6180 (55%)	2842 (24%)	1729 (29%)	6445 (20%)	9 (0.1%)	
Mortality Data (ADDE)	1242 (0.7%)	769 (0.8%)	227 (2.0%)	16 (0.1%)	77 (1.3%)	153 (0.5%)	0 (0%)	
Died during the study	22 396 (13%)	17 121 (17%)	1464 (13%)	348 (2.9%)	186 (3.2%)	3000 (9.4%)	277 (4.5%)	<0.001

*Median (IQR) for continuous variables or frequency (%) for categorical variables.
†Kruskal-Wallis rank sum test; Pearson's χ^2 test.
ADDE, Annual District Death Extract; EDDS, Emergency Department Dataset; PEDW, Patient Episode Dataset for Wales; SM, Substance misuse; SMDS, Substance Misuse Dataset ; WIMD, Welsh Index of Multiple Deprivation; WLGP, Welsh Longitudinal General Practice.
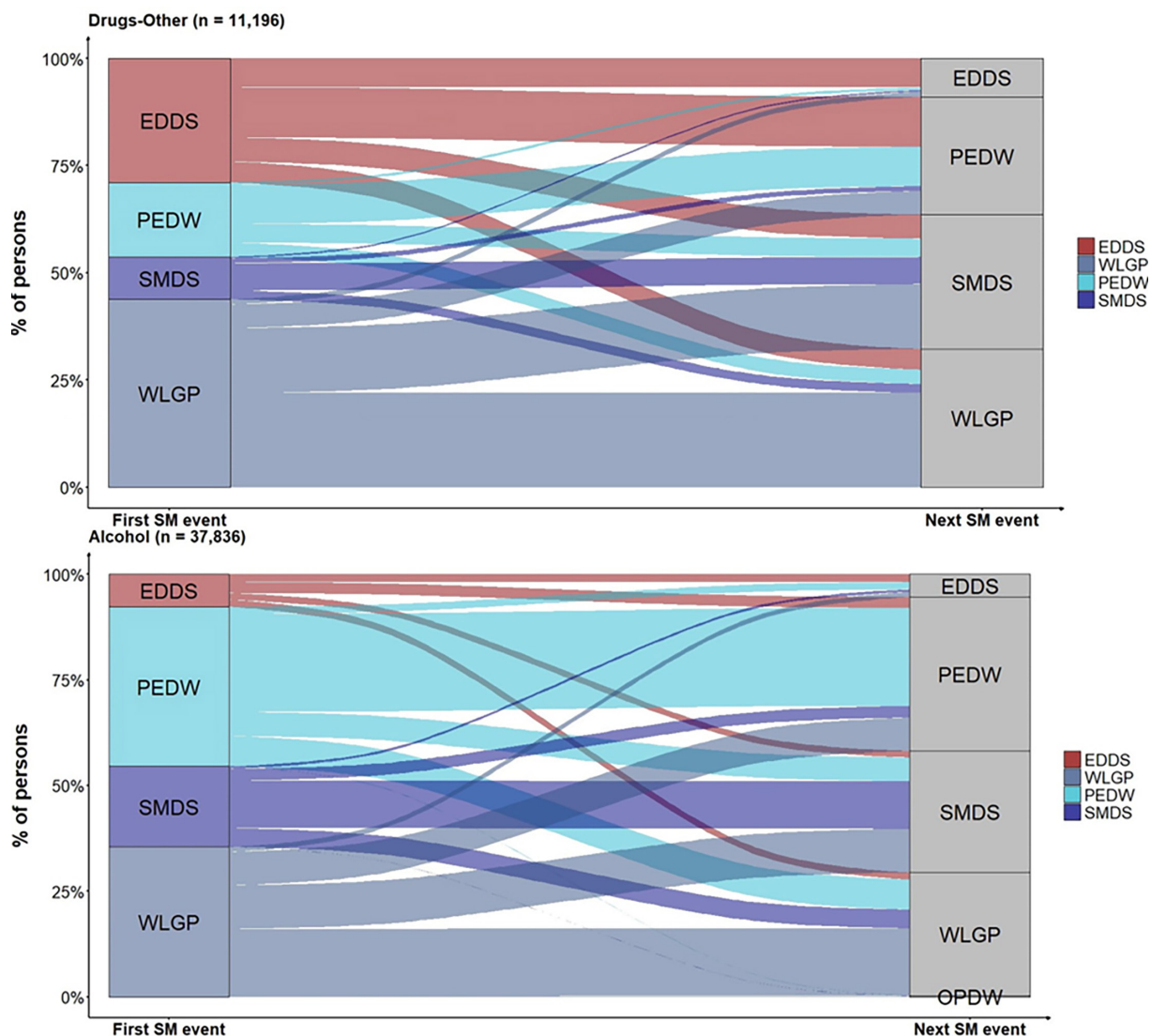
Figure 2 Flow of individuals between healthcare settings in Wales from their index substance misuse (SM) record to the next record for those whose index SM was alcohol and other drugs, 2010–2019. EDDS, Emergency Department Dataset; PEDW, Patient Episode Dataset for Wales; SMDS, Substance Misuse Dataset; WLGP, Welsh Longitudinal General Practice.

in table 2. Overall and across different substances, the number (and percentage) of GP contacts was consistently higher in the period after the index date. Of those who had GP contact, 51.0% and 64.0% made at least two contacts before and after the ISMD, respectively (see online supplemental appendix figure 3 for details and online supplemental appendix figures 4,5 *for breakdown by alcohol and drugs at index SM*).

GP contacts resulting in prescriptions for central nervous system (CNS) drugs (15.0%, (19 005)) and other therapeutic procedures (18.0%, (23 025)) were the most common reasons for GP attendances in the 2 years leading to ISMD. However, contacts for gastrointestinal drugs had the highest percentage change (61.0%) between both periods. The top 10 reasons differ by substance type, with CNS- and gastrointestinal-drug-related contacts mostly in the top five. Full details of the top 10 reasons and percentage change in the number of GP contacts before and after the index date, including a

breakdown by types of substances at the index SM event, are presented in online supplemental appendix tables 2-6.

Hospital admission: frequency and reasons for contacts

As shown in table 2, a similar number of persons had hospital admissions before (28 437 (17.0%)) and after (29 710 (18.0%)) their ISMD. However, the number of admissions was much higher after the index date (84 237 admissions from 49 327, a 70.8% increase from ISMD), while the median number of admissions was similar (two in each). Of all individuals who were admitted, 35.0% and 41.0% of people attended twice or more, prior to and after the ISMD, respectively (online supplemental appendix figure 6).

The number and percentage of persons and admissions were consistently higher after the ISMD than before, with the exception of those presenting with opioid use at the index event, where the percentage of persons prior

Table 2 Frequency of contacts in the 2 years before and after index substance misuse event in general medical practice (GP), accident and emergency (EDDS) and inpatient hospitalisation (PEDW), 2008–2021

	Whole cohort	Alcohol	Opioid	Cannabinoid	Stimulant	Drugs—other	Unknown
	(n=168 774)*	(n=101 768)*	(n=11 296)*	(n=11 909)*	(n=5872)*	(n=31 831)*	(n=6098)*
General medical practitioner (GP)							
Pre-SM GP contact: no of persons	38 593 (23%)	22 827 (22%)	3251 (29%)	2289 (19%)	1127 (19%)	7863 (25%)	1236 (20%)
Post-SM GP contact: no of persons†	50 121 (30%)	30 535 (30%)	3747 (34%)	3005 (25%)	1453 (25%)	9890 (31%)	1491 (24%)
Pre-SM GP contact: no of attendances							
Number of attendances	127 806	71 369	14 413	6076	2956	29 666	3326
Median (IQR)	6 (2, 16)	6 (2, 14)	9 (4, 21)	4 (2, 10)	4 (2, 9)	7 (3, 20)	4 (2, 10)
Post-SM GP contact: no of attendances†							
Number of attendances	173 104	102 795	16 749	8577	4342	36 488	4153
Median (IQR)	6 (3, 14)	6 (3, 13)	9 (4, 20)	4 (2, 10)	5 (2, 11)	7 (3, 16)	4 (2, 9)
Emergency department (EDDS)							
Pre-SM: no of unique persons (EDDS)	74 864 (44%)	42 642 (42%)	5713 (51%)	5780 (49%)	2989 (51%)	15 070 (47%)	2670 (44%)
Post-SM: no of unique persons (EDDS)†	80 143 (48%)	46 399 (46%)	5724 (52%)	5890 (50%)	3073 (53%)	16 455 (52%)	2602 (43%)
Pre-SM: EDDS attendances							
Number of attendances	162 188	85 930	15 111	12 692	6589	36 210	5656
Median (IQR)	3 (2, 5)	3 (1, 4)	4 (2, 7)	3 (2, 5)	3 (2, 5)	3 (2, 6)	3 (2, 5)
Post-SM: EDDS attendances†							
Number of attendances	205 998	113 942	17 147	14 601	7957	46 575	5776
Median (IQR)	4 (2, 7)	3 (2, 6)	4 (2, 9)	3 (2, 6)	3 (2, 6)	4 (2, 8)	3 (2, 5)
Inpatient admissions (PEDW)							
Pre-SM inpatient admissions—persons	28 437 (17%)	16 171 (16%)	2860 (25%)	1473 (12%)	797 (14%)	6352 (20%)	784 (13%)
Post-SM inpatient admissions—persons†	29 710 (18%)	19 100 (19%)	1915 (17%)	1626 (14%)	858 (15%)	5531 (17%)	680 (11%)
Pre-SM inpatient admissions							
Number of admissions	49 327	26 377	6319	2327	1182	11 969	1153
Median (IQR)	2 (1, 4)	2 (1, 3)	3 (2, 6)	2 (1, 3)	2 (1, 3)	2 (1, 4)	2 (1, 2)
Post-SM inpatient admissions							
Number of admissions	84 237	52 174	7417	3773	1989	17 295	1589
Median (IQR)	2 (1, 5)	2 (1, 5)	3 (2, 5)	2 (1, 4)	2 (1, 3)	3 (1, 5)	2 (1, 3)

*Median (IQR) for continuous variables or frequency (%) for categorical variables.
†Excluding those deceased at baseline.
EDDS, Emergency Department Dataset; PEDW, Patient Episode Dataset for Wales; SM, substance misuse.

(25.0%) to the index date was higher than after (17.0%). Although injury and poisoning and digestive disorders were the most common reasons for admissions in both periods, admissions relating to mental disorders more than tripled after the index SM date (8421 admissions from 2696, 212.0% increase), followed by injury and poisoning (112.0% increase)—online supplemental appendix figure 7.

Similar results were found after stratification by type of substance, with mental disorders and injury and poisoning consistently in the top five reasons. Cancer-related admissions were in the top 3 (based on percentage change) only where alcohol was the index substance. Online supplemental appendix tables 7–12 contain the full results for reasons and percentage change in hospital admissions broken down by type of substance.

The majority of individuals spent between 2 and 7 days in the hospital (46.0% before vs 43.0% after). While over 21.0% (before) and 27.0% (after) spent a minimum of 8 days (online supplemental appendix figure 8).

ED: frequency and reasons for contacts

In the 2-year period leading up to the ISMD, 44.4% (74 864/168 774) of the cohort had at least one ED attendance. This increased to 47.8% (80 143/167

532) in the 2 years post-ISMD. The median number of admissions in both periods was three. The total number of attendances preindex and postindex date was 162 188 and 205 999, respectively, indicating a 27.0% increase in the number of emergency admissions. In general, and across different substance types, poisoning or overdose and psychological/psychiatric conditions had the highest percentage increase between pre- and post-ISMD. Table 2 shows full results for emergency attendances, while results for the top 10 reasons for attendances and the percentage change (before and after index SM event) stratified by type of substance are presented in online supplemental appendix tables 13–18.

Last contact before index date

The last point of healthcare contact prior to the ISMD was mainly in the ED, ranging from 61.0% in the drugs—other category to 72.0% in those with cannabinoid and stimulant as the index event substance. Across different types of substances, injury and poisoning were the consistent reasons for contact after unspecified ('Other') reasons in various healthcare settings. Online supplemental appendix figure 9 shows results of the point of care of last contact before the ISMD, while the reason and place for last contact breakdown by substance type (alcohol, opioid, drugs—other, stimulant and cannabinoid) are presented in online supplemental appendix figure 10.

Time after index SM presentation until next SM event

There was a significant difference in survival times until the subsequent SM event within the cohort, when grouped by index substance (log rank test, p=0.0001). Figure 3 shows Kaplan-Meier survival curves for the length of time after the index SM event until the second event stratified by type of substance at baseline. At approximately 183 days (ie, 6 months), for example, 24.0% of those with stimulants as their index substance would have had another SM-related contact, compared with 18.0% for the cannabinoid group. The probability for a second SM event within 6 months of the first event was approximately 25.0% for those aged 35–44 years of age. The lowest probability (14.0%) was found in those aged 18–24. Results stratified by other characteristics such as age, sex, deprivation, ethnicity and healthcare setting of index substance are contained in online supplemental appendix figure 11.

Time after index SM event until first healthcare contact

Figure 3 also shows Kaplan-Meier survival curves for the length of time after the index SM event until the first healthcare contact. Noticeable differences were found in the survival times based on sociodemographic characteristics. Overall, at least 25.0% of the cohort were more likely to have a healthcare contact within 6 months of the

index event regardless of the type of index substance, especially if they were female, aged 10–34 years of age, from the most deprived quintile, or had their index SM contact in the ED. Results of the stratification by age, sex, deprivation and healthcare setting are presented in online supplemental appendix figures 12–15.

DISCUSSION

This study represents the first whole population data linkage analysis of the prehealthcare and posthealthcare service contacts of people with evidence of health-related harm due to substance use (drugs and/or alcohol) presenting in both primary and secondary care settings. Identification and profiling of the nature and scale of this cohort at a country level provide valuable evidence for both policy and health service improvements. These include adjustment of current estimates of SUDs by demographics, addressing training needs for health service professionals and strengthening systems for earlier engagement and timely referral to effective treatment to reduce morbidity and costs to health services.

This large cohort of individuals had up to six (median) healthcare contacts prior to and following their index SM event, each of which represented potential opportunities for intervention to at least identify drug and/or alcohol usage and engage to reduce further escalation with more severe outcomes. However, as clearly shown in figure 2, where the index SM event was in healthcare settings other than specialist SM treatment services (SMDS), only a small proportion (15.0% for alcohol (PEDW (inpatient admission) to SMDS) and (19.4% for 'Drugs-Other' (EDDS (ie, Accident & Emergency) to SMDS)) resulted in a referral or subsequent presentation to specialist services commissioned specifically to support and treat those experiencing substance use issues. Currently, there may be an over-reliance by health professionals on the patient recognising a problem with their substance use and presenting to health or specialist substance use treatment services for support. Given the stigma associated with alcohol and/or drug use disorders, misconceptions or ignorance regarding acceptable or 'healthy' levels of use, and evidence of lack of referral following index SUD events, it is clear that this patient-led approach is suboptimal. Direct, or potentially opt-out, referral mechanisms to low-threshold SM services designed to engage and provide bespoke SM interventions could reduce the subsequent representation to more generic healthcare services and, particularly as is currently the case, reduce the economic and capacity burden on EDs, primary and secondary care.

We found the highest number of individuals and frequencies of health services contact in the ED settings: 44.0% and 48.0% of the cohort had at least one ED contact before and after the index SM event, respectively. This equated to a 21.3% (n=43 810) increase in the number of ED attendances by the cohort, with patients with an alcohol index SM event accounting for around
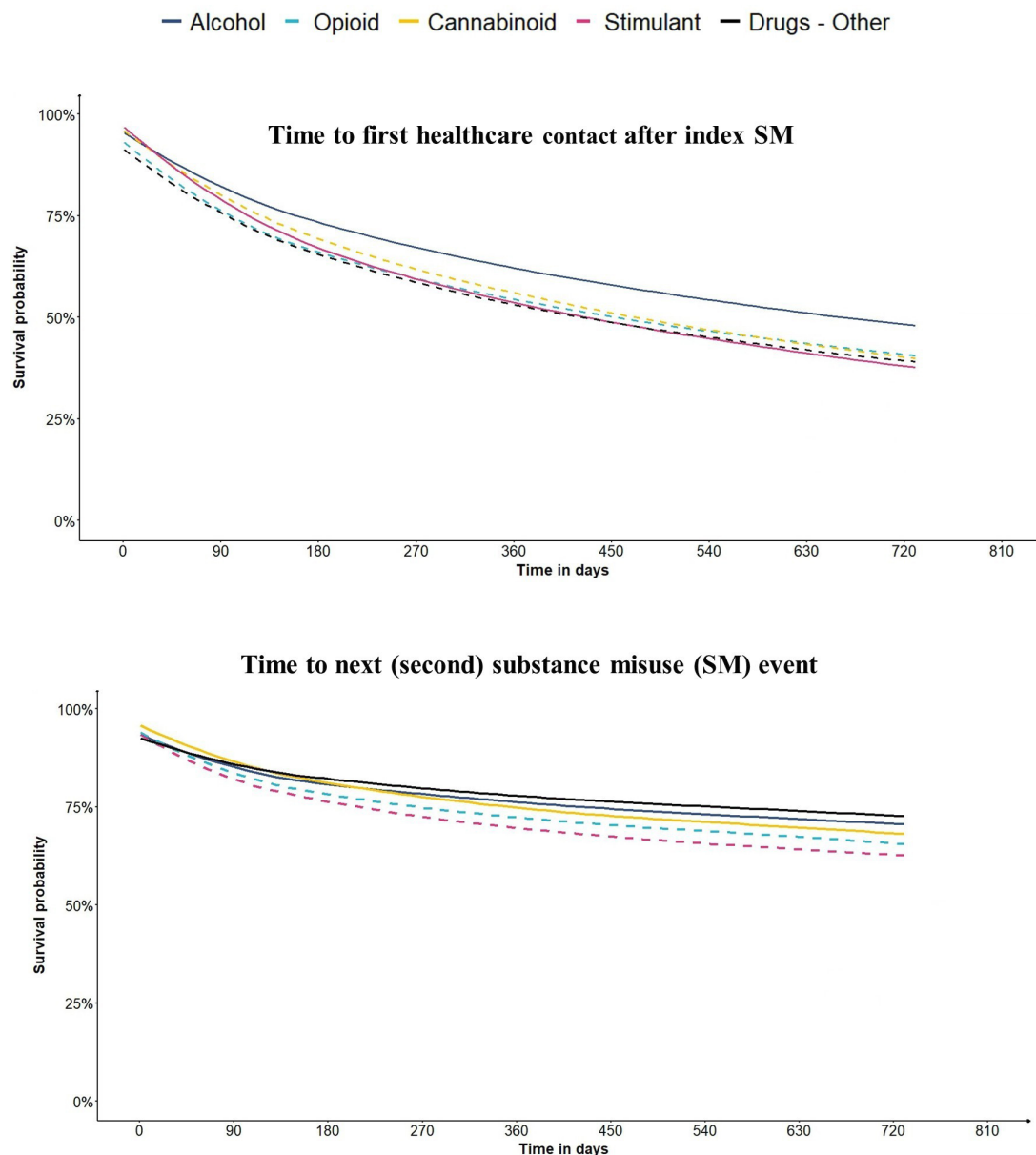
Figure 3 Time to first healthcare contact and next substance misuse (SM) event in the 2 years after the index SM date by index substance, between 2010 and 2021 (Smoothed Kaplan-Meier's Curve).

55%. Presentation at ED was also the most common last point of contact across various substance types (for between 62.0% and 72.0% of the cohort). Investment and strengthening of Drug and Alcohol Care and Liaison Teams within ED, secondary care settings and the community are required to support early identification, referral and adherence to low-threshold and specialist SM treatment.

Presentation within primary care saw an even greater proportional increase with 23.0% and 30.0% of the cohort in contact before and after the index event compared with pre-event. Prescription for CNS drugs (15.0%, (19 005)) was one of the most common reasons for GP attendances in the 2 years leading to ISMD. While these drugs can be used to treat a variety of conditions, including anxiety, depression, seizures, pain and psychosis, there may be a

benefit in strengthening the investigation of substance use among this patient group. Primary care settings represent potentially the first opportunity to identify and address emerging issues with regards to substance use and to engage and refer early to appropriate substance use treatment services. However, increased use of virtual or telephone consultations may impact these opportunities, and alternative approaches warrant investigation.

Across most substance categories, the number and percentage of persons and admissions were consistently higher after the ISMD than before, with the exception of those presenting with opioid, drugs—other and 'unknown' substance use at the index date, where the percentage of persons prior to the index date was higher than after. This may be due to an increased proportion of people dying from acute drug poisoning events and/

or an increase in referral by healthcare professionals to specialist substance use treatment services following index SM events among these subpopulations.

Unsurprisingly, mental health disorders, injury and poisoning had the largest percentage increase following the initial event and were consistently in the top four reasons for hospital admissions. Studies have shown that mental health problems are experienced by the majority of people who use drugs and alcohol as co-occurring conditions.[15–18] There were 8421 hospital admissions for drug-related mental and behavioural disorders, a 212.0% increase on pre- ISMD (2696). Although it is not clear what the underlying common causal pathway is, SUDs may trigger the development of a mental disorder in such a way that the additional disorder then runs an independent course and vice versa.[34] Either way, the coexistence of two or more clinical conditions in the same individual has major clinical implications and costs.

Previous studies have compared healthcare usage of individuals with SUD to other groups, such as those with type 2 diabetes mellitus or the general population, and highlighted EDs and GP settings as important sites for identifying those with potential SUD and for initiating interventions.[35–37] Our study is not only consistent with these findings but also goes further to strengthen the case for SM preventative interventions by highlighting that far more healthcare contacts were made after the index SM event compared with the same length of time before the index SM event. Evidence-based policies and prevention programmes, including behavioural and medication-assisted treatments, have been shown to significantly reduce SM and related harm, facilitate recovery from SUDs, prevent relapse and improve other outcomes, such as reducing criminal behaviour and the spread of infectious diseases.[38–42]

The burden of disease related to SM extends far beyond drug- or alcohol-attributable morbidity and mortality. SM is also highly comorbid with, or a risk factor for, other mental health disorders,[15–18] and associated harms extend to other individuals in the family and community—particularly women and children (eg, from alcohol-related injuries and violence and congenital anomalies such as fetal alcohol spectrum disorder). Comorbidities can complicate SM treatment courses as well as recovery from co-occurring mental health conditions.[15] This is consistent with this study's findings—which show a high percentage increase in mental health disorders, injury and poisoning after the initial SM event as compared with the prior period.

A broad range of evidence-based SM treatments is available and can be delivered in individual and/or group formats.[16 17] Also, economic studies have shown that upfront investment in SM prevention programmes is highly cost-effective, especially in brief intervention and treatment programmes for alcohol dependence and pharmacological treatments for opioid users.[16 43–45] However, due to the frequency of representations of patients with identified SUDs, there may be a prevailing sense of pessimism among health professionals as to the effectiveness of referral to specialist SM services or poor availability or accessibility of local SM services to which to refer. Efforts to share evidence of SM treatment effectiveness and demonstration of screening and early intervention approaches that improve patient outcomes and reduce healthcare costs are required.

In this study, we have highlighted that individuals with potential SM problems can be identified earlier from both primary and secondary care settings, and opportunities therefore exist to initiate effective early intervention to prevent or minimise escalation into increasingly harmful use through targeted intervention.

STRENGTHS AND LIMITATIONS

This study adopted a novel approach by linking inpatient, outpatient, A&E, GP, mortality and specialist substance use treatment service datasets to identify individuals with SM records and estimate their initial record and highlight potential missed opportunities for interventions. By linking data at a person level and following each individual longitudinally, we have been able to present a clear picture of types and timing of healthcare contacts in the 2 years before and after recorded SM events in routinely collected administrative data covering a whole population. The ability to track individuals for at least 5 years prior to the study start date and the use of validated substance use codes[30–32] gives us confidence that the index events were truly incident, and the findings reflect individuals with SM records during the selected period.

The size of our study allowed us to stratify by types of substance misused at baseline. However, it is important to note that while the index SM event is linked to one category of drugs or alcohol, it is possible that an individual may be using one or more categories of drugs and/or alcohol over the pre- and post-periods. About 14% of Welsh GP data are not available in SAIL, suggesting some individuals could have also been missed as a result. On the other hand, we may have included individuals who may have an extensive history of engagement with the healthcare system prior to our look-back period, thereby misidentifying their index event.

There is a wealth of information on these participants through linkage to the various routinely collected administrative datasets. However, routinely collected administrative data contain limited contextual information and may represent an underestimate of total health outcomes for these individuals (eg, where not brought to the attention of, and recorded by, these services). For example, information on the severity of SM was unavailable (possibly increasing the likelihood of omitted variable bias), and it is possible our cohort comprised mainly individuals who are already experiencing substantial health and related harms due to dependency. Also, as not all people with SM issues would necessarily have a healthcare record for it, our study was limited to those with SM-related healthcare records. Other

limitations of using routinely collected data for research have been captured elsewhere.[46]

Secondary care contacts (eg, inpatient and ED admissions) are usually communicated to primary care (GP). As such, it is possible that not only face-to-face or telephone consultations were included in the analysis, possibly leading to inflation of the number of GP contacts. We minimised this by restricting our codes to records that explicitly indicated face-to-face or virtual consultation as opposed to letters or clinical notes to the GP, for example.

Finally, person-level linkage can sometimes erroneously make false-positive links or fail to link when a true link exists (false negative). To minimise this, we restricted our cohort to only those with a deterministic or probabilistic matching or linkage score of at least 90%.[27]

CONCLUSION

This population data linkage approach has enabled a county-level profile of the nature and scale of SM events and health service contact, facilitating identification of, and enabling recommendations for, potential opportunities for early identification and engagement to reduce SM-related morbidity and economic and capacity burden to health services. We identified that individuals with SM records are frequent attendees to healthcare settings both before and after their index SM event. We also highlighted a potential failure with the referral system, where only a small proportion of individuals appear in specialist substance use services following SM events in primary or secondary care. There is a need to review or improve local and national-level health and substance use policy and systems to facilitate robust and integrated care pathways for people presenting with SM in different healthcare settings as early as possible.

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