BMJ Mental Health

PHARMACOLOGICAL TREATMENTS

Socioeconomic status and prescribing of ADHD medications: a study of ICB-level data in England

Muhammad Umair Khan,[1] Syed Shahzad Hasan [2]

► Additional supplemental material is published online only. To view, please visit the journal online (https://doi.org/10.1136/bmjment-2024-301384).

[1]Aston Pharmacy School, College of Health and Life Sciences, Aston University, Birmingham, UK
[2]Department of Pharmacy, School of Applied Sciences, University of Huddersfield, Huddersfield, UK

Correspondence to
Dr Syed Shahzad Hasan, Department of Pharmacy, University of Huddersfield, Huddersfield, UK; s.hasan@hud.ac.uk

Received 16 October 2024
Accepted 4 January 2025

ABSTRACT

Background Little is known about the impact of healthcare structural changes and socioeconomic indices, such as deprivation, mental health needs, and inequalities, on attention-deficit hyperactivity disorder (ADHD) medication prescribing across different regions in England.

Objective The objective was to examine trends in ADHD medication prescribing and explore their association with socioeconomic factors.

Methods A population-level observational study was conducted using the English Prescribing Dataset (from April 2019 to March 2024) published by the NHS Business Services Authority and the OpenPrescribing platform (Bennett Institute for Applied Data Science, University of Oxford). The study examined trends in five licensed ADHD medications at national, regional and integrated care board (ICB) levels, using linear regression and a generalised additive model to explore the association between socioeconomic factors and prescription rates.

Findings The prescriptions increased significantly from 25.17 items per 1000 population in 2019/20 (pre-COVID-19) to 41.55 items in 2023/24 (post-COVID-19), with an average annual increase of 18% nationally. Methylphenidate remained the most prescribed medication, while lisdexamfetamine showed the highest growth rate (55% annually, 95% CI 40% to 71%, $p<0.01$). Significant regional variations were observed, with London experiencing the highest annual increase (28%), and the Northeast and Yorkshire the lowest (13%). Socioeconomic factors, including ethnicity and deprivation, were significantly associated with ADHD prescription rates ($p<0.05$).

Conclusions Findings reveal a substantial increase in ADHD medication use in England following the COVID-19 pandemic, with significant variations at regional and ICB levels and complex socioeconomic influences.

Clinical implications Findings highlight the need to understand and address drivers of disparities in ADHD care while optimising management strategies across diverse populations.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The evidence consistently shows a significant increase in attention-deficit hyperactivity disorder (ADHD) medication, particularly in high-income countries, for both children and adults, attributed to greater awareness of ADHD, evolving diagnostic guidelines, and expanding treatment options.
⇒ Previous research has explored the role of socioeconomic factors—such as deprivation and healthcare access—on ADHD diagnosis and treatment.
⇒ There is a lack of comprehensive, multi-regional studies that account for recent healthcare structural changes and variations in prescribing practices.

WHAT THIS STUDY ADDS

⇒ The findings reveal that the increase in ADHD medication use is higher than reported in previous studies.
⇒ The study shows significant variations in ADHD medication prescribing at the regional and integrated care board levels in England.
⇒ The findings highlight the complex interplay between socioeconomic factors and ADHD treatment access, offering new insights for shaping targeted healthcare policies to address these disparities in ADHD treatment.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The increasing trend in ADHD medication use reflects growing awareness and diagnoses of ADHD, as well as the potential impact of COVID-19.
⇒ Regional disparities in ADHD prescriptions point to inequalities in access to care across England, driven by local healthcare policies, availability of services, and demographic factors.
⇒ The findings suggest prioritising equitable resource distribution and support across regions and exploring strategies to enhance access to ADHD care, particularly in underserved regions.

To cite: Khan MU, Hasan SS. *BMJ Ment Health* 2025;**28**:1–8.

BACKGROUND

Attention-deficit hyperactivity disorder (ADHD) is a common neurodevelopmental disorder characterised by inattention, hyperactivity and impulsivity.[1] These manifestations may limit the functional capabilities of an individual, such as reduced ability to concentrate on a given task, extreme fidgeting, tapping and impulsive actions that may harm the individual and others.[2] The lack of functional capabilities impacts academic performance, occupational difficulties, behavioural issues, and family and social relationships.[2]

ADHD is common in children, with a global prevalence rate of 7.2%.[3] The prevalence of ADHD in adults is on the rise, with a reported rate of 6.8%.[4] In the UK, a paper published in *The Lancet*[5] and the National Institute for Health and Care Excellence[6] reported an incidence rate of about 5% (n≈700 000) in children and about 3–4% in adults.

Medications play a crucial role in the management of ADHD. Currently, there are five medications licensed for the management of ADHD in the UK: three stimulants (methylphenidate, dexamfetamine, lisdexamfetamine) and two non-stimulants (atomoxetine, guanfacine). Their use in children and adults is supported by substantial evidence, including recommendations from various national[6] and international guidelines.[7 8] A meta-analysis of 133 double-blind, randomised controlled trials, including more than 10 000 children and 5000 adults, supported the use of medications, particularly stimulants, in managing ADHD symptoms.[9] Another study reported the effectiveness of ADHD medications in older children in improving quality of life and reducing functional impairment, emergency visits, suicidal rates, substance misuse and criminality.[10]

The role of medications becomes more important in the absence or lack of availability of alternative treatment options, such as psychological or behavioural therapy. A survey found that only about a quarter of the adult ADHD services in the UK offer a full range of treatment options, with most services offering pharmacological treatment (80%) compared with psychological treatment (50%).[11]

Several studies have reported an increase in the use of ADHD medications. A multinational study across 64 countries showed an annual increase of 9.72% from 2015 to 2019,[12] similar to an Australian study reporting an increase of 9.6% between 2011 and 2018.[13] A Canadian study reported an overall increase of 150% and 350% in children and adults, respectively, from 2005 to 2015.[14] Similarly, a German study reported an increase of 113% and 355% in younger and older adults, respectively, between 2008 and 2018.[15] In the UK, a study reported an increase of almost 800% from 1995 to 2015.[16] A more recent analysis of prescribing trends in the UK reported an annual increase of 11.07% between 2010 and 2019.[17]

In March 2020, WHO declared COVID-19 a pandemic, which resulted in a global healthcare crisis and the implementation of preventative measures such as lockdowns, business closures, staying at home, social distancing, school closures, and so on.[18] Evidence suggests that these measures resulted in increased anxiety, depression, family conflicts, loneliness and post-traumatic stress disorder.[19–21] Furthermore, there are reports of a strong association between the impact of the pandemic and the worsening of ADHD symptoms.[22 23]

The global increase in ADHD symptoms after the onset of COVID-19 has led to increased demand for ADHD-related services, including the use of medications. Early results from a few studies that reported prescribing data after the onset of COVID-19 suggest that the prescribing trends have increased compared with the pre-pandemic levels.[24–26] WHO declared in May 2023 that COVID-19 was no longer a pandemic-level threat,[27] resulting in restrictions being eased and progress towards normalisation. There is limited understanding of the trends in ADHD medication use beyond this period, as it is critical to understanding the long-term impact of COVID-19 on ADHD.

There have been reports indicating that regional variation and socioeconomic factors significantly impact ADHD and its treatment. For example, in the UK, studies have reported regional disparities in the context of the transition period (16–19 years) and adult services,[11] incidence and distribution of ADHD,[28] and prescribing of stimulant medications.[29] However, there remain knowledge gaps. First, the studies above were based on the previous NHS structure (clinical commission groups), which changed in 2022 to integrated care systems[30] and thus did not reflect the current divisions. Second, these studies either focused on specific populations or types of medication, necessitating a need for a broader overview of ADHD medication prescribing across different regions and the impact of socioeconomic indices such as deprivation, mental health needs, community needs, inequalities and ethnicity.

OBJECTIVE

This study aimed to analyse ADHD medication trends in England from April 2019 to March 2024 using population-level aggregated data. It examined these trends at national, regional and integrated care board (ICB) levels, covering the periods before, during and after the COVID-19 emergency. The study also aimed to analyse the impact of socioeconomic factors on ADHD medication use within the context of the ICB framework.

METHODS

Study sources

We analysed prescription reimbursement data from a large population-level English Prescribing Dataset (from April 2019 to March 2024) published by the NHS Business Services Authority (NHSBSA) and the OpenPrescribing platform developed by the Bennett Institute for Applied Data Science, Oxford University. This study is reported following the RECORD checklist for reporting observational studies.[31]

Study design

We conducted a population-level observational study using prescribing (reimbursement) data from OpenPrescribing, an interactive database containing monthly prescription data records published by the NHSBSA. The database includes prescriptions written by a range of prescribers, including paediatricians, psychiatrists, general practitioners and independent prescribing pharmacists, in England and dispensed in community settings. The database does not include prescriptions issued outside England or dispensed in other settings, such as hospitals and prisons. Further information about the development, validation and cleaning of this database can be found elsewhere.[32 33] The database has been used and cited in numerous studies analysing variations and trends in prescribed medications.[34 35]

ADHD medication prescriptions

Prescription data were extracted from April 2019 to March 2024 for all licensed ADHD medications (methylphenidate, dexamfetamine, lisdexamfetamine, atomoxetine, guanfacine). In the interactive search tool, each medication was searched by its chemical name (eg, methylphenidate) or BNF section (eg, section 4.4), with each chemical having a unique code (eg, 0404000M0). Data were extracted as an item, corresponding to the number of prescriptions dispensed for a medication. NHS England comprises seven regions (East of England, London, Midlands, Northeast and Yorkshire, Northwest, Southeast, and Southwest), each working in partnership with multiple integrated care boards (ICBs) with a total of 42 ICBs. Data were extracted for each ICB for all the licensed ADHD medications.

Socioeconomic factors

Several socioeconomic variables were used for analysis in this study based on aggregated data at the ICB level. Maternity needs

index, prescribing needs index, and inequality index data were extracted from the NHS England allocation documents, which are publicly available on the NHS England website.[36] NHS England allocates budgets to ICBs based on their geographical needs to reduce inequalities. We used the data for the year 2022/23 as this was used to assign the financial resources for the years 2023/24 to 2024/25. Further information on the description of these variables and how these were estimated is provided in a technical guide published by NHS England.[37] Data on the proportion of people in the most deprived decile in each ICB were extracted from the waterfalls analysis, which NHS England also used as part of financial allocations.[38] Ethnicity data were extracted from an NHS Digital document that combined Hospital Episode Statistics and Data for Pandemic Planning and Research COVID to estimate population-level data on ethnic categories.[39] The original document had several categories of ethnicity; however, for simplicity, we divided the population into white (eg, British, Irish) and non-white or mixed population.

Statistical analyses

A descriptive analysis was performed, and the number of prescriptions was calculated per year (from April 2019 to March 2024) based on monthly reports for each of the five medications at a national, regional and ICB level. First, the number of prescriptions was calculated for all the ICBs. Second, the number of prescriptions for a set of ICBs working within a particular region was summed to calculate the number of prescriptions for that region. Third, the number of prescriptions for all regions was summed to calculate the number of prescriptions at a national level. These calculations were repeated for all the medications.

Linear regression analysis was performed to identify the trends in the use of ADHD medications and the direction and rate of change from April 2019 to March 2024. The mean change per year was calculated by dividing the regression coefficient by the baseline number of prescriptions for the year 2019/20. A 95% CI was also computed to assess the precision of trend analysis, with a p-value of less than 0.05 indicating statistical significance.

The influence of socioeconomic factors on the use of ADHD medications was examined using a generalised additive model, which allows for a non-linear complex association between the predictor variables (socioeconomic variables) and the response variable (prescription count per 1000 population) by using smooth functions. The model treated age, inequality and prescribing index as smooth terms because of their potential non-linear relationship with the response variable, while treating maternity index, ethnicity and deprivation as linear terms; their association with the response variable was more straightforward and linear. The linearity was confirmed by visual inspection of the residual plot.

The smooth terms were modelled using penalised regression splines to estimate the non-linear effects of these terms (or variables) on prescription rates, and linear terms were modelled to capture their linear effects on prescription rates. All variables were treated as continuous variables. The significance of smooth and linear terms was assessed using the F-test and t-test. The overall model fit was evaluated using an adjusted R^2, generalised cross-validation score, Akaike information criterion, and Bayesian information criterion. All analyses were conducted using Microsoft Excel and R Foundation for Statistical Computing, version 4.3.1.

FINDINGS

Our analysis showed a significant increase in the number of prescriptions of all ADHD medications from the pre-COVID-19 period (2019/20=25.17 items per 1000 population) to the post-COVID-19 period (2023/24=41.55 items per 1000 population) at the national level. Table 1 presents the prescription items dispensed per 1000 population in primary care England and the change in the number of ADHD prescription items from the pre-COVID-19 period (2019) to the post-COVID-19 (2023) period.

Methylphenidate was the most prescribed ADHD medication in pre-COVID-19 (19 items per 1000 population) and post-COVID-19 (27 items per 1000 population) periods. Guanfacine was introduced in 2016 and was the least prescribed ADHD drug across the whole period between 2019/20 and 2023/24 (0.39 items in 2019 to 1.10 items in 2023 per 1000 population). Lisdexamfetamine was the second most prescribed ADHD drug after methylphenidate (2.86 items in 2019/20 to 8.68 items in 2023/24 per 1000 population) (online supplemental figure S1).

The regression analysis indicated a statistically significant increase in prescriptions for all ADHD medications (online supplemental figure S1). Overall, prescriptions for ADHD medications increased by 18% per year, on average, between 2019/20 and 2023/24. Although lisdexamfetamine and dexamfetamine had lower prescription items per 1000 population compared with methylphenidate, their use increased sharply by 55% (95% CI 39.6% to 70.7%, p<0.01) and 50% (95% CI 16.45% to 84.47%, p<0.05), respectively. Atomoxetine showed the smallest, yet significant, increase of 6.89% (95% CI 2.49% to 11.27%, p<0.05).

There is an upward trend in ADHD prescription items in all seven regions of England (online supplemental figure S2). However, there were variations in prescription trends across different regions (figure 1), with an average yearly increase ranging from 13% in the Northeast and Yorkshire region (95% CI 7.8% to 17.86%) to 28% in the London region (95% CI 19.17% to 36.67%). The second-highest change in prescriptions per year was noted in Southeast England (19.37%, 95% CI 12.38% to

Table 1 Average percentage change in number of prescriptions between pre-COVID-19 and post-COVID-19 at the national level

	Prescription items per 1000 population					Prescription trends	
Drugs	2019/20	2020/21	2021/22	2022/23	2023/24	Mean change per year as % of baseline (95% CI)	p value
Methylphenidate	19.06	19.29	21.55	23.94	26.93	11.42 (6.2 to 16.58)	<0.01
Dexamfetamine	0.75	0.87	1.11	1.45	2.28	50.47 (16.45 to 84.47)	<0.05
Lisdexamfetamine	2.86	3.71	5.11	7.39	8.68	55.15 (39.6 to 70.7)	<0.01
Atomoxetine	2.11	2.19	2.33	2.63	2.56	6.89 (2.49 to 11.27)	<0.05
Guanfacine	0.39	0.62	0.76	0.96	1.10	46.36 (39.45 to 53.4)	<0.01
Total	25.17	26.68	30.87	36.37	41.55	17.71 (11.49 to 23.93)	<0.01

Percentage change was calculated by dividing the regression coefficient by baseline prescriptions from 2019.
CI, confidence interval.

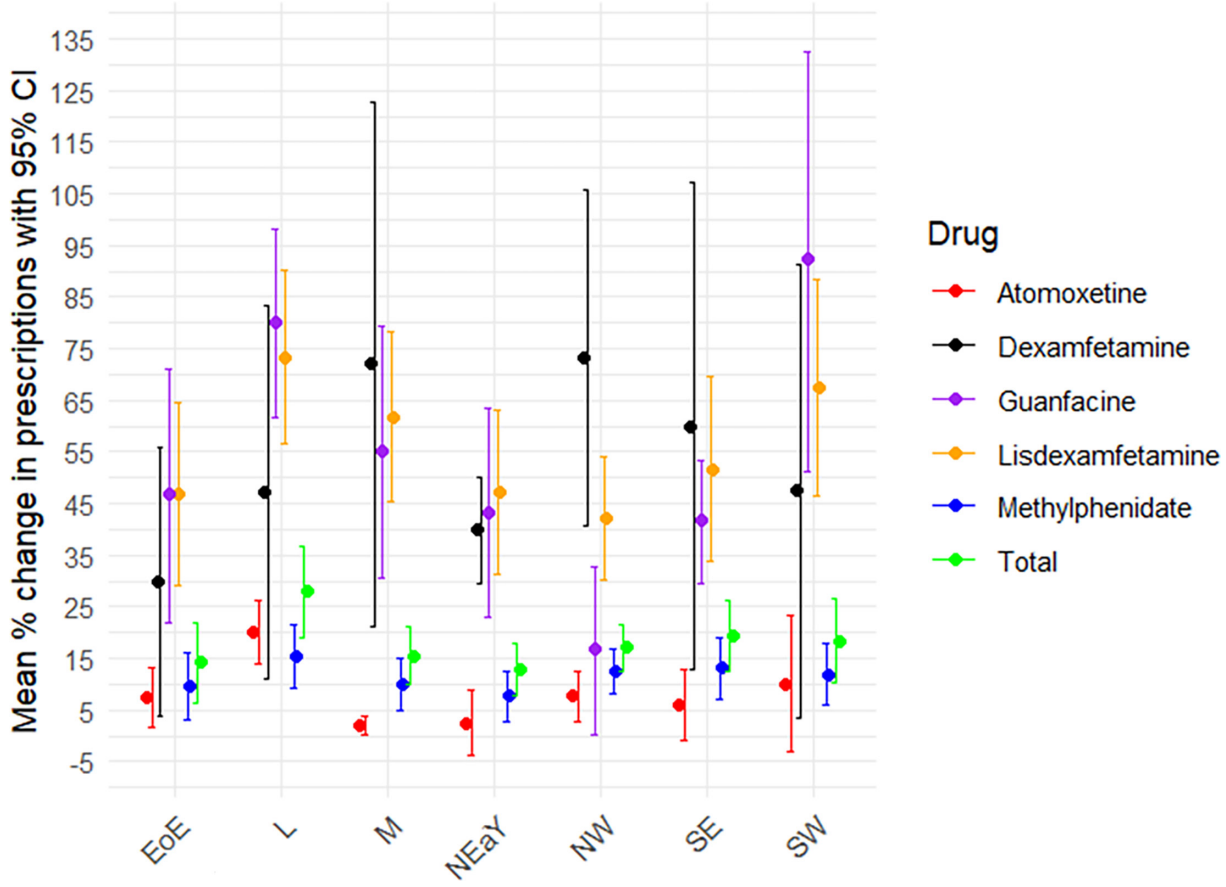

Figure 1 Mean percentage change in prescriptions with 95% CIs from 2019 to 2023 (regional level). (EoE, East of England; L, London; M, Midlands; NEaY, Northeast and Yorkshire; NW, Northwest; SE, Southeast; SW, Southwest).

26.37%). Interestingly, the Southeast region had the highest number of prescription items dispensed in the post-COVID-19 period (2023/24) (51.14 items per 1000 population), followed by the Northwest region (46.77 items per 1000 population), and East of England (46.63 items 1000 population) (see online supplemental table S1).

At the ICB level, there were notable variations in ADHD medication prescribing trends. The NHS Birmingham and Solihull ICB witnessed the highest increase in prescriptions (51.39%, 95% CI −2.54% to 105%, p>0.05), but with great variation within the ICB, as shown in figure 2. Conversely, the lowest increase was noted in NHS Norfolk and Waveney ICB (4.6%, 95% CI −0.5% to 9.7%, p>0.05). Interestingly, NHS Lincolnshire ICB had the highest prescription items dispensed post-COVID-19 (62.79 per 1000 population). Variations were also noted across the ICB regarding the type of medication prescribed. The largest increase in methylphenidate use was observed in NHS Birmingham and Solihull ICB, while the use of dexamfetamine was highest in NHS Lincolnshire ICB, lisdexamfetamine in NHS Nottingham and Nottinghamshire ICB, atomoxetine in NHS Frimley ICB, and guanfacine in NHS Dorset ICB (figure 2).

The generalised additive model showed significant statistical associations between socioeconomic variables and ADHD prescriptions. A significant linear relationship was observed between ADHD prescription items per 1000 population and regions with a higher proportion of ethnic minority groups (estimate 0.36, SE 0.13, p<0.05) and deprivation (estimate 1.11, SE 0.35, p<0.01). The model shows the non-linear, yet significant, association between age (estimated df (EDF)=7.15, Ref. EDF=8.07, p<0.01), inequality (EDF=8.91, Ref. EDF=8.98, p<0.01), and prescribing indices (EDF=6.76, Ref. EDF=7.77, p<0.01) with the prescription items per 1000 population (response variable). The high EDF suggests a complex, non-linear association between socioeconomic variables and ADHD prescription items. The model explained 94.90% of the deviation in ADHD prescription rates, with an adjusted R^2 value of 0.86, indicating a strong fit to the data. The generalised additive model is summarised in figure 3 and online supplemental table S2.

DISCUSSION

This study presents ADHD medication trends from April 2019 to March 2024, covering the period before, during and after COVID-19, and explores the impact of socioeconomic factors on ADHD medication use in England based on population-level data. ADHD prescriptions increased significantly between 2019/20 and 2023/24. Methylphenidate remains the most prescribed ADHD medication, while lisdexamfetamine and dexamfetamine showed the most significant upward trends. Regional variation was evident, with the London region having the highest average annual increase and the Northeast and Yorkshire having the lowest average annual increase in ADHD medication. At the ICB level, Birmingham and Solihull ICB had the highest, and Norfolk and Waveney had the lowest annual increase in ADHD medications. Ethnicity and deprivation had a significant linear relationship with ADHD prescriptions, while age, inequality and prescribing indices had a complex yet significant relationship with the prescribing rates.

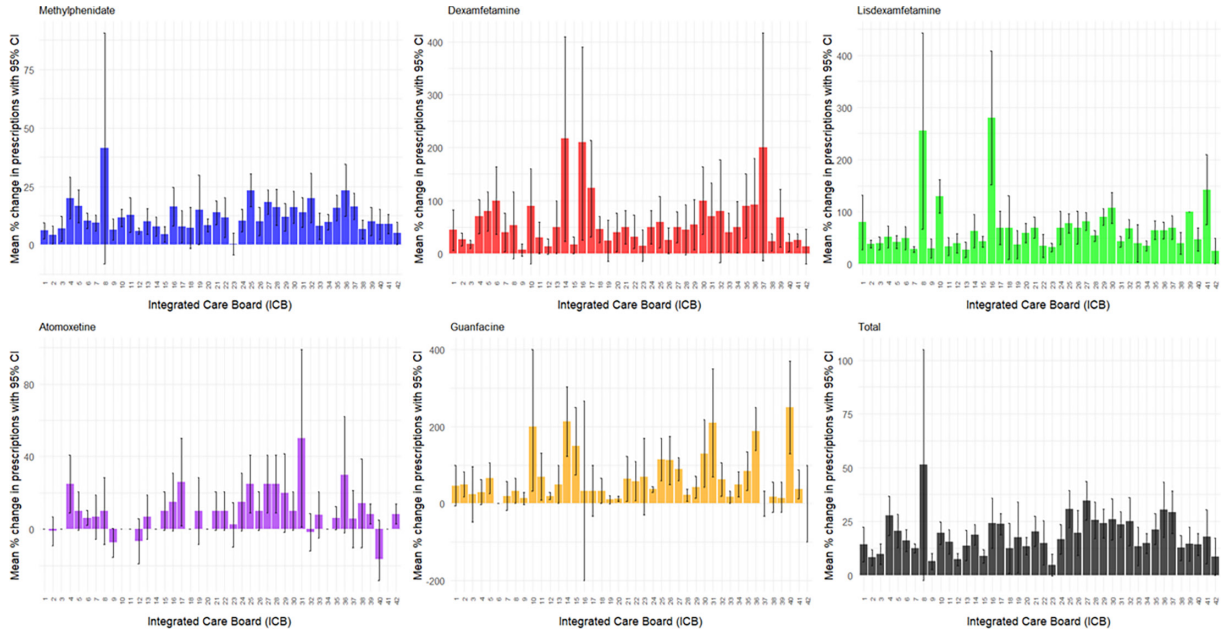

Figure 2 Regression analysis of yearly trends in prescriptions (items dispensed) at integrated care board (ICB) level. Note: 1=NHS Humber and North Yorkshire Integrated Care Board, 2=NHS North East and North Cumbria Integrated Care Board, 3=NHS South Yorkshire Integrated Care Board, 4=NHS West Yorkshire Integrated Care Board, 5=NHS Cheshire and Merseyside Integrated Care Board, 6=NHS Greater Manchester Integrated Care Board, 7=NHS Lancashire and South Cumbria Integrated Care Board, 8=NHS Birmingham and Solihull Integrated Care Board, 9=NHS Black Country Integrated Care Board, 10=NHS Coventry and Warwickshire Integrated Care Board, 11=NHS Derby and Derbyshire Integrated Care Board, 12=NHS Herefordshire and Worcestershire Integrated Care Board, 13=NHS Leicester, Leicestershire and Rutland Integrated Care Board, 14=NHS Lincolnshire Integrated Care Board, 15=NHS Northamptonshire Integrated Care Board, 16=NHS Nottingham and Nottinghamshire Integrated Care Board, 17=NHS Shropshire, Telford and Wrekin Integrated Care Board, 18=NHS Staffordshire and Stokeon-Trent Integrated Care Board, 19=NHS Bedfordshire, Luton and Milton Keynes Integrated Care Board, 20=NHS Cambridgeshire and Peterborough Integrated Care Board, 21=NHS Hertfordshire and West Essex Integrated Care Board, 22=NHS Mid and South Essex Integrated Care Board, 23=NHS Norfolk and Waveney Integrated Care Board, 24=NHS Suffolk and North East Essex Integrated Care Board, 25=NHS North Central London Integrated Care Board, 26=NHS North East London Integrated Care Board, 27=NHS North West London Integrated Care Board, 28=NHS South East London Integrated Care Board, 29=NHS South West London Integrated Care Board, 30=NHS Buckinghamshire, Oxfordshire and Berkshire West Integrated Care Board, 31=NHS Frimley Integrated Care Board, 32=NHS Hampshire and Isle of Wight Integrated Care Board, 33=Kent and Medway Integrated Care Board, 34=NHS Surrey Heartlands Integrated Care Board, 35=NHS Sussex Integrated Care Board, 36=NHS Bath and North East Somerset, Swindon and Wiltshire Integrated Care Board, 37=NHS Bristol, North Somerset and South Gloucestershire Integrated Care Board, 38=NHS Cornwall and the Isles of Scilly Integrated Care Board, 39=NHS Devon Integrated Care Board, 40=NHS Dorset Integrated Care Board, 41=NHS Gloucestershire Integrated Care Board, 42=NHS Somerset Integrated Care Board.

Several factors may contribute to the substantial increase in ADHD medication. Increased public and professional awareness, partly driven by social media platforms like TikTok and Instagram, has likely encouraged more people to seek assessment, diagnosis and treatment.[40–42] Platforms like TikTok and Instagram have become new hubs for ADHD campaigns, with thousands of people sharing their experiences, coping strategies and journey to diagnosis.[43] While social media has been instrumental in spreading ADHD awareness, it is crucial to approach the information with caution, as the accuracy and reliability of the content can vary significantly.[44] Misinformation on these platforms may lead to misconceptions about symptoms, diagnosis and treatment. There is a pressing need for research into effective methods for vetting and moderating ADHD-related information on social media platforms to ensure that awareness efforts do not inadvertently spread misinformation. Additionally, the role of professional diagnosis and treatment should be emphasised, balancing the role of social media with evidence-based practices.

The potential impact of the COVID-19 pandemic on ADHD prescribing trends cannot be overlooked. The pandemic has dramatically altered daily routines (eg, online or hybrid education and work), increased stress levels, and disrupted support systems (eg, healthcare accessibility) for many individuals. These changes may have exacerbated ADHD symptoms in some people, making those symptoms more noticeable and prompting individuals to seek diagnosis and treatment. Several studies have confirmed that the pandemic is associated with increased ADHD symptoms and psychological difficulties.[45–47] The long-term impact of the pandemic on ADHD prescribing trends remains a critical area for ongoing research and monitoring. While our study has identified significant changes in prescription patterns during and after the pandemic, it is crucial to determine whether these trends represent a temporary shift or a more permanent change in ADHD prescriptions.

Previous studies have analysed data only up to 2022, but there is no emphasis on the impact of COVID-19 and socioeconomic factors on ADHD medication prescribing.[17] For example, a similar study in the United States reported a significant increase in the use of stimulants (4007 prescriptions per month) between 2018 and 2022.[24] A study from Canada reported that the proportion of patients using ADHD medications increased from 12.9/1000 to 21.9/1000 between 2017 and 2021.[26] A multinational study of 47 countries showed an overall increase in

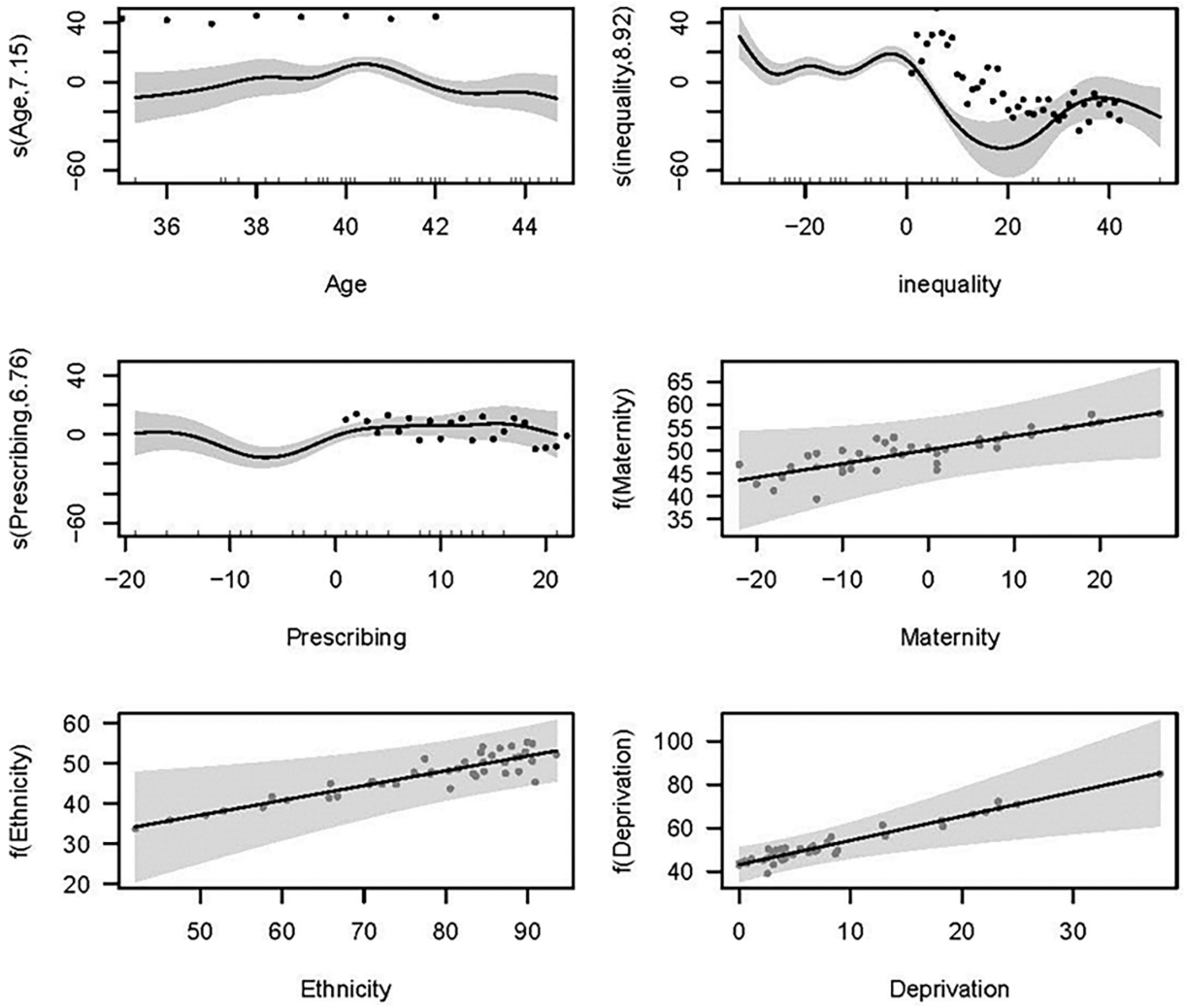

Figure 3 Association between socioeconomic variables and attention-deficit hyperactivity disorder (ADHD) prescriptions based on a generalised additive model.

the consumption of ADHD medications per country by 1.6% between 2014/19 and 2020/21.[25] Another large retrospective, observational study using population-based databases from 13 countries and one Special Administrative Region found that the prevalence of ADHD medication use among children increased over time in all countries and regions.[48] Methylphenidate was the most commonly used ADHD medication in most countries.[48] The current study adds trends in ADHD medication use beyond COVID-19 in the UK, which can help improve the understanding of ADHD medication prescribing beyond COVID-19 and the long-term impact of COVID-19 on ADHD.

In the UK, the use of ADHD drugs increased by 26% between 1998 and 2010.[49] However, it is important to note that only two drugs, methylphenidate (1998) and dexamfetamine (2008), were available for ADHD at the time of the analysis (online supplemental table S3). A more recent analysis of prescribing trends in the UK reported an annual increase of 11.07% between 2010 and 2019,[17] a period during which additional ADHD medications became available. Our study showed a more pronounced increase of 18% annually (11%–24%) between 2019/20 and 2023/24. In contrast to the previous studies, our study presents a percentage change in prescription items dispensed per 1000 population that helps to understand the trends more appropriately. Furthermore, the current study presents data covering the period before, during and after COVID-19 at an ICB level, assessing the impact of socioeconomic factors on prescriptions. This approach addresses gaps in the previous studies, offering a more comprehensive, up-to-date view of ADHD medication use in England.

Methylphenidate and lisdexamfetamine are considered first-line pharmacological treatment options for managing ADHD. Our findings show that methylphenidate remains the most prescribed medication, possibly due to its lower cost, availability of generic versions, and that it has been in use for decades, providing a wealth of long-term safety and efficacy data that may reassure both clinicians and patients. Furthermore, the availability of extended-release formulations is preferred due to lower risk of abuse, better medication adherence (given as a once-daily dose), and reduced risk of diversion as children do not require the dose at school and hence less stigmatisation.[50] However, the significant increase in lisdexamfetamine prescriptions observed in our study suggests a shifting landscape. This could be partly explained by a UK-based cost-effectiveness study, which found that lisdexamfetamine was more cost-effective compared with methylphenidate extended-release form and atomoxetine, reducing mean per-patient annual cost, and increasing mean quality-adjusted life years, respectively.[51]

Our analysis revealed significant ICB-level variations in ADHD medication prescribing across England. Demographic factors such as age, ethnicity and deprivation may contribute to these regional variations. Furthermore, local healthcare policies, availability of specialist ADHD services, and variations in diagnostic and prescribing practices could also significantly impact prescribing rates.[5] A report investigating the integrated care systems that constitute consistent ICBs in England found that each ICB varies significantly in size, complexity and demographic characteristics that determine their ability to deliver services.[52] Therefore, it is evident that a one-size-fits-all approach to ADHD services is not feasible. Some ICBs will require additional support and resources to effectively deliver ADHD-related services and meet the needs of their respective populations. This is particularly important for ICBs serving areas with higher levels of deprivation and greater ethnic diversity.

Regional variations and the need for tailored approaches to ADHD services across different ICBs are further illuminated by our analysis of socioeconomic factors and their relationship to ADHD prescriptions. Our findings highlight significant regional disparities in ADHD prescriptions driven by regional and socioeconomic factors such as ethnicity, deprivation and inequality. While ethnicity and deprivation showed linear relationships, non-linear trends in age, health inequality and prescribing indices suggest nuanced influences requiring further study. Our findings are in line with previously published studies. For example, an Australian study showed that children from socially disadvantaged families were less likely to receive medication,[53] similar to the findings on income disparity reported by Tu[26] in Canada. A US-based study reported regional disparity and ethnicity as factors influencing the use of ADHD medications, particularly stimulants,[54] similar to the studies from Germany,[55] Denmark[56] and Sweden.[57]

Strengths and limitations

To the best of our knowledge, this is the first study to examine ADHD prescribing patterns and their association with socioeconomic factors at an ICB level, covering the period before, during and after COVID-19. Another strength of this study lies in using a large sample of prescription items from a validated dataset to explore trends, providing confidence in the findings for researchers, clinicians and policymakers. One limitation is that the dataset is based on aggregate data, not including individual-level characteristics such as age, gender and ethnicity. These factors may influence the interpretation of findings as ADHD prevalence and treatment approaches may vary across these demographics. However, in line with the objectives, this study uses ICB-level data and provides valuable insights into regional prescribing trends, offering a broader understanding of variations in ADHD prescribing practices. Additionally, the observed increase in the prescription counts in this study may be influenced by factors such as longer durations of medication use, which cannot be determined from this database. Although the majority of the prescriptions are dispensed in primary care in England, the drugs dispensed in hospitals are not included in the database.

In conclusion, this nationwide population-level study with reimbursement data showed a significant increase in the proportion of people receiving ADHD drugs since the onset of COVID-19 in England. Among the five licenced drugs in the UK, methylphenidate (stimulant) was the most prescribed item throughout the years; however, lisdexamfetamine and dexamfetamine showed the most significant upward trends. Regional variations and complex relationships with socioeconomic factors were identified at ICB levels, highlighting the need for tailored ADHD services, support and resource allocation across different regions and ICBs in England. Future research should focus on understanding the long-term effects of increased medication use on patient outcomes and healthcare costs, and investigating the underlying factors contributing to variations between ICBs.

CLINICAL IMPLICATIONS

The findings of this study have significant implications for health policy and clinical practice. The significant rise in ADHD prescriptions across England highlights the urgent need for policies that address both regional and socioeconomic disparities in ADHD care access. Targeted efforts should be made to meet the needs of each region by identifying specific barriers to care and their root causes. Interventions such as reducing stigma, healthcare worker training, and outreach programmes may be beneficial, but these should be informed by a clearer understanding of service gaps, long waiting lists and the need for ethnically diverse and underserved communities. For clinical practice, the rapid increase in drugs like lisdexamfetamine and dexamfetamine calls for clinicians to carefully evaluate the appropriateness of prescribing these medications and consider a patient's unique demographic and socioeconomic context to optimise care and outcomes.

Contributors MUK: writing—original draft (lead), methodology (supporting), conceptualisation (lead), data curation (equal), and formal analysis (lead). SSH: writing—reviewing and editing (lead), conceptualisation (supporting), methodology (lead), data curation (equal), and formal analysis (supporting). MUK is responsible for the overall content [as guarantor].

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests No, there are no competing interests.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available in a public, open access repository. All data used in this study are publicly available. The data supporting this study's findings are available from the NHS study (https://www.nhsbsa.nhs.uk).

ORCID iD

Syed Shahzad Hasan http://orcid.org/0000-0002-4058-2215

REFERENCES

1 Cortese S, Coghill D. Twenty years of research on attention-deficit/hyperactivity disorder (ADHD): looking back, looking forward. *Evid Based Ment Health* 2018;21:173–6.
2 Weiss M. Functional impairment in adhd. In: *Attention deficit hyperactivity disorder in adults and children*. 2015: 42–52.
3 Thomas R, Sanders S, Doust J, *et al*. Prevalence of attention-deficit/hyperactivity disorder: a systematic review and meta-analysis. *Pediatrics* 2015;135:e994–1001.

4 Song P, Zha M, Yang Q, *et al*. The prevalence of adult attention-deficit hyperactivity disorder: A global systematic review and meta-analysis. *J Glob Health* 2021;11:04009.
5 Sayal K, Prasad V, Daley D, *et al*. ADHD in children and young people: prevalence, care pathways, and service provision. *Lancet Psychiatry* 2018;5:175–86: .
6 National Institute for Clinical Excellence (NICE). Attention deficit hyperactivity disorder: diagnosis and management. 2018. Available: https://www.nice.org.uk/guidance/ng87/resources/attention-deficit-hyperactivity-disorder-diagnosis-and-management-pdf-1837699732933 [Accessed 7 Jun 2024].
7 Australasian ADHD Professionals Association (AADPA). Australian evidence-based clinical practice guideline for attention-deficit-hyperactivity/disorder. 2022. Available: https://adhdguideline.aadpa.com.au/about/recommendations-summary/ [Accessed 7 Jun 2024].
8 Canadian ADHD Resource Alliance (CADDRA). Canadian ADHD practice guidelines. 2018. Available: https://adhdlearn.caddra.ca/wp-content/uploads/2022/08/Canadian-ADHD-Practice-Guidelines-4.1-January-6-2021.pdf [Accessed 7 Jun 2024].
9 Cortese S, Adamo N, Del Giovane C, *et al*. Comparative efficacy and tolerability of medications for attention-deficit hyperactivity disorder in children, adolescents, and adults: a systematic review and network meta-analysis. *Lancet Psychiatry* 2018;5:727–38.
10 Mechler K, Banaschewski T, Hohmann S, *et al*. Evidence-based pharmacological treatment options for ADHD in children and adolescents. *Pharmacol Ther* 2022;230:107940.
11 Price A, Ford T, Janssens A, *et al*. Regional analysis of UK primary care prescribing and adult service referrals for young people with attention-deficit hyperactivity disorder. *BJPsych Open* 2020;6:e7.
12 Chan AYL, Ma T-T, Lau WCY, *et al*. Attention-deficit/hyperactivity disorder medication consumption in 64 countries and regions from 2015 to 2019: a longitudinal study. *EClinicalMedicine* 2023;58:101780.
13 Klau J, Bernardo CDO, Gonzalez-Chica DA, *et al*. Trends in prescription of psychotropic medications to children and adolescents in Australian primary care from 2011 to 2018. *Aust N Z J Psychiatry* 2022;56:1477–90.
14 Morkem R, Patten S, Queenan J, *et al*. Recent Trends in the Prescribing of ADHD Medications in Canadian Primary Care. *J Atten Disord* 2020;24:301–8.
15 Grimmsmann T, Himmel W. The 10-year trend in drug prescriptions for attention-deficit/hyperactivity disorder (ADHD) in Germany. *Eur J Clin Pharmacol* 2021;77:107–15.
16 Renoux C, Shin JY, Dell'Aniello S, *et al*. Prescribing trends of attention-deficit hyperactivity disorder (ADHD) medications in UK primary care, 1995-2015. *Br J Clin Pharmacol* 2016;82:858–68.
17 Hasan SS, Bal N, Baker I, *et al*. Adverse Drug Reaction Reporting and Prescribing Trends of Drugs for Attention Deficit Hyperactivity Disorder in Primary Care England, 2010-2019. *J Atten Disord* 2022;26:467–75.
18 Pollard CA, Morran MP, Nestor-Kalinoski AL. The COVID-19 pandemic: a global health crisis. *Physiol Genomics* 2020;52:549–57.
19 Santomauro DF, Mantilla Herrera AM, Shadid J, *et al*. Global prevalence and burden of depressive and anxiety disorders in 204 countries and territories in 2020 due to the COVID-19 pandemic. *The Lancet* 2021;398:1700–12.
20 Brown SM, Doom JR, Lechuga-Peña S, *et al*. Stress and parenting during the global COVID-19 pandemic. *Child Abuse Negl* 2020;110:104699.
21 Yunitri N, Chu H, Kang XL, *et al*. Global prevalence and associated risk factors of posttraumatic stress disorder during COVID-19 pandemic: A meta-analysis. *Int J Nurs Stud* 2022;126:104136.
22 Rogers MA, MacLean J. ADHD Symptoms Increased During the Covid-19 Pandemic: A Meta-Analysis. *J Atten Disord* 2023;27:800–11.
23 Korpa T, Pappa T, Chouliaras G, *et al*. Daily Behaviors, Worries and Emotions in Children and Adolescents with ADHD and Learning Difficulties during the COVID-19 Pandemic. *Children (Basel)* 2021;8:995.
24 Chai G, Xu J, Goyal S, *et al*. Trends in Incident Prescriptions for Behavioral Health Medications in the US, 2018-2022. *JAMA Psychiatry* 2024;81:396–405.
25 Gimbach S, Vogel D, Fried R, *et al*. The impact of the COVID-19 pandemic on ADHD medicine consumption in 47 countries and regions. *Eur Neuropsychopharmacol* 2023;73:24–35.
26 Tu K, Butt D, Kalia S, *et al*. Trends in adhd visits and prescriptions before and during the covid-19 pandemic. *Ann Fam Med* 2023;21:4100.
27 Harris E. WHO Declares End of COVID-19 Global Health Emergency. *JAMA* 2023;329:1817.
28 Hire AJ, Ashcroft DM, Springate DA, *et al*. ADHD in the United Kingdom: Regional and Socioeconomic Variations in Incidence Rates Amongst Children and Adolescents (2004-2013). *J Atten Disord* 2018;22:134–42.
29 Hoang U, James AC, Liyanage H, *et al*. Determinants of inter-practice variation in ADHD diagnosis and stimulant prescribing: cross-sectional database study of a national surveillance network. *BMJ Evid Based Med* 2019;24:155–61.
30 Charles A. Integrated care systems explained. The King's Fund; 2022. Available: https://www.kingsfund.org.uk/insight-and-analysis/long-reads/integrated-care-systems-explained [Accessed 18 Aug 2022].
31 Benchimol EI, Smeeth L, Guttmann A, *et al*. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) statement. *PLoS Med* 2015;12:e1001885.
32 Curtis HJ, Goldacre B. OpenPrescribing: normalised data and software tool to research trends in English NHS primary care prescribing 1998-2016. *BMJ Open* 2018;8:e019921.
33 Walker AJ, Pretis F, Powell-Smith A, *et al*. Variation in responsiveness to warranted behaviour change among NHS clinicians: novel implementation of change detection methods in longitudinal prescribing data. *BMJ* 2019;367:l5205.
34 Curtis HJ, Walker AJ, MacKenna B, *et al*. Prescription of suboptimal statin treatment regimens: a retrospective cohort study of trends and variation in English primary care. *Br J Gen Pract* 2020;70:e525–33.
35 MacKenna B, Curtis HJ, Walker AJ, *et al*. Trends and variation in unsafe prescribing of methotrexate: a cohort study in English NHS primary care. *Br J Gen Pract* 2020;70:e481–8.
36 NHS England. Allocations. 2023. Available: https://www.england.nhs.uk/allocations/ [Accessed 12 Jun 2024].
37 NHS England. Technical guide to allocation formulae and convergence for 2023/24 and 2024/25 allocations. 2024. Available: https://www.england.nhs.uk/wp-content/uploads/2024/03/Allocations-2023-24-Technical-Guide-to-Formulae-v10.0.pdf [Accessed 12 Jun 2024].
38 NHS England. Waterfalls analysis. Change to integrated care board (ICB) core services target allocation. Available: https://www.england.nhs.uk/publication/change-to-icb-core-services-target-allocation-waterfalls/ [Accessed 12 Jun 2024].
39 NHS Digital. Ethnic category coverage. 2024. Available: https://digital.nhs.uk/data-and-information/publications/statistical/mi-ethnic-category-coverage/current [Accessed 12 Jun 2024].
40 Asherson P, Leaver L, Adamou M, *et al*. Mainstreaming adult ADHD into primary care in the UK: guidance, practice, and best practice recommendations. *BMC Psychiatry* 2022;22:640.
41 Singh I. ADHD in the united kingdom. In: *Global perspectives on ADHD: social dimensions of diagnosis and treatment in sixteen countries*. 2017: 97–117.
42 Yeung A, Ng E, Abi-Jaoude E. TikTok and Attention-Deficit/Hyperactivity Disorder: A Cross-Sectional Study of Social Media Content Quality. *Can J Psychiatry* 2022;67:899–906.
43 Boseley M. TikTok accidentally detected my ADHD. For 23 years everyone missed the warning signs. The Guardian; 2021.
44 Starvaggi I, Dierckman C, Lorenzo-Luaces L. Mental health misinformation on social media: Review and future directions. *Curr Opin Psychol* 2024;56:101738.
45 Behrmann JT, Blaabjerg J, Jordansen J, *et al*. Systematic Review: Investigating the Impact of COVID-19 on Mental Health Outcomes of Individuals With ADHD. *J Atten Disord* 2022;26:959–75.
46 Breaux R, Dvorsky MR, Marsh NP, *et al*. Prospective impact of COVID-19 on mental health functioning in adolescents with and without ADHD: protective role of emotion regulation abilities. *J Child Psychol Psychiatry* 2021;62:1132–9.
47 Hollingdale J, Adamo N, Tierney K. Impact of COVID-19 for people living and working with ADHD: A brief review of the literature. *AIMS Public Health* 2021;8:581–97.
48 Raman SR, Man KKC, Bahmanyar S, *et al*. Trends in attention-deficit hyperactivity disorder medication use: a retrospective observational study using population-based databases. *Lancet Psychiatry* 2018;5:824–35.
49 Ilyas S, Moncrieff J. Trends in prescriptions and costs of drugs for mental disorders in England, 1998-2010. *Br J Psychiatry* 2012;200:393–8.
50 Durand-Rivera A, Alatorre-Miguel E, Zambrano-Sánchez E, *et al*. Methylphenidate Efficacy: Immediate versus Extended Release at Short Term in Mexican Children with ADHD Assessed by Conners Scale and EEG. *Neurol Res Int* 2015;2015:207801.
51 Zimovetz EA, Joseph A, Ayyagari R, *et al*. A cost-effectiveness analysis of lisdexamfetamine dimesylate in the treatment of adults with attention-deficit/hyperactivity disorder in the UK. *Eur J Health Econ* 2018;19:21–35.
52 Dunn P, Fraser C, Williamson S, *et al*. Integrated care systems: what do they look like? The Health Foundation; 2022. Available: https://www.health.org.uk/sites/default/files/pdf/2022-07/2022%20-%20ICS%20characteristics_v3.pdf [Accessed 17 Aug 2024].
53 Efron D, Mulraney M, Sciberras E, *et al*. Patterns of long-term ADHD medication use in Australian children. *Arch Dis Child* 2020;105:593–7.
54 Piper BJ, Ogden CL, Simoyan OM, *et al*. Trends in use of prescription stimulants in the United States and Territories, 2006 to 2016. *PLoS One* 2018;13:e0206100.
55 Akmatov MK, Steffen A, Holstiege J, *et al*. Trends and regional variations in the administrative prevalence of attention-deficit/hyperactivity disorder among children and adolescents in Germany. *Sci Rep* 2018;8:17029.
56 Wallach-Kildemoes H, Skovgaard AM, Thielen K, *et al*. Social Adversity and Regional Differences in Prescribing of ADHD Medication for School-Age Children. JDBP 2015;36:330–41.
57 Jablonska B, Kosidou K, Ponce de Leon A, *et al*. Neighborhood Socioeconomic Characteristics and Utilization of ADHD Medication in Schoolchildren: A Population Multilevel Study in Stockholm County. *J Atten Disord* 2020;24:265–76.