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Mind the gap: an administrative data analysis of dental treatment outcomes and severe mental illness

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ABSTRACT

Background: Oral health of people with severe mental illness (SMI) remains an important public health issue, despite evidence pointing suboptimal dental health outcomes in this population.

Aims: We test the hypotheses that individuals with SMI have lower contact with dental services and higher levels of fillings and extractions. We also examine effect modification by age-group.

Methods: We used linked administrative data from general practitioner (GP), hospital and dental records to examine dental service use and treatments (extractions, fillings, crowns and x-rays) among the Northern Ireland hospital population between January 2015 and November 2019 ($N = 798,564$).

Results: After adjusting for available socio-demographic characteristics, analysis indicated lower levels of dental service use (OR = 0.80, 95% CI = 0.77, 0.84), including lower likelihood of fillings (OR = 0.81, 0.77, 0.84) and x-rays (OR = 0.77, 0.74, 0.81), but higher levels of extractions (OR = 1.23, 1.18, 1.29) among patients with SMI. We also found effect modification by age-group, with older individuals with SMI less likely to have each of the four dental treatments.

Conclusions: We suggest that in the general area of physical healthcare for people with SMI, oral healthcare is neglected. There is a need for improved understanding of the barriers to routine care and treatment, and development of psychoeducational interventions.

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Introduction

Over a lifetime, about 1% of the population will develop a severe mental illness (SMI) such as psychosis and schizophrenia (National Institute for Health and Care Excellence (NICE), 2014). Chesney et al. (2014) reported that individuals with SMI die on average 15–20 years earlier than the general population, having a higher prevalence of obesity, asthma, diabetes, Chronic Obstructive Pulmonary Disease (COPD), Coronary Heart Disease (CHD), Chronic Heart Failure (CHF) and stroke (National Mental Health Intelligence Network (NMHIN), 2018). In the United Kingdom (UK), responsibility for physical health monitoring of individuals with mental illness is shared between primary care and secondary care mental health teams. However, shared responsibility may leave people with SMI falling through the cracks (Butler et al., 2020).

Moreover, scant attention has been given to oral health disparities despite concerns about suboptimal dental health outcomes in this population (de Hert et al., 2011; Kisely et al., 2011, 2015; McCreddie et al., 2004; Wey et al., 2016). A systematic review and meta-analysis of oral health found that people with SMI were 2.8 times more likely to have lost all their teeth than the general population and had significantly higher decayed, missing and filled teeth or surface scores (Kisely et al., 2015). Kisely (2016) points to the two-way relationship between SMI and poor oral health. Firstly,

dental treatment may lead to or exacerbate symptoms of mental disorder. Secondly, individuals with SMI are more at risk of poor oral health, with key factors including poor nutrition and oral hygiene, dry mouth (xerostomia is more prevalent in those with SMI), side-effects of medication and financial barriers.

Critically, poor dental health is associated with other life-limiting conditions (LLCs) and has implications for service use and provision and premature mortality (Correll et al., 2017; de Hert et al., 2011; Scott & Happell, 2011). A better understanding of service use and oral health among people with SMI will inform the provision of improved physical healthcare services for these individuals. To date most studies in this area have focused on smaller community or clinical samples, limiting the extent to which the association between SMI and dental health can be examined, after controlling for other key factors. Based on a large administrative dataset, the current study allows an in-depth examination of disparities in dental health outcomes with respect to SMI. To the best of our knowledge this represents the first administrative data study of SMI and oral health in the UK. We hypothesised that individuals with SMI have a) *lower contact with dental services*; and b) *higher likelihoods of extractions and fillings than people in the general population*. Additionally, we examine the association between

SMI and crowns and x-rays and explore effect modification by age in relation to all dental health outcomes.

Materials and methods

This study is part of a relatively recent Administrative Data Research (ADR) initiative, funded by the United Kingdom (UK) Economic and Social Research Council (ESRC) to develop the use of routinely collected administrative data for research purposes. The population of interest is drawn from the Northern Ireland (NI) General Practitioner (GP) registered population (as of January 2013) which forms the *spine* of the study. This spine, which also contains some basic demographic information, is (separately) linked to routinely collected data on (a) hospital-based Patient Administration System (PAS) records on admissions and (b) dental health treatments, derived from Dental Payment System (DPS) data, both provided through the Health and Social Care Northern Ireland (HSCNI) Business Services Organisation (BSO). The data are classed as confidential: it is accessed from within a *secure setting*; by *accredited* researchers working under stringent protocols obviating disclosure problems; with data *de-identified* prior to researcher access.

Data

A total of 1,460,360 individuals aged 15 and over were registered with a GP in January 2013. These records were linked with both PAS data from January 2013 to November 2019 and DPS data, covering the period January 2015 to November 2019. DPS data prior to January 2015 were not available to the research team. While the hospital data includes information on dates of both admissions and discharges, this study focusses mainly on the collected data on primary and secondary diagnoses associated with each episode. Of the 1.4 million noted above, 798,564 individuals were also included as hospital (PAS) patients during the follow-up period. A total of 536,775 of these hospital patients appeared on DPS data, as identified by any dental visit. The remaining 261,789 individuals were therefore assumed not to have visited a dentist or received treatment and coded as zero on these variables to facilitate analysis. Private dental work and treatment carried out in hospitals was not included in the analysis.

Ethical approval was not required for this study as it was facilitated via the Health and Social Care Northern Ireland (HSCNI) Honest Broker Service (HBS) and a Memorandum of Understanding is in place to permit HSCNI datasets to be used for research purposes. Research limited to secondary use of information previously collected during normal care (without an intention to use it for research at the time of collection) is generally excluded from Research Ethics Committee review, provided that the patients or service users are not identifiable to the research team in carrying out the research. The dataset was fully anonymised at the point of access.

Consent was not required for this study as data was provided in anonymised format meaning the rights of individuals is respected with adequate privacy protection. Access was provided to the de-identified data via a secure research environment and members of the research team were required to sign a Research Data Access Agreement and Disclosure Policy Agreement prior to gaining access to the data. These contracts and organisational controls ensure no individual can be re-identified during the analysis or in any of the outputs.

Measures

Outcomes

Five key dichotomous outcomes (0 = no, 1 = yes) were defined based on DPS data: a summary variable identified any dental service engagement between January 2015 and November 2019; and (based on four-digit Statement of Dental Remuneration (SDR) codes) four broad dental treatment outcomes: extractions, fillings, crowns, and x-rays were derived. Individuals not appearing on DPS records ($n = 261,789$) were assumed not to have had any of the four treatments and coded as zero for both dental service engagement and treatment outcomes.

Explanatory variables

The presence of any severe mental illness (SMI) was determined from international classification of disease (ICD) codes contained as part of the extensive diagnostic codes within PAS data. A dichotomous indicator (0 = no, 1 = yes) identified individuals with ICD codes F20-F29 (schizophrenia, schizotypal and delusional disorders) or F31 (bipolar disorder) recorded as their primary or subsidiary diagnosis at any point between January 2013 and November 2019. This classification is in line with previous definitions reported by NMHIN (2018) and Hardoon et al. (2013).

Individual characteristics available from administrative data and known to be associated with SMI and/or oral health were controlled for in the models. These included: sex (male, female); age-group (15–24, 25–34, 35–44, 45–54, 55–64, 65–74 and 75 years and over); marital status (married/separated, single, divorced, widowed and unknown); locale of residence (urban, intermediate, and rural); and deprivation decile (1 = most deprived to 10 = least deprived) (Northern Ireland Statistics and Research Agency (NISRA), 2018).

Analysis

Frequencies examined population characteristics for persons aged 15 and over (as of January 2013) and appearing on PAS at any point over the follow-up. Prevalence of dental service use and treatment was determined as that proportion of the population recording a dental visit or treatment. Logistic regression, reporting odds ratios (OR) and 95% confidence intervals, firstly examined crude associations between SMI and the explanatory variables for each of the dental outcomes. Potential confounding of the association of

SMI with each outcome was subsequently examined by including SMI with each additional explanatory variable in turn. Five fully adjusted models then examined whether SMI was independently associated with any dental service use, extractions, fillings, crowns, and x-rays. In a further series of models, the interaction of SMI and age-group and its association with the five outcomes was examined. Likelihood ratio tests assessed effect modification at the 5% level of significance. All analyses were produced using Stata version 14.

Role of the funding source

This work was undertaken for a project as part of Administrative Data Research Northern Ireland, which is supported by the Economic and Social Research Council (ESRC) (project number: ES/L007509/1). The funder had no role in the study design; in the collection, analysis, and interpretation of data; in the writing of the report; and in the decision to submit the paper for publication.

Results

Prevalence of SMI and dental health outcomes

Table 1 provides an overview of the hospital population characteristics as well as the prevalence of SMI, dental service use and treatments. An estimated 1.2% (9,656) recorded an SMI diagnosis from hospital records at some point during follow-up. Most SMI patients were single (39.8% compared to 20.2% of non-SMI patients) and less likely to live in rural settings (21.3% as against 32.5% of non-SMI patients). SMI patients were also more likely to live in communities classed as deprived: 16.6% of SMI patients lived in the most deprived areas compared to 9.9% of non-SMI patients. Over two-thirds (67.3%) of the non-SMI hospital population received dental treatment over the follow-up compared with 62.2% of persons SMI-diagnosed, while the proportions recording individual treatments was as follows: extractions (21.8% and 27.6% for non-SMI and SMI-diagnosed people respectively), fillings (48.9% versus 44.1%), crowns (8.0% versus 8.6%) and x-rays (52.1% versus 45.9%). Fillings and extractions were significantly lower ($p < 0.001$) among SMI patients when compared to non-SMI patients. Conversely, extractions and crowns were significantly higher.

Association of SMI with dental service use and dental treatments

In univariable analysis (Table 2): a diagnosis of SMI was associated with reduced likelihood of any dental service use (OR = 0.81, 95%CI = 0.77, 0.83); including receipt of fillings (OR = 0.82, 0.79, 0.86); and x-rays (OR = 0.78, 0.75, 0.81); but higher likelihood of extractions or crowns (OR = 1.37, 1.31, 1.43 and OR = 1.09, 1.01, 1.17 respectively). With the exception of extractions (OR = 0.96, 0.95, 0.98), females were more likely than males to have received any of

the other treatments. Ageing was associated with uniformly reducing gradients, recording lower likelihood of any dental service use (including fillings and x-rays) while, for extractions and crowns, higher likelihoods were recorded for persons in middle-ages, generally increasing to age 45-54 before reducing at older ages. Compared to persons married/separated: those widowed were less likely to receive any dental treatment and, with the exception of crowns, single persons recorded higher likelihoods over all other interventions. Compared with those living in urban areas, rural residency was associated with lower dental service use (at both semi-rural and fully rural levels); while all outcomes were generally more likely among individuals living in the most deprived areas.

Examination of the confounding effects of the above characteristics on the association of SMI (results available on request) over all the dental outcomes shows little evidence of confounding, with changes in the OR associated with SMI of less than 10% in each case. The positive association of SMI with any crowns became non-significant however with adjustment for age-group, locale of residence and area level deprivation.

Following full adjustment for available socio-demographic characteristics (Table 3), any dental service use, fillings and x-rays remained less likely among the SMI group. While the strength of association was slightly attenuated, individuals with SMI remained more likely to have had any extractions (OR = 1.23, 95%CI = 1.18, 1.29). In the fully adjusted model, there was no association recorded between SMI and receiving crowns.

Interaction of SMI and age-group

Effect modification of the association between SMI and dental outcomes by age-group was explored through the addition of an interaction term in fully adjusted models (Table 4). Likelihood ratio (LR) tests compared each null model with a model including an interaction term and for all five outcomes there was strong evidence of effect modification by age-group – for models relating to any dental visit, extractions, fillings, crowns, and x-rays LR χ^2 were 155.20, 292.55, 320.13, 117.02 and 183.94 respectively, with $p < 0.001$ over all model comparisons. There was strong evidence that individuals with SMI in older age-groups were less likely to have visited a dentist or had any of the four individual dental treatments. The most notable modification was in relation to extractions and crowns – the null models for these outcomes (shown in Table 3) had previously indicated that older individuals were more likely to have these treatments, while interaction with the presence of SMI (shown in Table 4) shows a reversal of this trend, with older individuals with SMI less likely to have extractions and crowns.

Discussion

Consistent with other studies (NMHIN, 2018; Hardoon et al, 2013), we found that a small proportion of patients

Table 1. Sociodemographic characteristics and treatment outcomes of SMI diagnosed and non-SMI diagnosed hospital population.

Variable	Category	All hospital patients % (n = 798,564)	Non-SMI diagnosed patients % (n)	SMI diagnosed patients % (n)
SMI			98.8 (788,908)	1.2 (9,656)
Sex (n = 798,557)	Male	43.4 (346,806)	43.4 (342,295)	46.7 (4,511)
	Female	56.6 (451,751)	56.6 (446,608)	53.3 (5,143)
Age-group (n = 798,564)	15-24	8.9 (70,823)	8.9 (69,973)	8.8 (850)
	25-34	16.2 (129,718)	16.3 (128,373)	13.9 (1,345)
	35-44	14.7 (117,522)	14.7 (115,990)	15.9 (1,532)
	45-54	17.0 (135,633)	17.0 (133,773)	19.3 (1,860)
	55-64	15.7 (125,723)	15.7 (124,128)	16.5 (1,595)
	65-74	14.5 (115,528)	14.5 (114,140)	14.4 (1,388)
	75+	13.0 (103,617)	13.0 (102,531)	11.3 (1,086)
Marital Status (n = 798,564)	Married/separated	43.8 (349,372)	44.0 (346,911)	25.5 (2,461)
	Single	20.4 (163,246)	20.2 (159,407)	39.8 (3,839)
	Divorced	2.3 (18,131)	2.24 (17,662)	4.9 (469)
	Widowed	6.0 (48,040)	6.0 (47,488)	5.7 (552)
	Unknown	27.5 (219,775)	27.6 (217,440)	24.2 (2,335)
Locale of residence (n = 798,437)	Urban	20.5 (163,635)	20.4 (160,943)	27.9 (2,692)
	Intermediate	47.2 (376,505)	47.1 (371,600)	50.8 (4,905)
	Rural	32.4 (258,297)	32.5 (256,241)	21.3 (2,056)
Deprivation decile (n = 798,437)	1 (most deprived)	10.0 (80,010)	9.9 (78,409)	16.6 (1,601)
	2	10.3 (82,424)	10.3 (81,078)	13.9 (1,346)
	3	10.2 (81,568)	10.2 (80,459)	11.5 (1,109)
	4	10.8 (86,101)	10.8 (85,065)	10.7 (1,036)
	5	10.8 (86,070)	10.8 (85,082)	10.2 (988)
	6	9.9 (78,791)	9.9 (77,966)	8.6 (825)
	7	10.2 (81,427)	10.2 (80,591)	8.7 (836)
	8	9.9 (78,739)	9.9 (78,047)	7.2 (692)
	9	9.0 (71,751)	9.0 (71,154)	6.2 (597)
	10 (least deprived)	9.0 (71,556)	9.0 (70,933)	6.5 (623)
All dental service use (n = 798,564)	None	32.8 (261,789)	32.7 (258,141)	37.8 (3,648)
	Some	67.2 (536,775)	67.3 (530,767)	62.2 (6,008)
Extractions (n = 798,564)	None	78.2 (624,173)	78.2 (617,183)	72.4 (6,990)
	Some	21.8 (174,391)	21.8 (171,725)	27.6 (2,666)
Fillings (n = 798,564)	None	51.2 (408,749)	51.1 (403,349)	55.9 (5,400)
	Some	48.8 (389,815)	48.9 (385,559)	44.1 (4,256)
Crowns (n = 798,564)	None	92.0 (734,869)	92.0 (726,045)	91.4 (8,824)
	Some	8.0 (63,695)	8.0 (62,863)	8.6 (832)
X-rays (n = 798,564)	None	48.0 (383,459)	47.9 (378,231)	54.1 (5,228)
	Some	52.0 (415,105)	52.1 (410,677)	45.9 (4,428)

Estimates of dental treatments are based on the period from January 2015–November 2019.

The 261,789 hospital patients that did not visit a dentist/did not appear on DPS data in this period were assumed not to have received dental treatment and were coded as zero on all dental outcomes.

(1.2%) had a SMI diagnosis recorded on their records over a seven-year period. Our findings suggest a somewhat depressing, but perhaps unsurprising, level of dental neglect among people with SMI in NI. Teeth extraction is much more likely in this population and, even after adjusting for available socio-demographic characteristics, they are less likely to have fillings and x-rays. Relatively low engagement with dental services and less *remedial* treatment work is reflected in higher levels of tooth loss - a sequelae which raises concerns about the availability, access, and promotion of routine dental care treatment for people with SMI.

The lower likelihood of dental service use among those with SMI reflects findings from other studies (Denis et al., 2020; Mackell et al., 2005; McCreadie et al., 2004; Nielsen et al., 2010; Persson et al., 2009; Teng et al., 2016). The Persson et al. (2009) study of schizophrenia patients found that just 31% had visited their dentist during the previous three years, while earlier research noted that only 42% of schizophrenia patients regularly brushed their teeth (Hede, 1995).

Our study also suggests age-group can modify the relationship between SMI and dental health, with older SMI-diagnosed individuals less likely to use dental services and

less likely to have had each of the four dental treatments. This was most notable in relation to extractions and crowns, with a reversal of the age trend when compared to null models. Higher rates of dental treatments among younger people with SMI mirrors findings from a report published by Public Health England (PHE), with multi-morbidity more pronounced among younger SMI patients (NMHIN, 2018).

Our findings on dental health among individuals with SMI may reflect lower levels of standard health care received by these individuals in the UK generally (Chesney et al., 2014; de Hert et al., 2011; Lawrence & Kisely, 2010). Individual factors including avoidance, dental phobia and lack of awareness among patients of links between mental and physical health needs have been noted as key contributory factors (De Hert et al., 2011). De Hert and colleagues (2011), also highlight the role of service-related factors such as fragmentation of physical and mental healthcare systems and lack of clarity on who is responsible for detecting and managing physical healthcare needs among patients with SMI. Although strategies to tackle disparities in health care have been initiated (The Mental Health Taskforce, 2016) they are thought to have underperformed (NHS England, 2021) with evidence highlighting important barriers such as

Table 2. Socio-demographic characteristics associated with selected dental health outcomes in the Northern Ireland hospital population.

	All Dental service use OR (95% CI)	Extractions OR (95% CI)	Fillings OR (95% CI)	Crowns OR (95% CI)	X-rays OR (95% CI)
SMI(ref No)					
Yes	0.81 (0.77, 0.83)	1.37 (1.31, 1.43)	0.82 (0.79, 0.86)	1.09 (1.01, 1.17)	0.78 (0.75, 0.81)
Sex (ref males)					
Female	1.42 (1.41, 1.44)	0.96 (0.95, 0.98)	1.16 (1.14, 1.17)	1.06 (1.04, 1.08)	1.31 (1.29, 1.32)
Age-group (ref 15–24)					
25–34	1.08 (1.05, 1.10)	0.89 (0.87, 0.91)	1.08 (1.07, 1.11)	1.47 (1.41, 1.53)	1.05 (1.03, 1.07)
35–44	0.82 (0.80, 0.84)	1.06 (1.04, 1.09)	1.06 (1.04, 1.08)	2.06 (1.99, 2.14)	0.85 (0.83, 0.86)
45–54	0.68 (0.67, 0.70)	1.36 (1.33, 1.39)	1.00 (0.99, 1.02)	2.45 (2.36, 2.53)	0.66 (0.65, 0.68)
55–64	0.54 (0.53, 0.55)	1.34 (1.31, 1.37)	0.81 (0.79, 0.82)	2.14 (2.06, 2.23)	0.44 (0.43, 0.45)
65–74	0.38 (0.37, 0.39)	1.04 (1.02, 1.07)	0.54 (0.54, 0.56)	1.34 (1.28, 1.39)	0.24 (0.24, 0.25)
75+	0.15 (0.15, 0.16)	0.53 (0.52, 0.54)	0.21 (0.21, 0.22)	0.46 (0.43, 0.48)	0.08 (0.08, 0.09)
Marital status (ref married/separated)					
Single	1.15 (1.13, 1.16)	1.08 (1.07, 1.10)	1.12 (1.11, 1.13)	0.92 (0.90, 0.94)	1.37 (1.35, 1.38)
Divorced	1.05 (1.02, 1.09)	1.52 (1.47, 1.57)	1.08 (1.05, 1.11)	1.42 (1.36, 1.49)	1.01 (0.98, 1.04)
Widowed	0.34 (0.33, 0.34)	0.63 (0.61, 0.64)	0.35 (0.34, 0.35)	0.41 (0.39, 0.43)	0.24 (0.23, 0.25)
Unknown	0.84 (0.83, 0.85)	0.96 (0.85, 0.97)	0.89 (0.88, 0.90)	0.92 (0.90, 0.94)	0.93 (0.92, 0.94)
Locale of residence (ref urban)					
Intermediate	0.97 (0.96, 0.98)	0.89 (0.88, 0.91)	0.96 (0.95, 0.97)	0.84 (0.82, 0.86)	1.01 (0.99, 1.02)
Rural	0.91 (0.90, 0.93)	0.78 (0.77, 0.79)	0.92 (0.91, 0.93)	0.78 (0.77, 0.80)	0.97 (0.95, 0.98)
Deprivation decile (ref 1–most deprived)					
2	0.93 (0.91, 0.95)	0.84 (0.82, 0.86)	0.93 (0.92, 0.95)	0.83 (0.80, 0.86)	0.96 (0.94, 0.98)
3	0.93 (0.91, 0.95)	0.77 (0.75, 0.79)	0.93 (0.92, 0.95)	0.79 (0.77, 0.82)	0.97 (0.95, 0.99)
4	0.91 (0.89, 0.93)	0.70 (0.69, 0.72)	0.92 (0.90, 0.94)	0.76 (0.74, 0.79)	0.93 (0.92, 0.95)
5	0.89 (0.87, 0.91)	0.67 (0.66, 0.69)	0.91 (0.89, 0.93)	0.76 (0.74, 0.79)	0.95 (0.93, 0.97)
6	0.95 (0.93, 0.97)	0.68 (0.67, 0.70)	0.96 (0.94, 0.98)	0.82 (0.80, 0.85)	1.02 (1.00, 1.04)
7	1.00 (0.98, 1.03)	0.70 (0.68, 0.72)	0.99 (0.97, 1.01)	0.85 (0.82, 0.88)	1.09 (1.07, 1.11)
8	0.99 (0.97, 1.02)	0.64 (0.63, 0.65)	0.96 (0.94, 0.98)	0.83 (0.80, 0.86)	1.05 (1.03, 1.07)
9	0.89 (0.87, 0.91)	0.61 (0.59, 0.62)	0.92 (0.90, 0.94)	0.81 (0.78, 0.84)	1.01 (0.99, 1.03)
10 (least deprived)	0.80 (0.79, 0.82)	0.50 (0.49, 0.51)	0.81 (0.79, 0.83)	0.75 (0.72, 0.78)	0.93 (0.91, 0.94)

Data represent Odds Ratios (and 95% confidence intervals) from univariable analyses.

Significant associations at the 5% level of significance are shown in bold.

Table 3. Fully adjusted logistic regression models showing association of SMI with dental outcomes.

	Dental service use OR (95% CI)	Extractions OR (95% CI)	Fillings OR (95% CI)	Crowns OR (95% CI)	X-rays OR (95% CI)
SMI(ref No)					
Yes	0.80 (0.77, 0.84)	1.23 (1.18, 1.29)	0.81 (0.77, 0.84)	1.01 (0.94, 1.09)	0.77 (0.74, 0.81)
Sex (ref males)					
Female	1.41 (1.40, 1.42)	1.01 (1.00, 1.02)	1.15 (1.14, 1.16)	1.12 (1.10, 1.14)	1.27 (1.26, 1.28)
Age-group (ref 15–24)					
25–34	1.00 (0.97, 1.02)	0.92 (0.90, 0.94)	1.05 (1.03, 1.07)	1.48 (1.42, 1.54)	1.00 (0.98, 1.02)
35–44	0.77 (0.75, 0.78)	1.14 (1.11, 1.16)	1.04 (1.02, 1.06)	2.14 (2.05, 2.22)	0.81 (0.79, 0.82)
45–54	0.63 (0.61, 0.64)	1.47 (1.44, 1.51)	0.98 (0.96, 1.00)	2.54 (2.44, 2.64)	0.63 (0.62, 0.64)
55–64	0.50 (0.49, 0.51)	1.48 (1.44, 1.51)	0.79 (0.78, 0.81)	2.26 (2.17, 2.35)	0.42 (0.41, 0.43)
65–74	0.35 (0.35, 0.36)	1.17 (1.14, 1.20)	0.55 (0.53, 0.56)	1.43 (1.37, 1.50)	0.23 (0.23, 0.24)
75+	0.15 (0.14, 0.15)	0.61 (0.59, 0.63)	0.22 (0.22, 0.23)	0.51 (0.48, 0.54)	0.08 (0.08, 0.09)
Marital status (ref married/separated)					
Single	0.77 (0.76, 0.78)	1.11 (1.09, 1.13)	0.90 (0.89, 0.92)	1.03 (1.01, 1.05)	0.85 (0.84, 0.87)
Divorced	1.00 (0.97, 1.04)	1.29 (1.25, 1.33)	1.02 (0.99, 1.06)	1.22 (1.16, 1.28)	1.02 (0.99, 1.05)
Widowed	0.71 (0.69, 0.72)	0.85 (0.83, 0.88)	0.72 (0.70, 0.73)	0.76 (0.73, 0.80)	0.68 (0.66, 0.69)
Unknown	0.80 (0.79, 0.81)	0.96 (0.95, 0.98)	0.86 (0.85, 0.87)	0.96 (0.94, 0.98)	0.86 (0.85, 0.87)
Locale of residence (ref urban)					
Intermediate	0.97 (0.95, 0.98)	0.97 (0.96, 0.99)	0.96 (0.95, 0.97)	0.85 (0.83, 0.87)	1.00 (0.99, 1.02)
Rural	0.87 (0.86, 0.88)	0.83 (0.82, 0.85)	0.88 (0.87, 0.89)	0.78 (0.76, 0.80)	0.93 (0.92, 0.95)
Deprivation decile (ref 1–most deprived)					
2	0.99 (0.96, 1.01)	0.88 (0.86, 0.90)	0.98 (0.96, 1.00)	0.89 (0.86, 0.93)	1.02 (1.00, 1.04)
3	1.03 (1.01, 1.05)	0.83 (0.81, 0.85)	1.02 (0.99, 1.04)	0.89 (0.86, 0.93)	1.07 (1.05, 1.10)
4	1.01 (0.99, 1.04)	0.76 (0.74, 0.78)	1.01 (0.99, 1.03)	0.86 (0.83, 0.89)	1.04 (1.02, 1.07)
5	1.00 (0.98, 1.02)	0.74 (0.72, 0.76)	1.00 (0.98, 1.03)	0.87 (0.83, 0.90)	1.07 (1.05, 1.10)
6	1.08 (1.06, 1.11)	0.76 (0.74, 0.77)	1.07 (1.05, 1.09)	0.95 (0.92, 0.99)	1.17 (1.15, 1.20)
7	1.14 (1.11, 1.16)	0.76 (0.74, 0.78)	1.09 (1.07, 1.11)	0.96 (0.92, 0.99)	1.26 (1.23, 1.29)
8	1.16 (1.13, 1.18)	0.70 (0.68, 0.71)	1.08 (1.06, 1.10)	0.94 (0.90, 0.97)	1.25 (1.22, 1.28)
9	1.03 (1.00, 1.05)	0.64 (0.63, 0.66)	1.03 (1.01, 1.05)	0.91 (0.88, 0.95)	1.21 (1.18, 1.24)
10 (least deprived)	0.95 (0.93, 0.97)	0.51 (0.50, 0.53)	0.92 (0.90, 0.94)	0.81 (0.78, 0.84)	1.17 (1.14, 1.19)

Significant associations at the 5% level of significance are shown in bold.

resource constraints, uncertainty of the role of Community Mental Health Trusts (CMHTs) in monitoring physical health, and lack of training (Butler et al., 2020). Preliminary analysis for this study found a strong association between

social deprivation and SMI and therefore treatment costs may also be an important barrier to regular dental visits.

We suggest that in the general area of physical healthcare for people with SMI, oral healthcare is neglected. There is a

Table 4. Logistic regression models showing association of SMI and age-group interactions with dental outcomes.

	Dental service use OR (95% CI)	Extractions OR (95% CI)	Fillings OR (95% CI)	Crowns OR (95% CI)	X-rays OR (95% CI)
SMI*age-group (ref SMI*15-24)					
SMI*25-34	1.01 (0.82, 1.25)	0.99 (0.82, 1.19)	1.00 (0.84, 1.19)	1.15 (0.83, 1.58)	0.98 (0.82, 1.18)
SMI*35-44	1.22 (1.00, 1.50)	1.09 (0.91, 1.30)	1.06 (0.89, 1.26)	1.07 (0.78, 1.45)	1.08 (0.90, 1.30)
SMI*45-54	0.96 (0.80, 1.16)	0.83 (0.70, 0.99)	0.75 (0.63, 0.88)	0.77 (0.57, 1.04)	0.79 (0.67, 0.94)
SMI*55-64	0.75 (0.62, 0.91)	0.62 (0.52, 0.75)	0.54 (0.46, 0.65)	0.50 (0.36, 0.69)	0.65 (0.55, 0.78)
SMI*65-74	0.56 (0.46, 0.68)	0.38 (0.31, 0.47)	0.38 (0.32, 0.46)	0.35 (0.24, 0.52)	0.45 (0.37, 0.55)
SMI*75+	0.56 (0.45, 0.69)	0.25 (0.19, 0.34)	0.33 (0.26, 0.42)	0.24 (0.12, 0.49)	0.40 (0.30, 0.53)

All models are fully adjusted for sex, marital status, locale of residence and area level deprivation.

Significant associations at the 5% level of significance are shown in bold.

need to improve understanding of the barriers to routine care and treatment, and further develop psychoeducational interventions at community and primary care services, and service user levels.

Strengths and limitations

This is the first population-based administrative data study in the UK to examine dental outcomes among people with severe mental illness. In this respect we have extended the evidence base through the linkage of large clinically relevant datasets and used internationally recognised diagnoses to define the population at risk, and clearly defined dental treatments as outcomes. Unfortunately, dental treatments undertaken in hospitals were not included, giving potentially biased estimates. However, currently in the UK very few patients have long-stay admissions and this is unlikely to alter the findings greatly. Although we examined treatments over a five-year period, the cross-sectional nature of the study limits any causal inferences. Moreover, as with most administrative data studies, we had limited explanatory covariates to further our understanding of personal characteristics and contextual factors.

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Author statement

FF MR and GL were involved in the literature search, study design and data interpretation. FF and MR were involved in data acquisition and undertook formal analysis. FF drafted the original manuscript, which was reviewed and edited by MR and GL. All authors had access to the data. FF and MR verified the underlying data and accept responsibility for the decision to submit for publication.

Disclosure statement

The authors confirm that there are no competing interests to declare.

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Data availability statement

The linked administrative data that support the findings are safeguarded and only available to members of the research team. Syntax files developed to produce findings reported in this study are available on request from the corresponding author.

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