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Impact of COVID-19 pandemic on community medication dispensing: a national cohort analysis in Wales, UK

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Abstract

Background
Population-level information on dispensed medication provides insight on the distribution of treated morbidities, particularly if linked to other population-scale data at an individual-level.

Objective
To evaluate the impact of COVID-19 on dispensing patterns of medications.

Methods
Retrospective observational study using population-scale, individual-level dispensing records in Wales, UK. Total dispensed drug items for the population between 1st January 2016 and 31st December 2019 (3-years, pre-COVID-19) were compared to 2020 with follow up until 27th July 2021 (COVID-19 period). We compared trends across all years and British National Formulary (BNF) chapters and highlighted the trends in three major chapters for 2019-21: 1-Cardiovascular system (CVD); 2-Central Nervous System (CNS); 3-Immunological & Vaccine. We developed an interactive dashboard to enable monitoring of changes as the pandemic evolves.

Result
Amongst all BNF chapters, 73,410,543 items were dispensed in 2020 compared to 74,121,180 items in 2019 demonstrating -0.96% relative decrease in 2020. Comparison of monthly patterns showed average difference (D) of $-59{,}220$ and average Relative Change (RC) of -0.74% between the number of dispensed items in 2020 and 2019. Maximum RC was observed in March 2020 (D $= +1{,}224{,}909$ and RC $= +20.62\%$), followed by second peak in June 2020 (D $= +257{,}920$, RC $= +4.50\%$). A third peak was observed in September 2020 (D $= +264{,}138$, RC $= +4.35\%$). Large increases in March 2020 were observed for CVD and CNS medications across all age groups. The Immunological and Vaccine products dropped to very low levels across all age groups and all months (including the March dispensing peak).

Conclusions
Reconfiguration of routine clinical services during COVID-19 led to substantial changes in community pharmacy drug dispensing. This change may contribute to a long-term burden of COVID-19, raising the importance of a comprehensive and timely monitoring of changes for evaluation of the potential impact on clinical care and outcomes.

Keywords
community dispensing; dispensed medication; public health; COVID-19; interactive dispensing dashboard

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Introduction

The novel SARS-CoV-2 coronavirus disease (COVID-19) pandemic resulted in unprecedented changes in health care service provision [1]. While technology has provided an increase in telephone or virtual appointments, there has been an overall net reduction in primary care appointments [2]. An increase in demand for essential medicines coupled with complex medicines supply chain issues, enforcement of social distancing, quarantine, and self-isolation has impacted the prescribing and dispensing of medicines [3, 4].

We searched PubMed central on 27$^{\text{th}}$ August 2021 for articles published in the last year that used two main keywords 'dispensing pattern/trend' and 'prescribing pattern/trend' (supplementary 1). We reviewed the titles and, if required, the abstracts of all 368 articles, and then classified studies into drug-specific (e.g. antibiotics, anti-inflammatory or other drugs) or disease-specific (e.g. heart failure, type 2 diabetes mellitus, upper respiratory tract infection). Two population-scale studies were found, with the most relevant one containing an eight-month follow up into the pandemic. This study looked at the impact of COVID-19 on prescribing of a specific drug using electronic prescribing data for England, and reported a significant rise of inhaled corticosteroid prescriptions at the start of the pandemic [5]. The second study analysed prescribing trends over time across Wales, UK using data primarily collected for financial reimbursement of prescribed medication; however, this study ended prior to the pandemic [6]. Neither of the studies provided comparable pre- and post-pandemic data for multiple drug categories.

Studies using survey and patient data report a change in medication use during the pandemic [5, 7, 8]. Changes in service delivery have been monitored through multiple national audits, which often lag considerably behind the real-time [9, 10]. There is an urgent need to focus appropriate resources on optimisation of medication dispensing monitoring systems, especially in vulnerable patient groups, for example those receiving immunosuppressive drugs [11].

Electronic dispensing records holding information on all dispensed prescriptions in primary care provide a unique opportunity to monitor dispensing trends. These have recently become available to the research community in Wales. We aimed to: 1) measure the general impact of the COVID-19 pandemic on dispensing patterns; 2) create an enhanced national research-ready data asset (RRDA) of all primary care dispensing records for the entire population of Wales for use in research and intelligence; and 3) provide a monitoring platform of real-time trends.

Method

Study design and data sources

We conducted a retrospective observational study, accessing population-scale individual-level community dispensing data using the Secure Anonymised Information Linkage (SAIL) Databank [12, 13]. For the purposes of COVID-19 research and intelligence, the SAIL Databank was granted permission under the Control of Patient Information (COPI) [14] notice to acquire and anonymise the Welsh Dispensing Data Set (WDDS). The WDDS records information on all national health service (NHS) primary care general practitioner (GP) prescribed medications, and associated information, for medications dispensed by community dispensing contractors (community pharmacies, dispensing general practices, general practices that personally administer prescription medication, and dispensing appliance contractors). The data were available on a monthly basis from 2016 to end of July 2021 [15].

The WDDS data are provided to the SAIL Databank by NHS Wales Shared Services Partnership (NWSSP). The data are captured from prescriptions submitted to NWSSP, on a monthly basis, by all primary care dispensing contractors to claim remuneration for dispensing in accordance with the provisions of the National Health Service (Pharmaceutical and Local Pharmaceutical Services) Regulations 2013. The WDDS data are limited to NHS prescriptions containing a 2D matrix barcode; forms with a bar code are only produced by GP clinical systems. The GP system-produced forms account for 98% of total dispensing (remainder from, hand written, hospital outpatient, dental, etc.). Nearly all (97%) of GP system-produced forms are read by scanners. Therefore, the dataset accounts for 94% of all prescriptions dispensed and subsequently submitted for reimbursement. These proportions did not change over the period of the data supplied to this study. Medications for Welsh residents that are dispensed against non-barcoded prescriptions, over the counter or dispensed outside Wales are not included in this data. The WDDS data are made available to SAIL on a monthly basis with approximately a 6-week lag to allow for official reporting and quality assurance processes [13].

Dispensing data from 1$^{\text{st}}$ January 2016 to 31$^{\text{st}}$ December 2019 (counterfactual pre-COVID-19, "C16 cohort") were compared to every year data from 1$^{\text{st}}$ January 2020 and followed up until 27th July 2021 (COVID-19 period, "C20 cohort"). We used two purpose-built residency spine e-cohorts capturing all people who were alive and resident in Wales [16]. As part of the process in creating the residency spine, for each period cases were removed if they died or moved out of Wales at the start of the observation window [16]. Drug dispensing history was retrieved from individual-level linked dispensing records using anonymised linkage fields (ALFs), and the date of dispensing of the medications.

Dispensed items in WDDS are originally coded in Dictionary of Medicines and Devices (DM + D), which we mapped at the code level to their corresponding British National Formulary (BNF) code(s) using a complete extract of mappings from National Health Service Business Services Authority (NHS-BSA) services published in December 2020 [17]. Where the BSA mapping was not available, NHS Terminology Reference-Data Update Distribution (known as TRUD) tables were used to map DM+D codes to seventh character BNF codes [18] (see Supplementary 1 for more details on mapping). We created a semi-automated pipeline to generate, for each monthly extract of the data, an RRDA. The most recent version of documentation is provided in Supplementary 2.

Data were aggregated by month and year for items in each BNF chapter. We compared dispensing rates between the C16 and C20 cohorts for all of the BNF chapters and provide them as part of the interactive dashboard; we also highlight in text

the three major BNF chapters: I) Cardiovascular Systems; II) Central Nervous System; and III) Immunological Products & Vaccines. We calculated age-standardised dispensing rates per 100,000 population. Five-year age bands were used with upper bound of all those aging 90 years or more using the 2013 European Standard Population (ESP) [19]. Dispensing trends were assessed based on total quantity of dispensed items for each BNF chapter per year [20] and the number of patients who have had at least one item dispensed, as documented in their WDDS records.

Statistical analysis

Per person dispensing rates were calculated based on the total number of dispensed items and the total number of patients with a dispensing record on each period. Dispensing rates were calculated for each year. The difference (D) and relative changes (RC) were calculated for comparison of monthly trends in dispensing between 2020 records and 2019. All statistical procedures are performed in R (v3.5) and the code is available at: https://github.com/SwanseaUniversityMedical/WDDS.

Interactive dashboard

We developed an interactive dashboard using R shiny [21] allowing up-to-date dynamic monitoring of trends in the current year, an enables the opportunity for comparison between the most up to date data with previous years' patterns. The dashboard is accessible at https://wdds.ml/.

Results

Cohort curation

3,228,062 patients in the WDDS were included in the two e-cohorts [22]. Of those 3,154,657 (97.7%) had at least one dispensed item (with a total of 393,235,198 dispensed items), were resident in Wales from 2016 onward, and were able to be linked. This comprised 86.2% of Welsh residents. A mapping rate of 99.9% was achieved for mapping all DM+D recorded dispensed items to BNF codes (Figure 1 & Supplementary Figures 1a & 1b).

Drug dispensing trends

We observed a -0.96% relative decrease in total number of dispensed items in 2020 compared to 2019 (73,410,543 vs 74,121,180; 95% CI $[-3.72, 1.80]$). At the same time, the overall rate of dispensed items per person increased from 32.43 items per person in 2019 to 34.00 items per person in 2020, representing a Difference (D) of $+1.57$ and a Relative Change (RC) of 4.8% (Table 1.a).

Comparison of monthly patterns of dispensed items between 2020 and 2019 showed a notable difference between the total number of dispensed drug items each month, with an average monthly difference of $-59{,}220$ and an average RC of -0.74%. In the first two months of 2020, total number of dispensed items were approximately the same as expected numbers in 2019 (average D $= -11{,}801$, average RC $= -0.19\%$).

In March 2020, following lockdown restrictions the total number of dispensed items was 20.62% higher than 2019 (D $= +1{,}224{,}909$, RC $= +20.62\%$). Following the March peak, number of dispensed items in April and May 2020 were lower compared to the same months in 2019 with a 5.34% relative decrease in April (D $= -338{,}715$, RC $= -5.34\%$) followed by the biggest observed fall in May 2020, where the total number of dispensed items was 11.34% lower than in May 2019 (D $= -726{,}065$, RC $= -11.34$).

The second peak in the total number of monthly dispensed items was observed in June 2020 (D $= +257{,}920$, RC $=$

Figure 1: CONSORT of cohort extraction and number of matched mapped DM + D codes to BNF

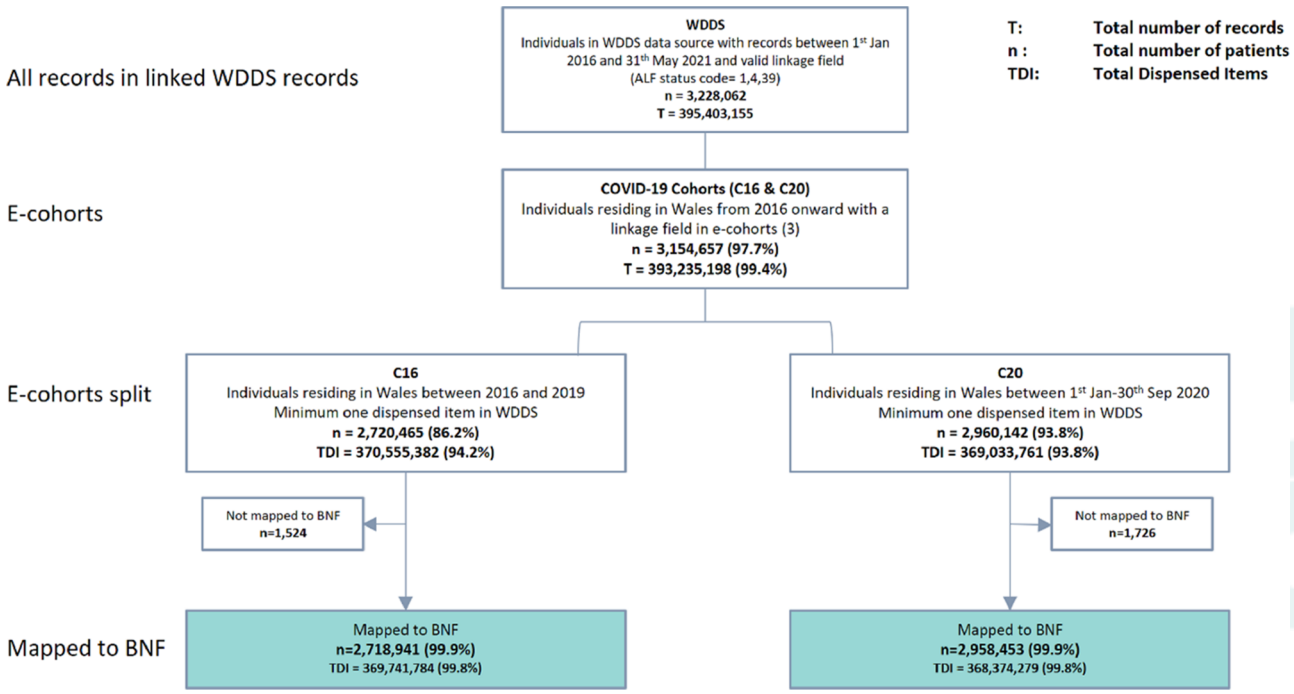


Figure 2: Total number of dispensed items per month of the year and relative changes – in 2020 & 2021 vs 2019

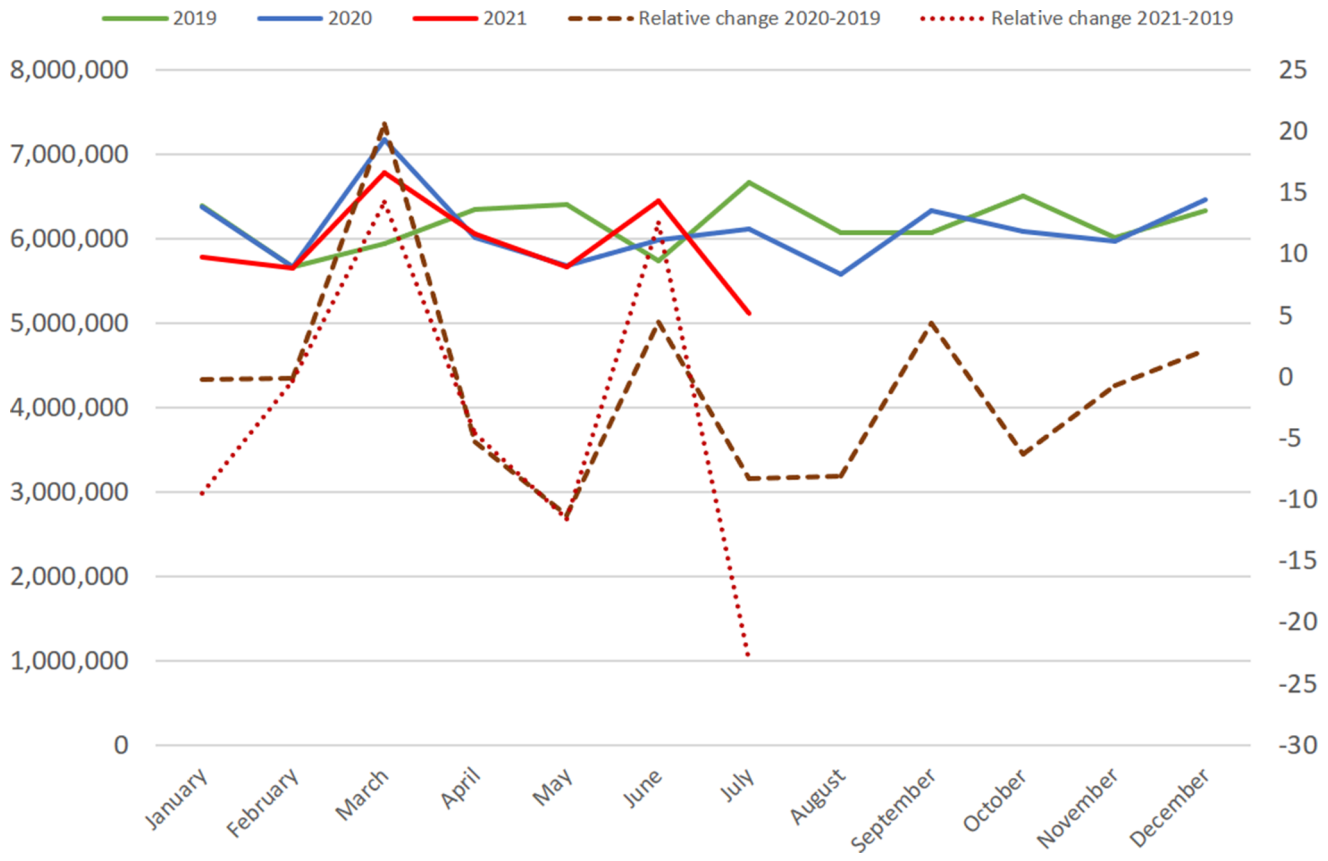


Table 1.a: Number of dispensed items per year

Year	Number of dispensed items	Number of patients with a dispensed record	Dispensed Rate per person
2021	* 41,498,339	* 1,939,714	* 21.39
2020	73,410,543	2,159,425	34.00
2019	74,121,180	2,285,658	32.43
2018	71,966,717	2,277,964	31.59
2017	67,603,413	2,274,791	29.72
2016	64,635,006	2,283,701	28.30

*numbers and rates until 27$^{\text{th}}$ July 2021

+4.50%). Although the number of dispensed items increased in June, similar to the March peak this was also followed by a further reduction in total number of dispensed items in subsequent months with an average of −8.22% lower dispensing in July and August 2020 compared to the same periods in 2019 (average D = −523,554, average RC = −8.22).

A third peak representing a 4.35 % greater number of dispensed items was observed in September 2020 compared to September 2019 (D = +264,138, RC = +4.35) which similarly was followed by a fall in total number of dispensed items in the October 2020 compared to October 2019 (D = −412,452, RC = −6.35%).

Similar to trends at the start of 2020, we observed minimal difference in the total number of dispensed items in November 2020 compared to November 2019 (D = −44,710, RC = −0.74), this was followed by a 2.13% relative increase in December 2020 compared to 2019 (D = +135,048, RC = +2.13%). This December increase followed by a −9.51% relative decrease in January 2021 (D = −607,836, RC = −9.51%) and the trend was upward until a peak in March 2021 (D = +842,447, RC = +14.18%) which was similar but smaller than the 2020 peak. This was followed by a (again, similar) decreased total number of dispensed items in April and May 2021 and then an even greater peak in June 2021 than observed in 2020 (D = +717,496, RC = +12.52%) (Table 1.b & Figure 2).

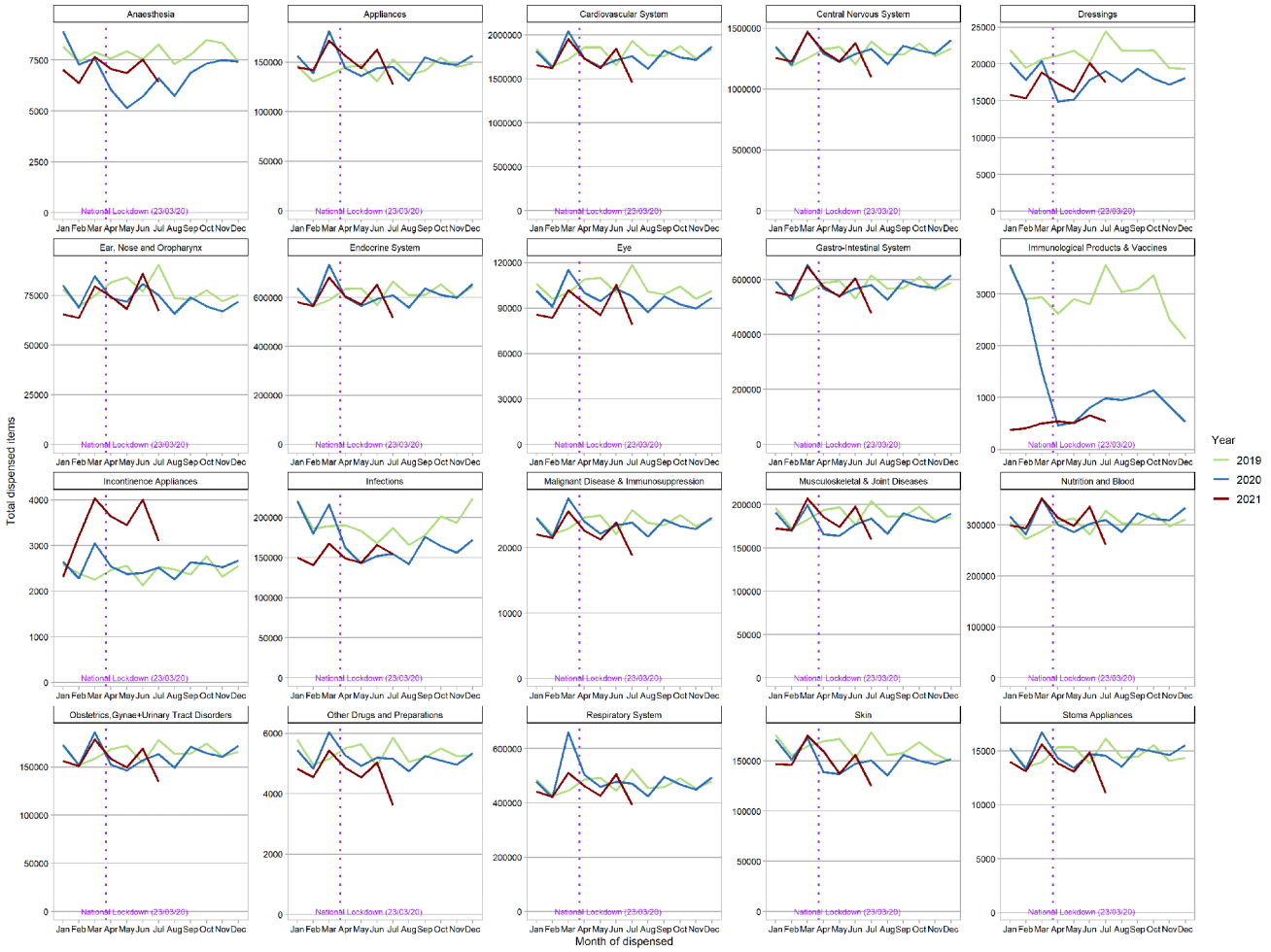
The observed increase in March 2020 was consistent for items in the majority of BNF chapters, except for items in the Anaesthesia and the Immunological products & Vaccines products. The total number of dispensed Anaesthetic products in March 2020 was consistent with March 2019 and the Immunological products & Vaccines were significantly lower in

Table 1.b: Number of dispensed items per month of the year

Month	Number of dispensed items 2019	Number of dispensed items 2020	Number of dispensed items 2021	Difference $(D_{2020}) * (n_{2020} - n_{2019})$	Relative Change% (RC)$*$ (D_{2020}/n_{2019})	Difference $(D_{2021}) * (n_{2021} - n_{2019})$	Relative Change% (RC)$*$ (D_{2021}/n_{2019})
January	6,393,077	6,377,687	5,785,251	−15,390	−0.24	−607,826	−9.51
February	5,665,736	5,657,524	5,645,095	−8,212	−0.14	−20,641	−0.36
March	5,940,887	7,165,796	6,783,334	1,224,909	20.62	842,447	14.18
April	6,349,153	6,010,438	6,053,215	−338,715	−5.34	−295,938	−4.66
May	6,404,268	5,678,203	5,663,819	−726,065	−11.34	−740,449	−11.56
June	5,730,026	5,987,946	6,447,522	257,920	4.50	717,496	12.52
July	6,661,809	6,109,081	5,120,103	−552,728	−8.30	−1,541,706	−23.14
August	6,065,380	5,571,000		−494,380	−8.15		
September	6,068,666	6,332,804		264,138	4.35		
October	6,500,323	6,087,871		−412,452	−6.35		
November	6,012,412	5,967,702		−44,710	−0.74		
December	6,329,443	6,464,491		135,048	2.13		

*Signs indicate direction of change in 2020 compared to 2019

Figure 3: Number of dispensed items per BNF chapter per month – in 2020 & 2021 vs 2019 (numbers of each chapter are individually scaled)



March 2020 compared to March 2019 and stayed on the same low level during 2021. This differed from the overall patterns (Figure 3). For dynamic comparisons of all years, please see Supplementary Figures 2.1 to 2.3 or visit our online dashboard at http://wdds.ml/).

Trends of drug dispensing rates in three selected major BNF sections over years

Using European age-standardised dispensing rates, we focused on the comparison between 2020 and 2021 versus 2019 for

Figure 4: Age-standardised dispensing rates for *cardiovascular system* in per 100,000 pop'n per year and month for 2020 & 2021 vs 2019

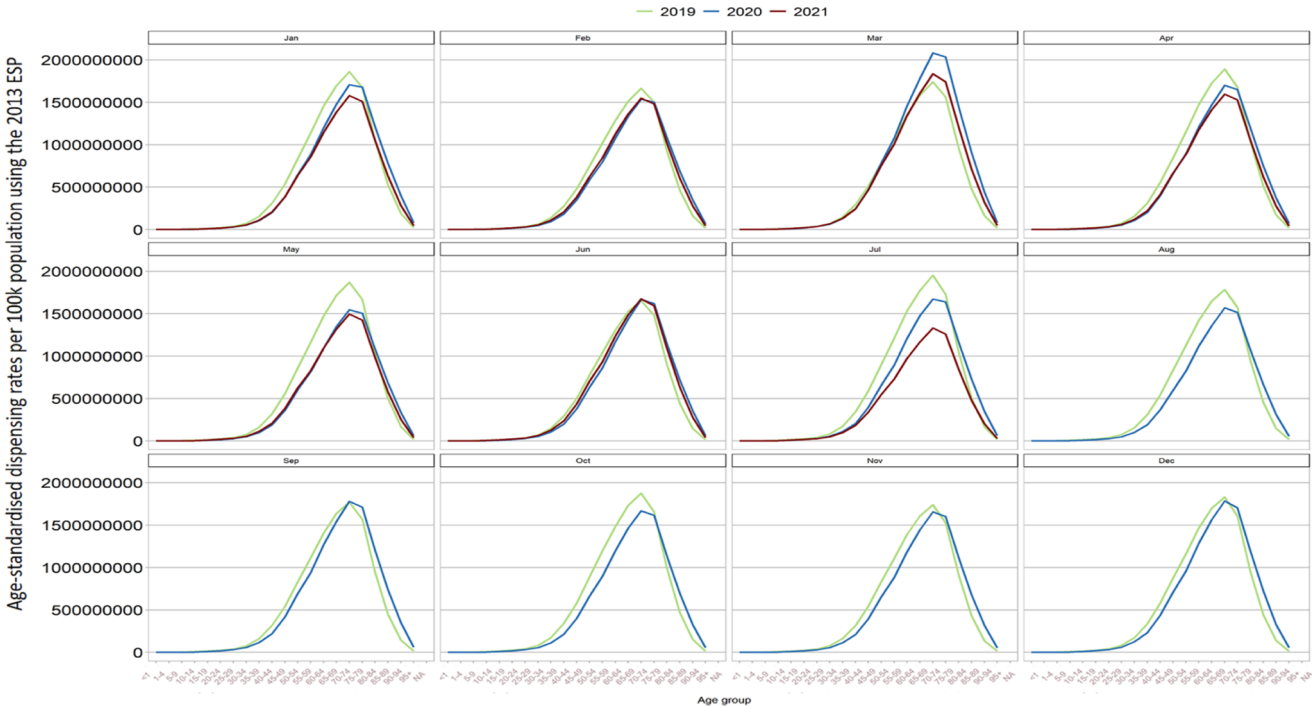
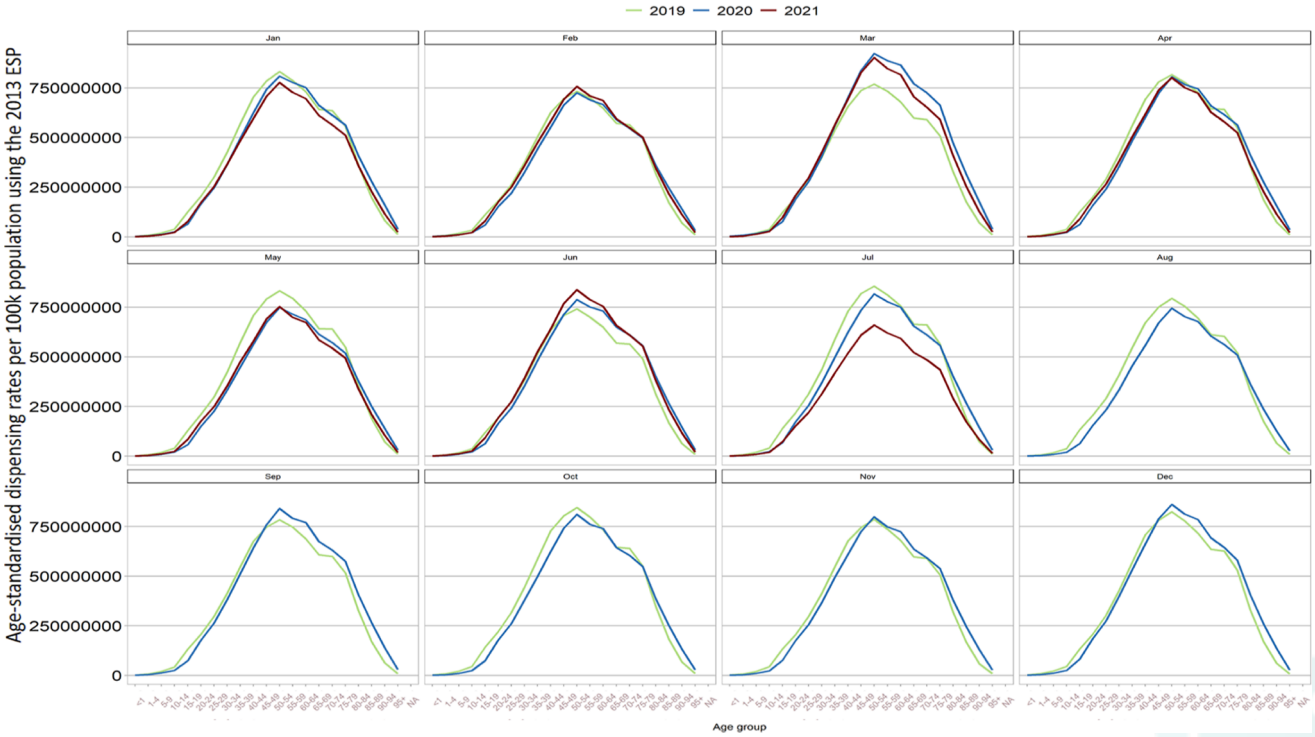


Figure 5: Age-standardised dispensing rates for *Central Nervous System* in per 100,000 pop'n per year and month for 2020 & 2021 vs 2019

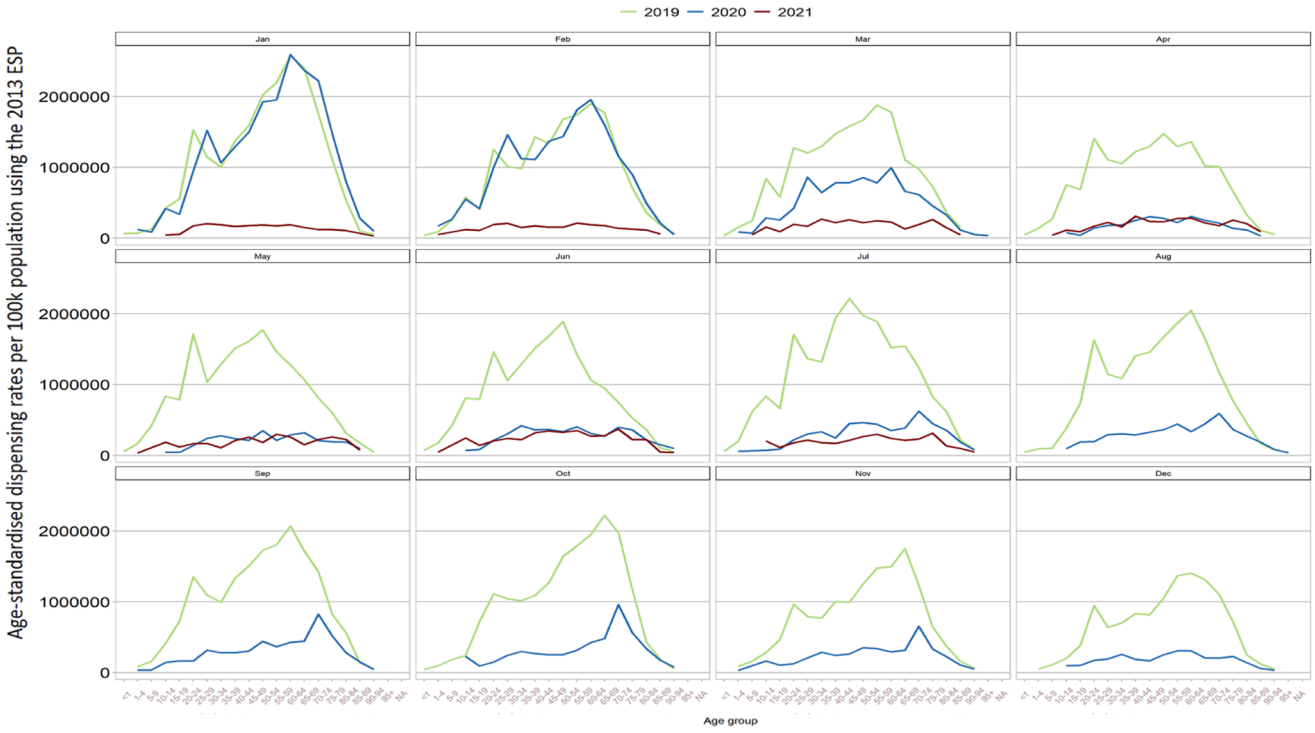


dispensing in Cardiovascular Systems (CVS), Central Nervous Systems (CNS) and Immunological Products and Vaccines (IPV) chapters. All three groups showed similar trends between the years for January and February.

For CVS, dispensing increased considerably during March 2020, followed by a reduction in April and May, recovery to 2019 levels in June, a drop in July and August, and recovery again in September 2020 (Figure 4 – Supplementary Figure 3.1).

For CNS dispensing, the March 2020 peak was observed, followed by a reduction in May followed by a notable reduction at the end of the 2020 in November and December compared to 2019 (Figure 5 – Supplementary Figure 3.2).

Figure 6: Age-standardised dispensing rates for *Immunological Products & Vaccines* in per 100,000 pop'n per year and month for 2020 & 2021 vs 2019



For IPV, although the 2020 dispensing patterns for January and February mirrored 2019 levels, for all other months (and across all age groups), there was a large decline in 2020 that continued in 2021 (Figure 6 – Supplementary Figure 3.3).

Discussion

Summary of findings

Community dispensed medication provides a direct insight into healthcare delivery and service utilisation. Monitoring of trends in dispensed drug items under classified drug categories can also provide a proxy into communities' health and existing comorbidities. This assimilation of national dispensing data in Wales resulted in the construction, curation and ongoing maintenance of a linkable RRDA. This can be used for near real-time monitoring of dispensing trends in Wales as well as facilitating the current and future research and intelligence outputs around COVID-19 within the SAIL Databank, and longer-term, pending governance approvals for wider non-COVID-19 use. The RRDA is accompanied with sufficient metadata allowing researchers, analysts and other users comprehensive access to research resources when using the dispensing data. We have specifically initiated the development of a harmonised approach to establish a federated analysis process across multiple trusted research environments. Our dashboard was developed and updated each month for this comparative analysis using aggregated level data, to enable timely monitoring of dispensing trends over time as the care system adapts to the evolving challenges of the pandemic.

Our data show a small relative decrease of 1% in total number of dispensed drug items in 2020 compared to 2019 despite the huge impact of COVID-19 on attendances. We show in detail, across all BNF chapters, changes in patterns of drugs dispensed during the COVID-19 period. In general, the peak in the total number of dispensed items coincided with the first UK and Wales national lockdown starting from 23 March 2020 (See supplementary Figure 4 for timeline of lockdowns in Wales-UK), during the first peak of the pandemic in March 2020. We observed a dramatic reduction in the dispensing of Immunological Products & Vaccines at the start of lockdown in the COVID-19 period. While routinely dispensed vaccines in pharmacies are mainly related to travel - such as yellow fever and rabies, the demand for these naturally been reduced during the COVID-19 period. Similarly, obtaining vaccines from pharmacies through practice nurses prior to house visits may have been less frequent during COVID-19 lockdown periods (See supplementary Figure 4 for timeline of lockdowns in Wales-UK). The current COVID-19 pandemic has interrupted routine immunisation pathways and led to dramatic shifts in the dispensing of Immunological Products & Vaccines [19, 20].

While our observation matches what has been reported in other studies such as Kaye et al. [7]; the increase of dispensed items in March cannot be considered to reflect better adherence, but more likely reflects a planned change in service delivery procedures in the context of the COVID-19 contact mitigation measures taken to reduce transmission across communities.

These peaks could also be explained by stockpiling prescriptions or filling prescriptions claimed. Although there is very limited other UK evidence, this pheonomenon has been evident elsewhere [23]. Our data showed that this peak occurred in most drug categories and was followed by a dip in the following two months (lockdown period), suggestive of batch-dispensing in preparation for the national lockdowns in March 2020 (See supplementary Figure 4 for timeline of

lockdowns in Wales-UK). It is also possible that patients had spare prescriptions to hand and felt a sense of urgency to get them dispensed.

Interestingly, we observed similar monthly trends during 2021 (up to the last data extract available to the study). Given that there was no additional lockdowns in Wales in 2021 (supplementary Figure 4), observing similar trends in dispensing peaks in March and June of 2020 and 2021indicates a persistent change in community dispensing practices beyond the first year of the pandemic.

Strengths and limitations

The population-scale individual-level data used in our study are available as a monthly extract to SAIL Databank; this provides the opportunity to use aggregated level data for monitoring trends in near real-time, as well as exploring the effect of individual-level factors such as age, sex, socioeconomic status and ethnicity. We acknowledge the known difference between prescribing and dispensing and accounting for dosage and duration of dispensed medication. We nonetheless believe that providing an easy to analyse platform for monitoring monthly trends of dispensing data provides a unique opportunity not only to monitor and evaluate prescribing and dispensing trends in near real-time, but also to explore the effect of changing treatment patterns on outcomes considering a comprehensive selection of patient-level factors. Our study developed a linked dispensing dataset which mapped DM+D codes to the BNF codes and chapters. This provides many further opportunities to investigate trends within each drug category, as well as wider collaboration across harmonised data sources. While our study demonstrates changes in dispending behaviour, our ability to identify whether these observed changes were due to prescribers' dispensing behaviour or other public health interventions such as programs aiming to increase adherence to medications or appropriate prescribing is limited.

Conclusion

Dispensing patterns can be used as a proxy measure for monitoring community and population-level effects of COVID-19 on healthcare services. This provides a unique and transparent system for continuous monitoring of drug prescribing and dispensing, offering an unprecedented opportunity to evaluate the clinical and health impacts of changes in treatment patterns. Such an approach has the potential to identify areas of unmet clinical need, the requirement for and impact of care quality improvement programmes, and novel insights into disease management.

Acknowledgments

This study makes use of anonymised data held in the Secure Anonymised Information Linkage (SAIL) Databank. This work uses data provided by patients and collected by the NHS as part of their care and support. We would also like to acknowledge all data providers who make anonymised data available for research. We wish to acknowledge the collaborative partnership that enabled acquisition and access to the de-identified data, which led to this output. The collaboration was led by the Swansea University Health Data Research UK team under the direction of the Welsh Government Technical Advisory Cell (TAC) and includes the following groups and organisations: the SAIL Databank, Administrative Data Research (ADR) Wales, Digital Health and Care Wales (DHCW), Public Health Wales, NHS Shared Services Partnership (NWSSP) and the Welsh Ambulance Service Trust (WAST). All research conducted has been completed under the permission and approval of the SAIL independent Information Governance Review Panel (IGRP) project number 0911.

Statement on conflicts of interest

The author(s) declare(s) that they have no competing interests.

Ethics Statement

The data used in this study are pseudonymised patient data and hence we did not required ethical approval. Data was accessed from the SAIL Databank (https://saildatabank.com/) at Swansea University, Swansea, UK. All proposals to use SAIL data are subject to review by an independent Information Governance Review Panel (IGRP). Before any data can be accessed, approval must be given by the IGRP. The IGRP gives careful consideration to each project to ensure proper and appropriate use of SAIL data which covers informed consent of participants where applicable. When access has been approved, it is gained through a privacy-protecting safe haven and remote access system referred to as the SAIL Gateway. SAIL has established an application process to be followed by anyone who would like to access data via SAIL https://www.saildatabank.com/application-process.

Availability of data and materials

The aggregated data generated in this study are available for download from our website: https://wdds.ml/ with other materials such as code being accessible from repository at: https://github.com/SwanseaUniversityMedical/concept-library.

The main individual-level data sources used in this study are available in the SAIL Databank at Swansea University, Swansea, UK, but as restrictions apply they are not publicly available. All proposals to use SAIL data are subject to review by an independent Information Governance Review Panel (IGRP) which includes members of the public and external experts in data security. Before any data can be accessed, approval must be given by the IGRP. The IGRP gives careful consideration to each project to ensure proper and appropriate use of SAIL data. When access has been granted, it is gained through a privacy protecting safe haven and remote access system referred to as the SAIL Gateway. SAIL has established an application process to be followed by accredited bona fide researchers to access data for approved research purposes at https://www.saildatabank.com/application-process/

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Authors' contributions

FT and AA contributed to all of the steps of the design, implementation, analysis and writing of the manuscript from inception. AA developed the proposal and the main conceptual idea. FT, LN and AA contributed to development and finalisation of mapping algorithm. FT designed, implemented, conduct the analysis and deployed the online tool. FT and AA jointly developed the first draft of the manuscript. RAL, MG, JH and DH conceived and designed the analysis. FT, AA, LN, DH, GD, MG, RG, JL, NJ, AM, JH and RAL have discussed, reviewed and contributed to the final manuscript.

Public and patient involvement

This project is undertaken under a proposal which has been submitted to the independent Information Governance Review Panel (IGRP) that includes members of the public (IGRP Project: 0911). Two members of the public are contributing to the scientific steering group of IGRP panel. The need for expedited analysis of these data in response to COVID-19 redirected our main focus to the research and the nature of anonymised patient data isolates the researcher from direct contact with patients involved in the study; however, the development of our online visualisation tool was intended for a lay audience. We are also intending to work closely with SAIL consumer panel group who are facilitating patient and public engagement through providing a platform for research to be presented and reviewed by members of public.

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Abbreviations

BNF:	British National Formulary
C16:	Electronic cohort for period of 2016-2019 (3)
C20:	Electronic cohort for 2020
CNS:	Central Nervous Systems
CVS:	Cardiovascular Systems
D:	Difference
DM + D:	Dictionary of medicines and devices
IVP:	Immunological Products and Vaccines
NHS BSA:	NHS Business Services Authority
NHS TRUD:	Terminology Reference-Data Update Distribution
Pop'n:	Population
RC:	Relative Change
RRDA:	Research Ready Data Asset
TDI:	Total Dispensed Items
WDDS:	Welsh Dispensing Data Set

Supplementary 1

PubMed full search details:

1. dispensing pattern[All Fields] OR prescribing pattern[All Fields] AND ("2020/01/01" [PubDate] : "2021/08/29" [PubDate])

2. prescribing trend[All Fields] AND ("2020/01/01" [PubDate] : "2021/08/29"[PubDate])

Date of search: 27th August 2021

1. Articles retrieved 324

2. Articles retrieved 42

Supplementary 2: Metadata of RRDA_WDDS

The aim of this document is to provide meta-data descriptions for the variables / columns found in the Research Ready Data Asset (RRDA) found in the RRDA_WDDS.

These are a combination of the original variables / columns found in the WDDS data source, as well as additional variables / columns generated as part of the creation of the RRDA_WDDS.

Note: for information on the original WDDS data please see the HDR innovation gateway on (https://web.www.healthdatagateway.org/dataset/50ef6443-ed4b-40f9-97fb-1cfd53be6579), the current official source of meta-data and documentation for data sources in the SAIL Databank.

Technical document: Research Ready Data Asset of Welsh Dispensing DataSet (RRDA-WDDS)

We provide here a summary of reproducible code to generate a RRDA for the Welsh Dispensing Dataset (WDDS). The main purpose for creating RRDA version of WDDS was to reach a BNF-mapped linkable version of the data tables from 2016 onward following each update of the underlying WDDS data. The main tables used in generation of RRDA views are: **SAIL0911V.WDDS_DISPENSING** | **SAIL0911V.WDDS_DISPENSING_ALF**. We have also used SNOMED to BNF mapping tables from SAILUKHDV schema as well as those published by NHS Business Analysis Service (BSA).

Main resources and code syntax

Please note that any previous date versioning should be replaced by the most recent coverage of the data in the code to protect loss of previous versions of tables. For required updates in code search 'Update'

SNOMED(DM+D) to BNF codes

The main data is coded in SNOMED Drugs Medications + Dimensions(DM+D) codes. Reference data published by NHS BSA were used to map these into the BNF codes. You are required to check and compare the date of latest release to existing reference tables in SAIL and import new ones if published.

The updated files need to be stored in *BNF mapping* folder in a csv format and use one of the pre-versions to harmonised column names (copy and paste column names across to the new csv file). The file can then be imported using 00.a.import_ref_tables followed by creating 01a & 01b

Variable/Column name	Variable/Column description	In original WDDS (1)	RRDA (2)
ALF_PE	Anonymised Linkage Field	1	
DT_PRESCRIBED	Date of prescription as appears on the prescription note	1	
PRAC_CD_E	Encrypted General Practice code	1	
DMDCODE_PRESCRIBED	DM + D or SNOMED code of prescribed drugs	1	
PRODUCT_PRESCRIBED	DM + D or SNOMED Description: name and dosage of drugs	1	
QTY_PRESCRIBED	Quantity prescribed	1	
QTY_PRESCRIBED_VAL	Quantity prescribed as a volume	1	
QTY_UOM_CODE	Quantity Unit of Measurement (UOM) code	1	
MONTH_DISPENSED	Month of dispensing	1	
DISPENSER_ID	ID code of dispenser pharmacy	1	
FORM_NO	Form number	1	
DMD_CD_WDDS	DM+D or SNOMED code of prescribed drugs	2	
BNF_COMBINED	Mapped BNF codes	2	
BNF_COMBINED_DESC	Description of BNF codes	2	
The following fields are presented to enable checks on quality of mapping			
DMD_CD_BSA	DM + D codes existing in BSA resource	2	
DMD_DESC_BSA	Description of the codes from BSA resource	2	
DMD_DESC_UKHDV	Description of DM + D codes from UKHDV schema	2	
BNF_NAME_BSA	Description of BNF codes from BSA resource	2	
BNF_UKHDV	BNF codes from UKHDV schema-7 character	2	
BNF_UPDATED_UKHDV	Edited version of BNF codes from UKHDV	2	
BNF_SUBPARAGRAPH	Description of 7 character BNF codes	2	
WDDS data info field			
AVAIL_FROM_DT	Available from date of WDDS	1	

for creation of single and merged reference tables used in each extract.

Note: 01b code is holding the most recent version of RRDA_REF mapping table and is the latest version of codes used in 01a to generate dated version of merged mapping tables; therefore please ensure any essential updates from 01a is carried over into insert section of 01b script (the creation of table script will stay unchanged).

Short data summary

The most recent version of RRDA_WDDS table, has a coverage range of 2016-01-01 up to 2021-07-27; holding dispensing records of 3,228,092 individuals with 30,103 dispensed drug items coded in DM+D snomed codes which were mapped to 29,479 BNF codes.

The single reference tables imported from BSA: some months gets published as one view the dates refers to latest coverage

	RRDA_WDDS_REF_BNF_SNOMED_
View name	**Coverage of data**
_202008	August 2020
_202010	October 2020
_202011	November 2020
_202012	December 2020
_202101	January 2021
_202104	April 2021
_202105	May 2021
_202106	June 2021
_202107	July 2021
_202108	August 2021

The merged reference tables are used to generate RRDAs

	RRDA_WDDS_REF_BNF_SNOMED_MERGED_
View name	**Coverage of data**
_20201230	30th December 2020
_20210101	1st January 2021
_20210531	31st May 2021
_20210630	30th June 2021
_20210831	31st August 2021

RRDA tables

Following each updated extract of the data, the codes in 02a & 02b can be used to create versioned and undated RRDAs. All versions of RRDA's are preserved to support reproducibility of research using older versions; therefore please run any drop statement with extra cautious and checks in advance and if unsure prior to any actions please contact: fatemeh.torabi@swansea.ac.uk.

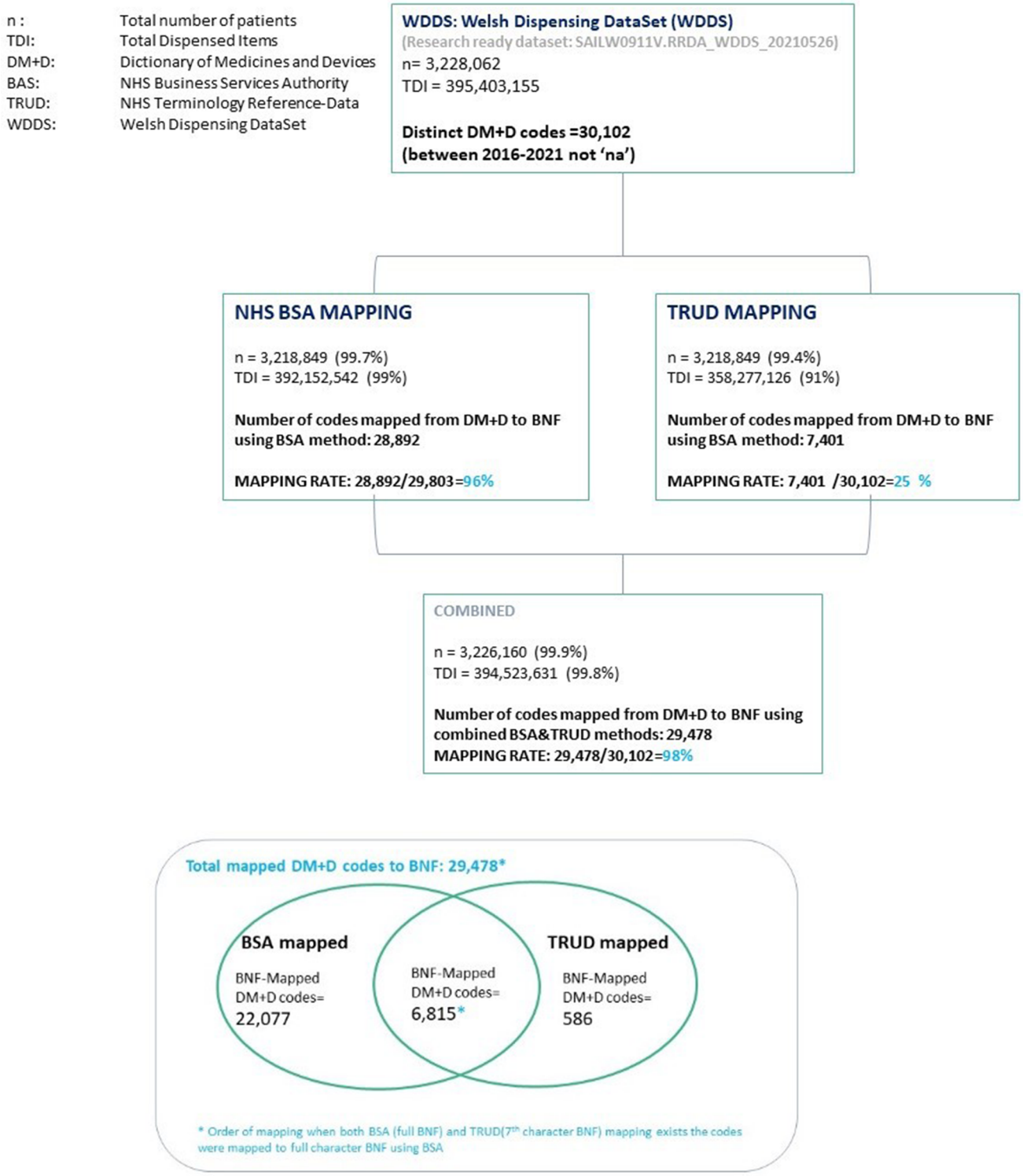
Note: as the insert to the WDDS mapped linked tables were broken down, following updates of coverage, please review the last lines of insert statements to ensure additional coverage are included.

avail_from_dt = 2021-09-14
max_coverage_no_rule=2021-08-31
coverage-70%-rule=2021-07-27

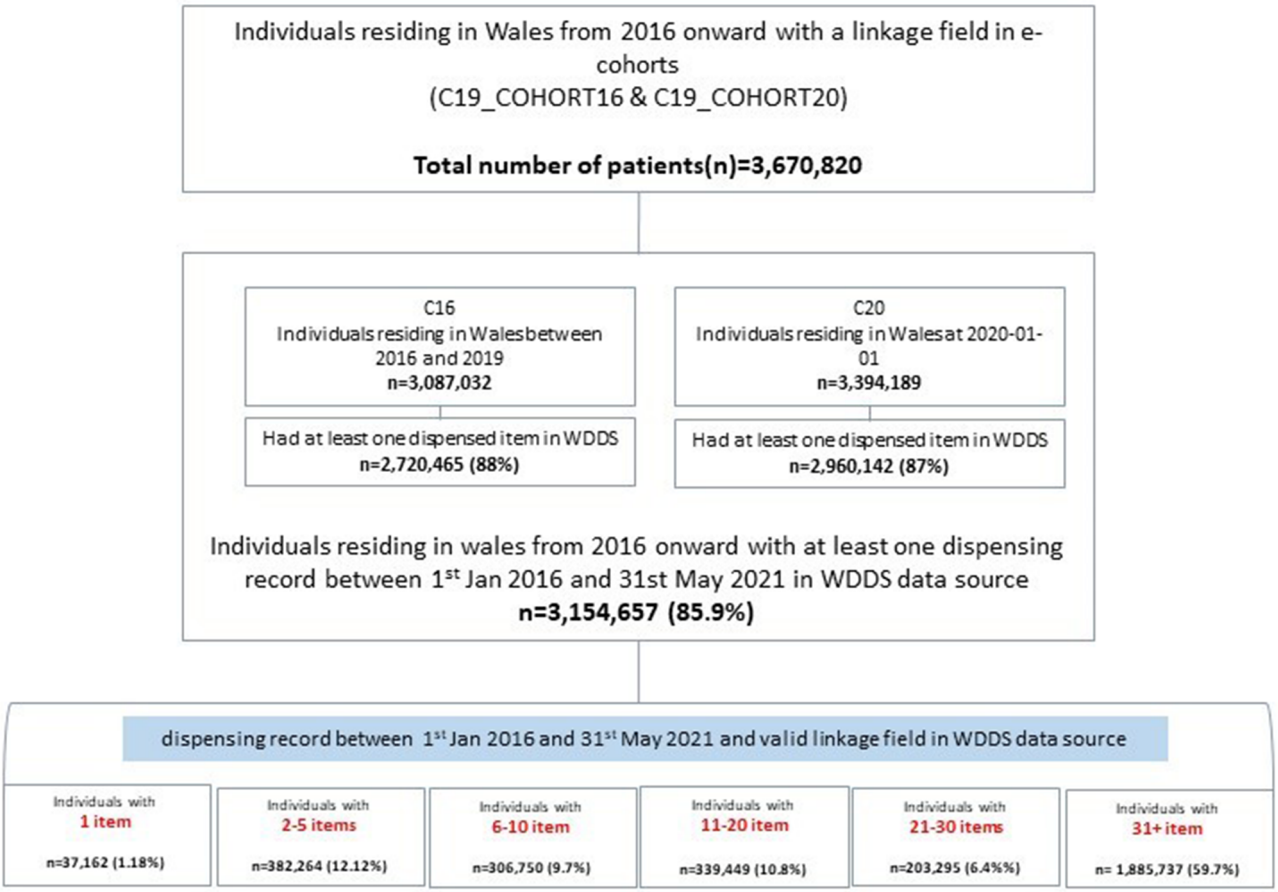
Please see the 'RRDA_WDDS-Meta-data' file for full description of columns in the table.description of columns in the table.

	RRDA_WDDS_
View name	**Coverage of data**
_20210223	23rd February 2021
_20210326	26th March 2021
_20210427	27th April 2021
_20210526	26th May 2021
_20210624	24th June 2021
_20210727	27th July 2021

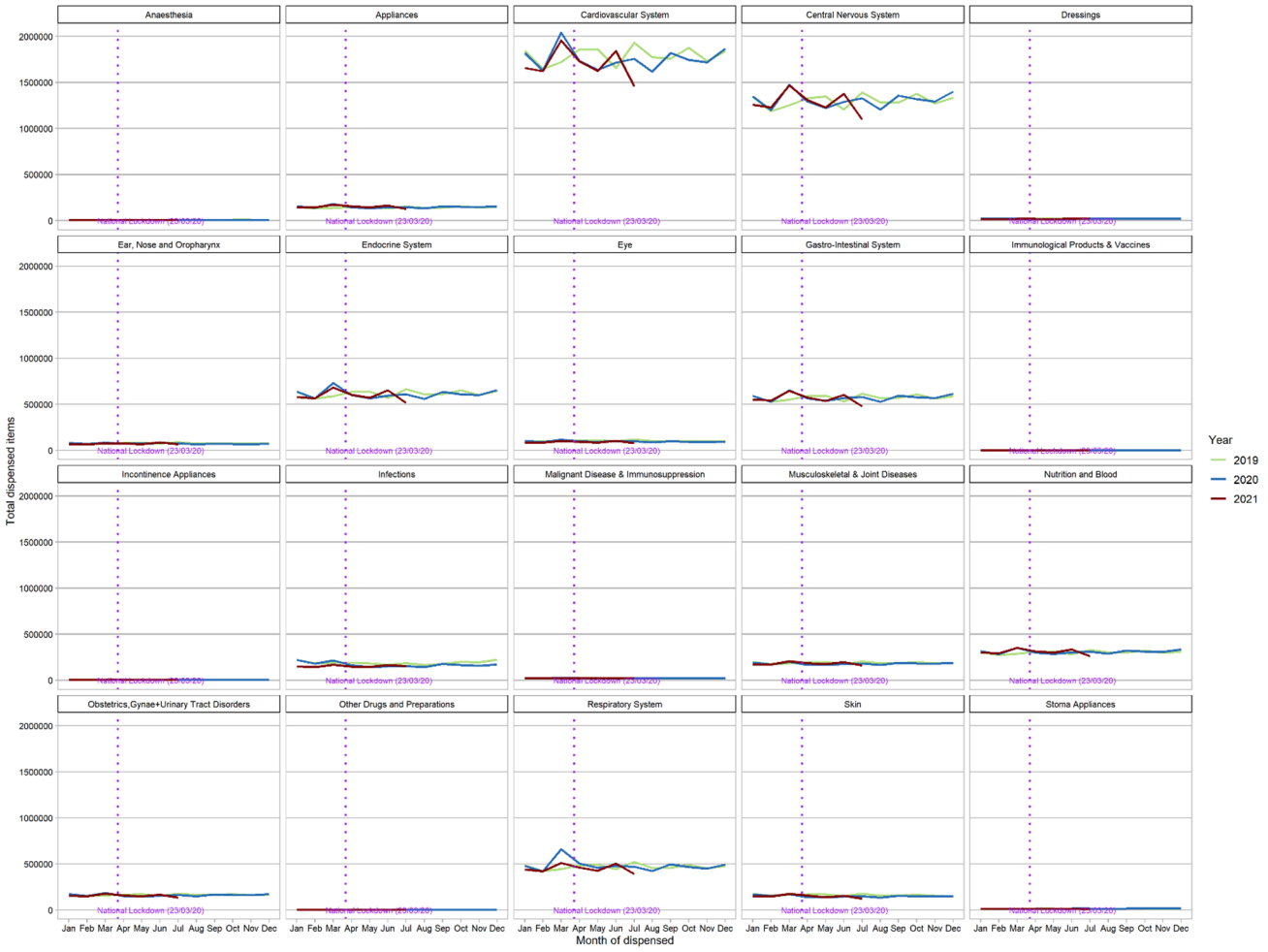
Supplementary Figure 1a: Mapping of DM + D codes from WDDS to BNF codes



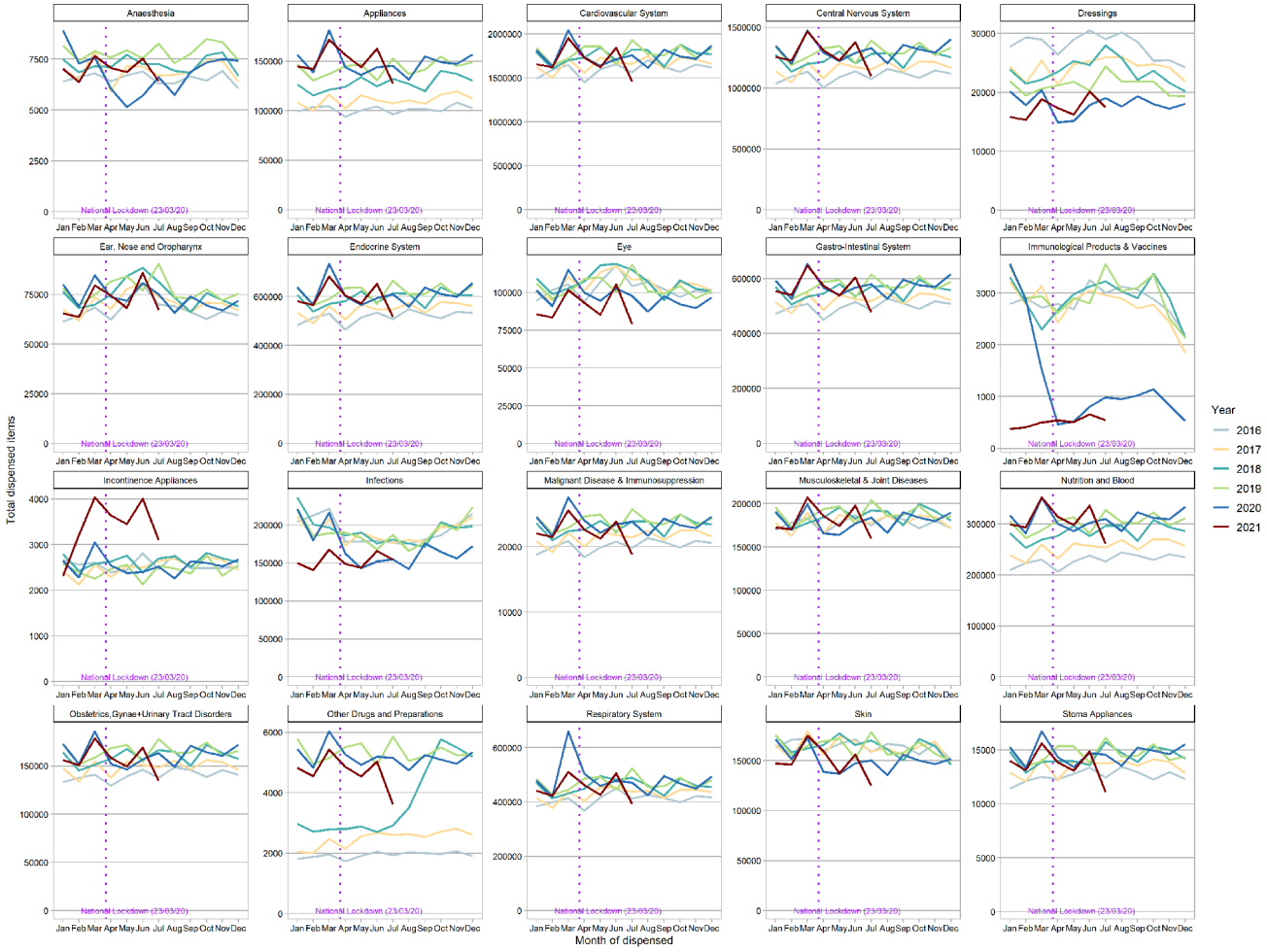
Supplementary Figure 1b: Number of dispensed items for individuals residing in Wales and linked to WDDS



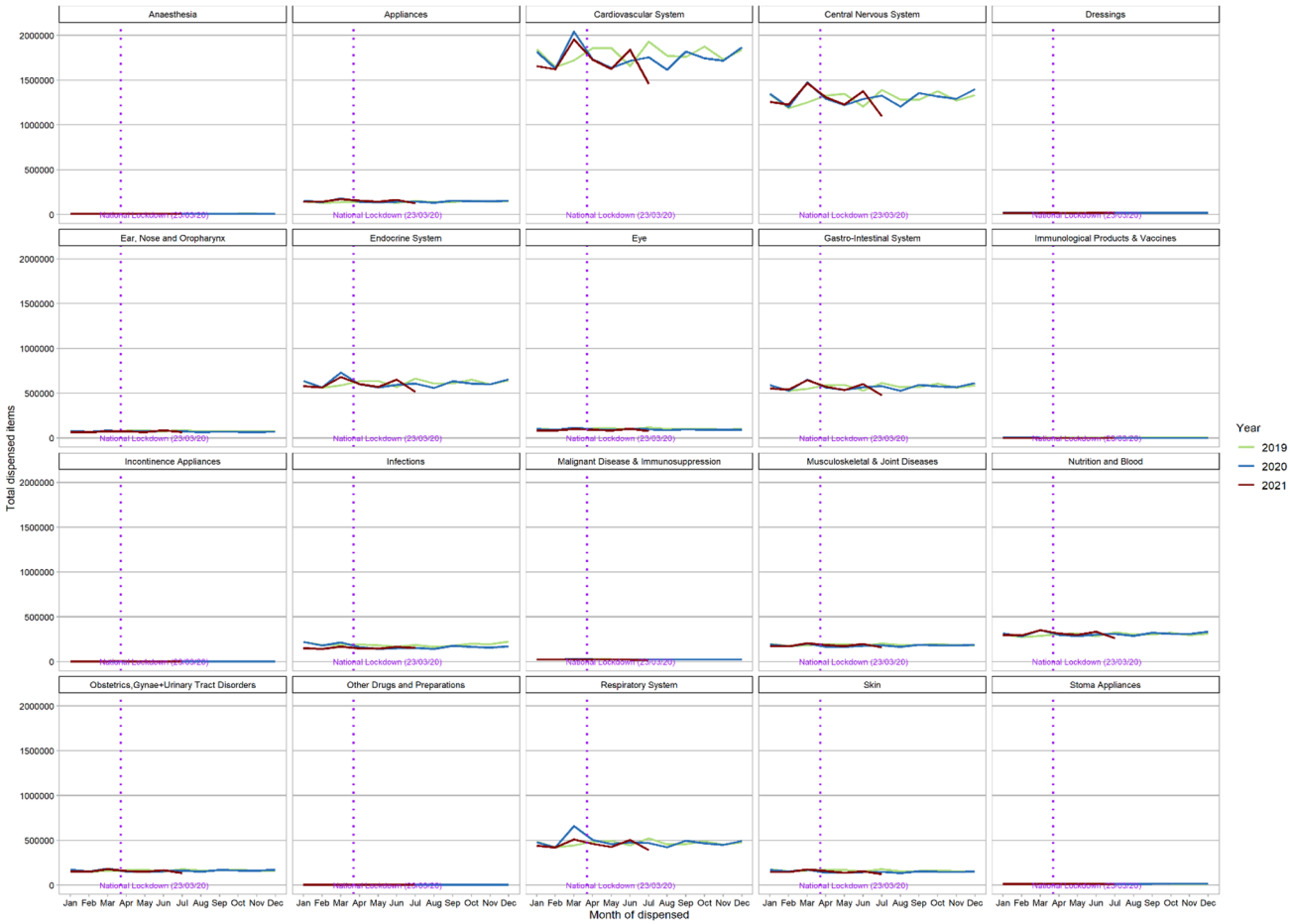
Supplementary Figure 2.1: Number of dispensed items per BNF chapter-2020-21 vs 2019 harmonised scale



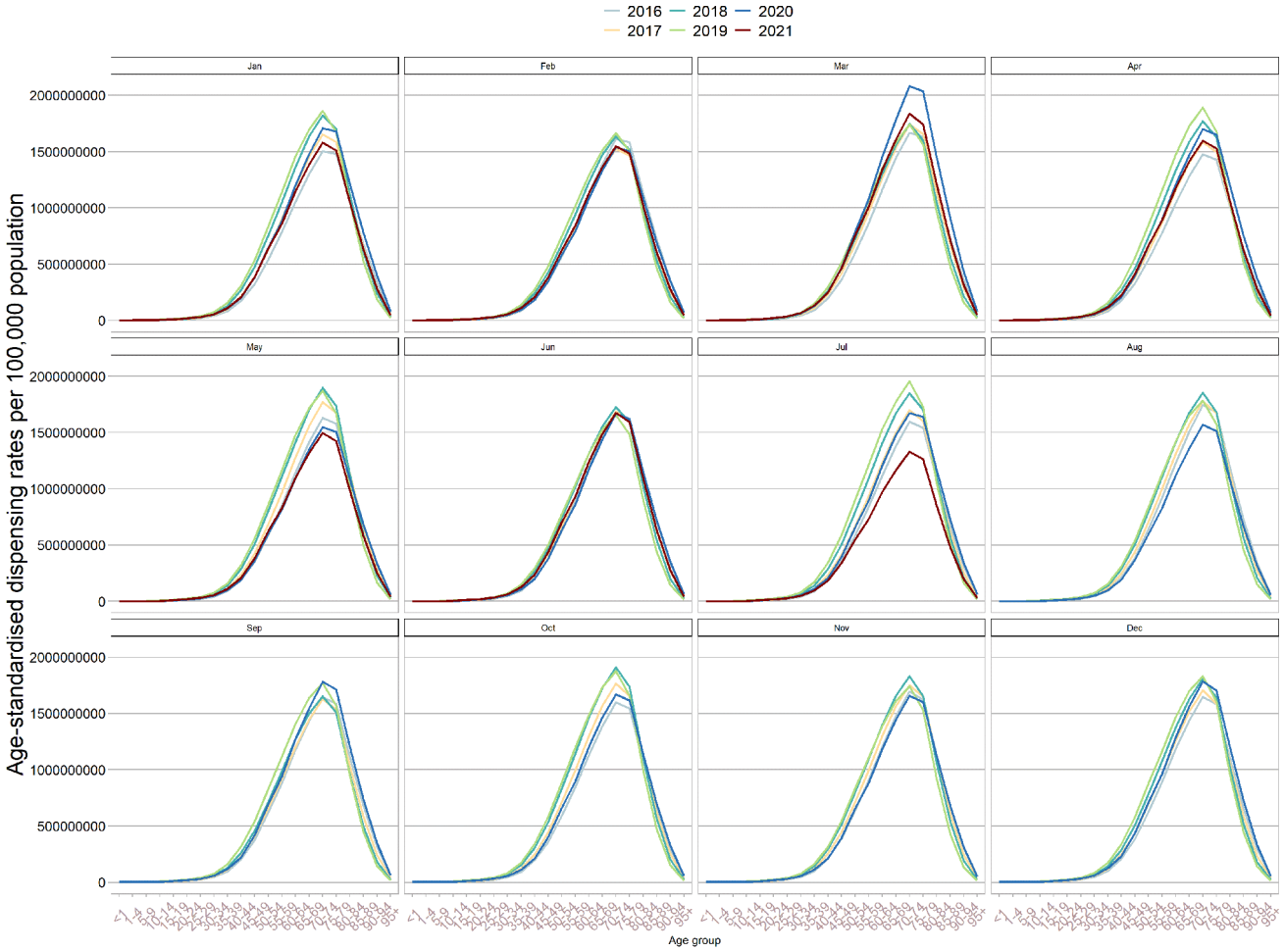
Supplementary Figure 2.2: Number of dispensed items per BNF chapter per month –in all years (numbers of each chapter are individually scaled)



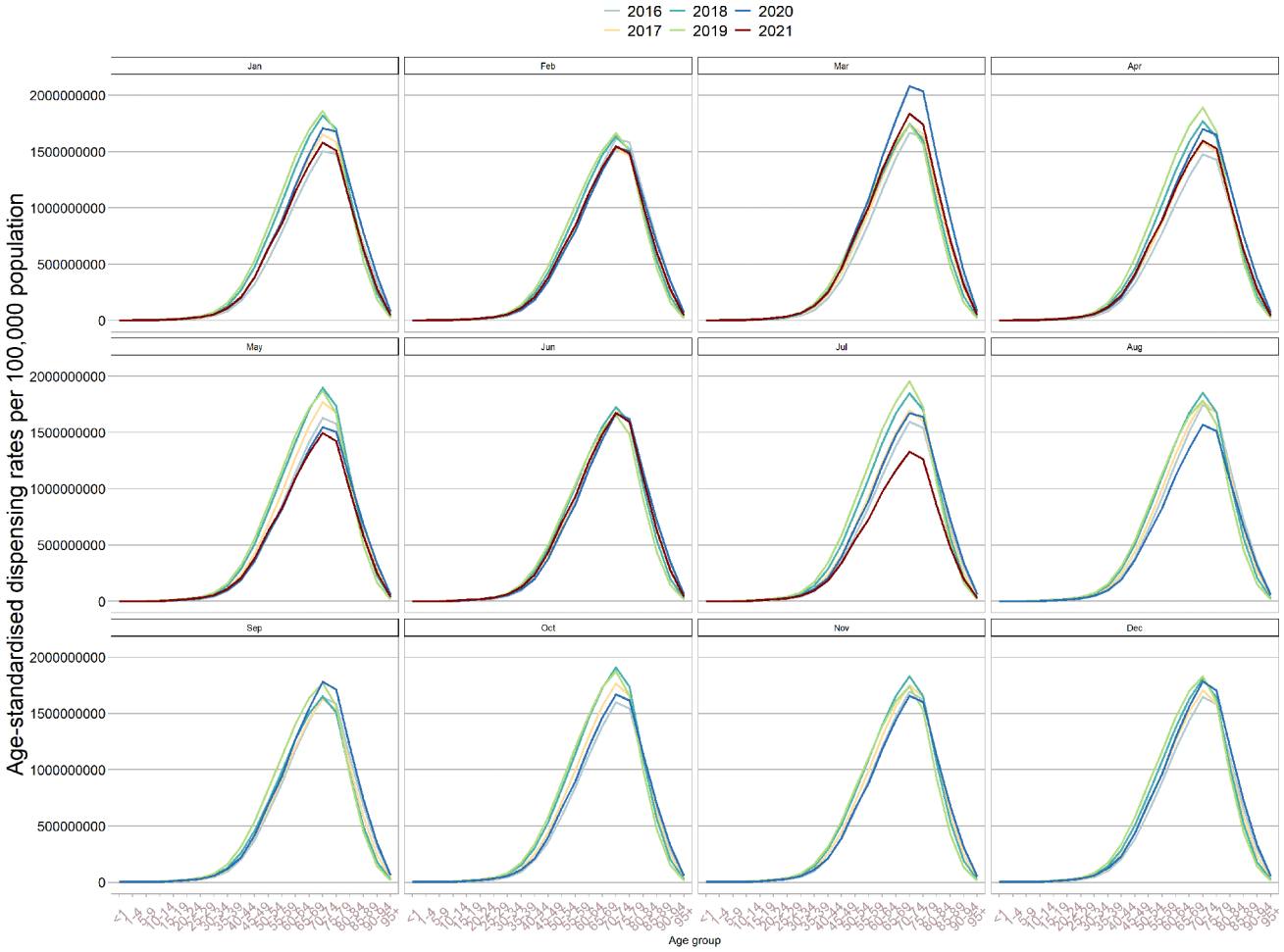
Supplementary Figure 2.3: Number of dispensed items per BNF chapter per month –in all years - harmonised scale



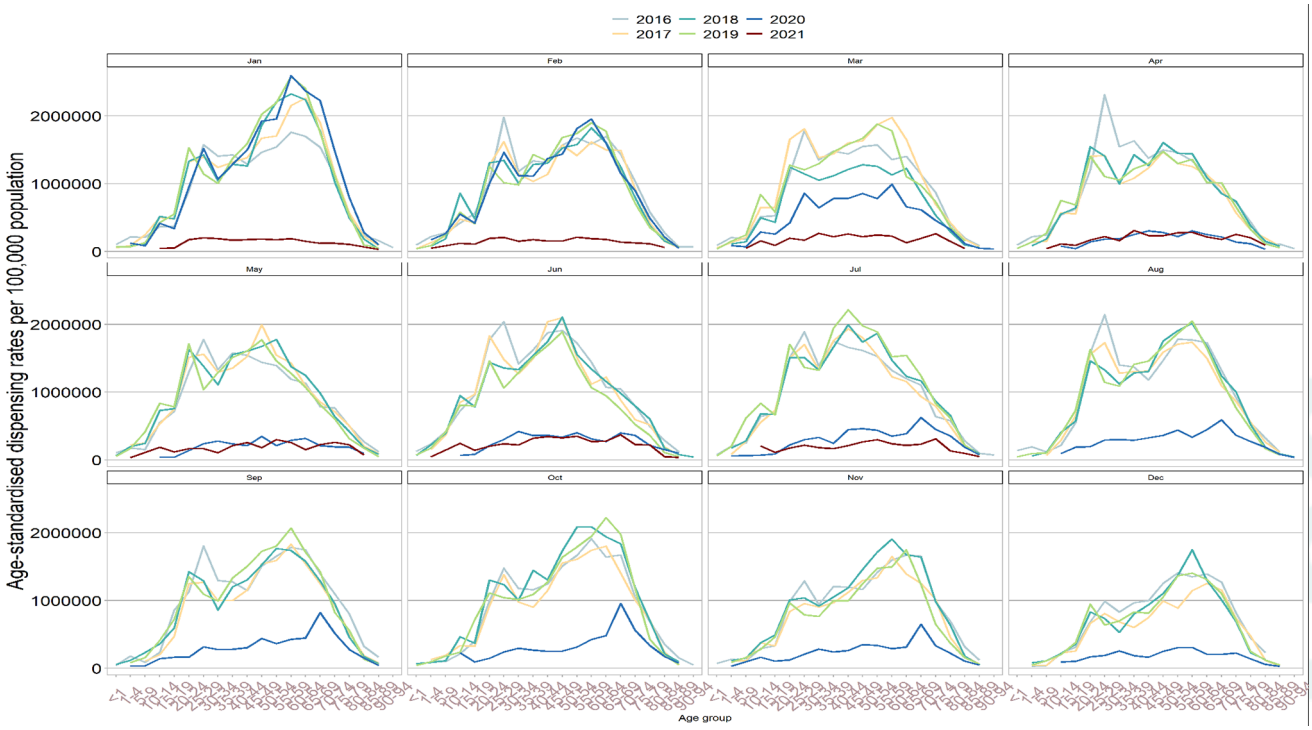
Supplementary Figure 3.1: Age-standardised dispensing rates for *cardiovascular system* in per 100,000 pop'n per year and month



Supplementary Figure 3.2: Age-standardised dispensing rates for *Central Nervous System* in per 100,000 pop'n per year and month



Supplementary Figure 3.3: Age-standardised dispensing rates for *Immunological Products & Vaccines* in per 100,000 pop'n per year and month



Supplementary Figure 4: Timeline of COVID-19 lockdowns in Wales