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RESEARCH ARTICLE

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Trends in medicine utilisation in public and private healthcare facilities before and during COVID-19: a nationwide analysis of medicine procurement and sales data, 2018–2022

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ABSTRACT

Background: There was a fluctuation in medication demand and supply during COVID-19 pandemic. This study aimed to assess the trend of drug utilisation in Malaysia in 2018–2022 and evaluate the impact of COVID-19 on drug utilisation rates.

Methods: We conducted a repeated cross-sectional study of pharmaceutical sales data from public and private sectors in Malaysia from 2018 to 2022. Drug utilisation rates for the period after the onset of COVID-19 (2020–2022) was compared with the earlier period (2018–2019). Interrupted time-series regression analyses evaluated level and slope changes compared to pre-COVID-19 pandemic level for quarterly rates of drugs utilisation in public and private sectors.

Results: There was an immediate reduction in the utilisation rates for all drugs after COVID-19 in public (−20.4%; $p = 0.043$) and private sectors (−22.4%; $p = 0.003$). In both sectors, significant level changes were observed for anti-infectives, musculoskeletal, neurological, respiratory, and sensory organs preparations following COVID-19 pandemic, followed by a sustained increase in trend from 2020 to 2022. Public sector had a 22.2% reduction in the utilisation of cardiovascular drugs ($p = 0.002$), particularly for renin–angiotensin system (RAS) agents (−47.4%, $p = 0.019$). Private sector had large changes for anti-infectives (−53.6%, $p < 0.001$) and neurological drugs (−51.4%, $p < 0.001$), driven by an immediate level reduction in antibacterials

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(−54.2%, $p < 0.001$) and cough and cold preparations (−59.2%, $p < 0.001$). Classes with agents used for COVID-19 treatment, such as systemic corticosteroids, antibiotics, and antivirals had an increasing trend between April 2020 and December 2022, although some slope changes were not statistically significant.
Conclusion: A significant reduction in the overall drug utilisation rates was observed in the public and private sectors in Malaysia as an immediate impact of the COVID-19 pandemic in 2020. The impacts varied by therapeutic class and health sector. This finding provides an understanding of the changing patterns of drug utilisation that were affected by disease outbreaks for future planning of pandemic preparedness.

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KEYWORDS Drug utilisation; COVID-19; pharmacoepidemiology

Introduction

Drug utilisation studies are important as it describes and analyse patterns of drug use in the population and health facilities. Information on drug utilisation can help to inform interventions to improve the use of medicines, serving as a proxy of healthcare utilisation and disease burden (Chini et al., 2011). Changes in drug utilisation rates can be influenced by various factors, including population demographics, evolving disease patterns, emerging therapies, and drug supply. Of particular interest is the coronavirus disease (COVID-19) caused by the SARS-CoV-2 virus which has resulted in a global pandemic since March 2020 (World Health Organization, 2020). As multiple waves of the COVID-19 pandemic hit countries worldwide, various aspects of healthcare delivery and services were impacted by the adoption of containment measures (Hashim et al., 2021). Alongside a rise in COVID-19 cases, there were instances of stockpiling of medicines, as well as disruptions in drug supply chains worldwide (Al Zoubi et al., 2021; Suda et al., 2022). Simultaneously, treatment strategies for COVID-19 were continuously refined as the COVID-19 pandemic evolved over time.

In Malaysia, the government implemented its first national lockdowns (known as Movement Restriction Orders, MCO) from March 18 to May 4, 2020, aimed at limiting and containing the spread of COVID-19 infection (Ang et al., 2021). The focus during the lockdown was on flattening the COVID-19 curve, minimising unnecessary patient and healthcare workers exposure, and conserving resources such as personal protective equipment, critical care services, and blood. Consequently, non-essential healthcare services, including elective surgeries, were postponed or cancelled (Azzeri et al., 2021; Sureshkumar et al., 2023). Face-to-face visits to doctors were shifted to remote consultations, and various measures were implemented

to ensure patients continued access to prescription medications. After May 2020, the MCO was implemented in various forms, with the reopening of sectors in stages and gradual easing of restrictions in accordance with the trajectory of COVID-19 cases in the country. Malaysia officially transitioned to the endemic phase on 1 April 2022, with almost all services and sectors having returned to normalcy.

Given the burden and various impacts of COVID-19 on health systems and populations, understanding drug use patterns during this period is important to determine the extent to which it affects the use of overall and specific drugs. Therefore, this study aimed to investigate trends and changes in drug utilisation patterns in Malaysia from 2018 to 2022 and evaluate the impact of COVID-19 on these trajectories. The magnitude of changes was assessed in both the public and private health sectors to determine if variations exist between sectors.

Methods

Setting

The Malaysia healthcare system is comprised of government-led public sector and fee-for-service private sector. The public health sector is a highly subsidised healthcare by the government of Malaysia mainly provided by the Ministry of Health through hospital and clinic services. Besides, there are public healthcare facilities governed by the Ministry of Higher Education (university hospitals and clinics) and the Ministry of Defence (army hospitals and clinics). The private sector complements the public sector by providing health services for patients who opt to pay through out-of-pocket, private health insurance, or employers' contributions. Private hospitals and clinics (general practitioners) are heavily concentrated in urban areas, while community pharmacies that sell over-the-counter and prescription drugs are available in most areas across Malaysia (Hamidi et al., 2021; Ong et al., 2022; Tan et al., 2021). Since Malaysia has yet to implement dispensing separation as a national policy, the separation of prescribing and dispensing of medications is only implemented in public healthcare facilities but not so common in private practices. The distribution of drug utilisation by sector and types of facilities is described in Supplemental Appendix 1.

Study design

We conducted a repeated cross-sectional study using pharmaceutical sales data from both public and private sectors in Malaysia, covering the years 2018–2022.

Data sources

Data were obtained from IQVIA Malaysia National Sales Audit Database, provided by the Pharmaceutical Services Programme, Ministry of Health (MOH) Malaysia, ensuring a comprehensive overview of drug utilisation. The database contains information on purchases of medicine in Malaysia's public and private health sectors, including sales, quantity, and product details. IQVIA is a for-profit organisation that collects and provides data and information on pharmaceutical market intelligence in over 100 countries around the world. Data for the public health sector were provided via a partnership program between MOH and IQVIA Malaysia and includes information from MOH procurement database for hospitals and clinics operated by the MOH, as well as data from government health facilities operated by non-MOH ministries and organisations. The private sector includes pharmaceutical sales data from private hospitals, general practitioner clinics, community pharmacies, and other private organisations. Detailed information on this database is described elsewhere (Ministry of Health Malaysia, 2020).

Data collection

Sales data were collected quarterly and categorised by therapeutic class, including anti-infectives, musculoskeletal, neurological, respiratory, sensory organ preparations, cardiovascular drugs, and agents used for COVID-19 treatment, such as systemic corticosteroids, antibiotics, and antivirals. Drug products are coded according to the Anatomical Therapeutic Chemical (ATC) classification defined by the European Pharmaceutical Market Research Association (EPHMRA) (EPHMRA, 2022). Medicine (drug) utilisation was estimated based on procurement and sales volumes reported in standard dosage units (DU). Each DU is defined to represent the number of doses of a product sold according to product form, for example, one tablet, one vial or ampoule, or an equal amount of liquid. The population denominator for each year was obtained from the Malaysia Department of Statistics.

Drug utilisation rates for the period after the onset of COVID-19 (2020–2022) were compared with the pre-pandemic period (2018–2019). Drug utilisation rates were calculated by dividing the sum of drug utilisation volume (measured in dosage units) by the mid-year population size for the particular year. This rate is multiplied by 1000 and presented as dosage units per 1000 population.

$$\text{Drug utilisation rates} = \frac{\text{Total drug use in dosage units}}{\text{Total mid} - \text{year population size}}$$

Primary outcome was utilisation rates by major therapeutic classes. Secondary outcome was utilisation of the following therapeutic subgroups: (1) drugs

for cardiovascular system; (2) drugs for diabetes; (3) drugs for alimentary tract system; (4) vitamins, (5) drugs for respiratory system; (6) systemic hormones; (7) systemic anti-infectives; (8) immunosuppressants; (9) anaesthetics, analgesics, antipyretics, and antirheumatic; (10) antiseptics and disinfectants.

Data analysis

Descriptive statistics were used to describe the trend of drug utilisation rates across the study period, expressed as quarterly and annual utilisation rates. Changes in the annual drug utilisation rates were presented as percentage change, calculated using the difference between utilisation rates for each year relative to the previous year.

To measure the effect of COVID-19 pandemic on drug utilisation rates, data were categorised into periods as follows: (1) pre-COVID-19: January 2018 to March 2020 and (b) post-COVID-19: April 2020 to December 2022.

Interrupted time-series regression analysis (Jandoc et al., 2015) was performed to evaluate changes in the level and slope of drug utilisation rate. The analyses assessed immediate reduction and subsequent trends in utilisation rates across different therapeutic classes and sectors (public vs. private) using the following model:

$$Yt = \beta 0 + \beta 1 * t0 + \ \beta 2 * t cov19 + \beta 3 * t af\_cov19 + \varepsilon t$$

where *Yt* is the outcome variable measured in each quarter; t_0 is the time measured in quarters since January 2018; t_{cov19} is a dummy indicator representing the impact of the COVID-19 pandemic with a value of 0 (before April 2020) and 1 (April 2020 onwards); t_{aft_Cov19} is the time after the pandemic begins to have an impact. The ITS analysis with the Newey–West estimator was applied using the STATA programme *itsa* (Linden, 2015; Turner et al., 2021).

The level change represents the immediate impact of the pandemic, while the slope change indicates the trend over time post-pandemic onset. *P*-values were calculated to determine the statistical significance of changes in utilisation rates. A *p*-value of less than 0.05 was considered statistically significant.

All analyses were performed using STATA version 15 (StataCorp).

Results

Between 2018 and 2022, drug utilisation totalled nearly 3 million units per 1000 population, with 43.5% of these coming from the public sector. Table 1 summaries the rates of drug utilisation and their distribution by

Table 1. Distribution of drug utilisation rates by therapeutic class (ATC group level 1) and stratification by public and private sector, 2018–2022.

			Public		Private	
Drug class by ATC classification	Units per 1,000	% of total drugs	Units per 1,000	%	Units per 1,000	%
All drugs	2,682,060.3		1,167,240		1,514,820	
A: Alimentary tract & metabolism	570,266.7	21.3%	312,897.1	26.8%	257,369.6	17.0%
B: Blood & blood-forming organs	68,495.9	2.6%	49,812.2	4.3%	18,683.7	1.2%
C: Cardiovascular system	402,575.0	15.0%	318,460.4	27.3%	84,114.6	5.6%
D: Dermatological	513,112.4	19.1%	113,563.3	9.7%	399,549.0	26.4%
G: Genito urinary system & sex hormones	23,952.0	0.9%	9716.3	0.8%	14,235.7	0.9%
H: Systemic hormones	36,367.2	1.4%	15,036.3	1.3%	21,330.9	1.4%
J: Systemic anti-infectives	51,849.2	1.9%	19,927.0	1.7%	31,922.2	2.1%
L: Antineoplastic & immunomodulatory	5651.0	0.2%	4247.4	0.4%	1403.6	0.1%
M: Musculoskeletal system	99,861.5	3.7%	18,315.4	1.6%	81,546.1	5.4%
N: Nervous system	189,791.9	7.1%	89,382.4	7.7%	100,409.4	6.6%
P: Parasitology	6687.4	0.2%	2778.2	0.2%	3909.2	0.3%
R: Respiratory system	388,637.8	14.5%	129,570.1	11.1%	259,067.8	17.1%
S: Sensory organs	324,812.3	12.1%	83,533.8	7.2%	241,278.5	15.9%

Units are expressed as dosage units per 1,000 population. Mid-year population size of Malaysia was used as denominator.

therapeutic classes, stratified by sector. Among the 13 therapeutic classes analysed, the highest utilisation was drugs for alimentary tract and metabolism (21.3% of the total), followed by dermatological drugs (19.1%), and cardiovascular drugs (15.0%). In the public sector, cardiovascular drugs had the highest utilisation, accounting for 27.3% of the total, closely followed by drugs for the alimentary tract and metabolism (26.8%). In contrast, the private sector saw the highest utilisation of dermatological drugs (26.4%), followed by respiratory drugs (17.1%), and alimentary tract and metabolism drugs (17.0%).

Trends in drug utilisation

Figure 1 illustrates the trends in quarterly drug utilisation rates per 1000 population in the public and private sectors from 2018 to 2021. The utilisation rates of all drugs in both public and private sectors remained relatively stable and consistent during the early part of the study period (2018–2019), with an upward trend beginning in the second quarter of 2019. A substantial drop in utilisation rates occurred after the first quarter of 2020 that affected both sectors and the low rates persisted for the remainder of 2020. This decline coincides with the implementation of the initial COVID-19 lockdown measures. Descriptive comparisons between the years for annual percentage change in drug utilisation rates from 2018 to 2022, stratified by therapeutic classes, are shown in Figure 2 and Supplemental Appendix 2. The majority

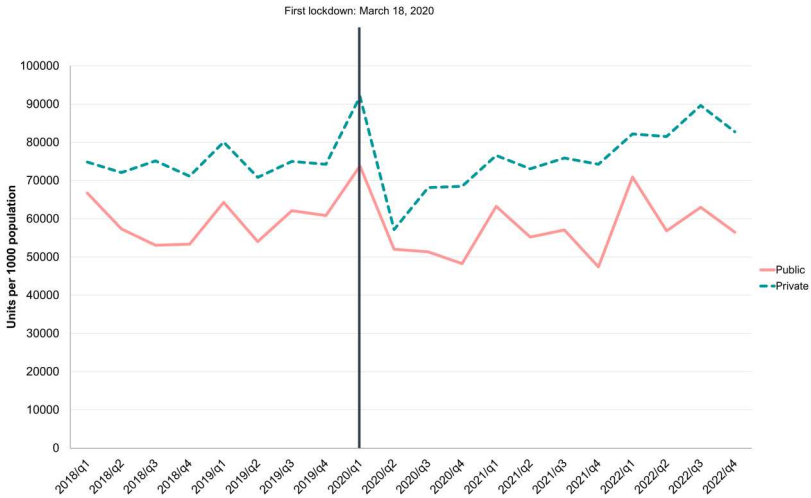

Figure 1. Quarterly utilisation rates of all drugs in 2018–2022, by public and private sectors.

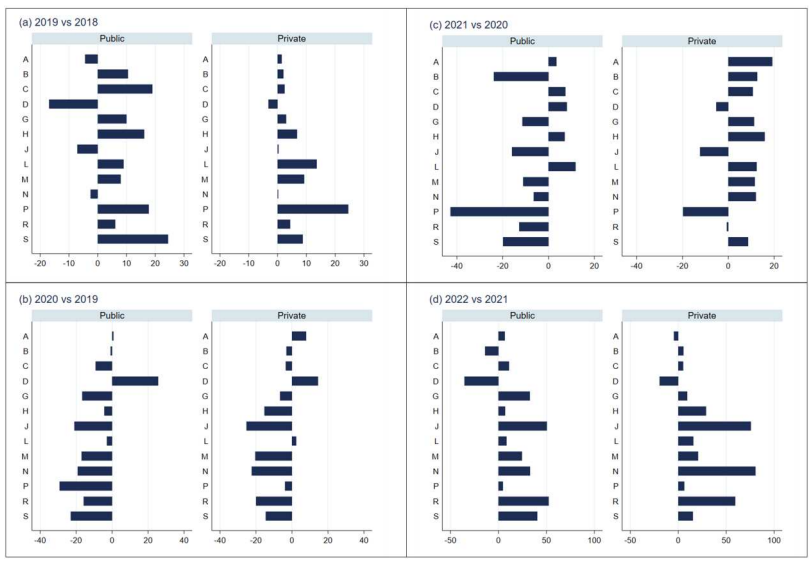

Figure 2. Annual percentage change in drug utilisation rates in public and private sectors between 2018 and 2022, by ATC group level 1. ATC group: A – alimentary tract and metabolism; B – blood and blood-forming organs, C – cardiovascular system, D – dermatological, G – genitourinary system and sex hormones, H – systemic hormones, J – systemic anti-infectives, L – antineoplastic and immunomodulators, M – musculoskeletal system, N – nervous system, P – parasitology, R – respiratory system, S – sensory organs.

of drug classes exhibited higher utilisation rates in 2019 compared to 2018, with varying trends across different categories between the public and private sectors (Figure 2(a)). Notable changes were observed in 2020 for both sectors, where utilisation rates of almost all therapeutic classes fell substantially as compared with 2019 (Figure 2(b)), except for dermatological drugs which saw a surge (+25.6% in public and +14.5% in private). In 2021, utilisation rates for most drugs in the public sector continued to decline, whereas the private sector began to show growth in utilisation rates relative to the previous year. By 2022, utilisation rates across all therapeutic classes in both the public and private sectors have increased compared to 2021.

Furthermore, we observed varying changes in drug utilisation rates across different subgroups between 2018 and 2022 (Table 2). The growth in the utilisation rates of dermatological was largely driven by the increased use of antiseptics and disinfectants in both sectors in 2020, though this usage was markedly reduced by 2022. The usage of vitamins showed an increasing trend beginning in 2020. Cardiovascular drugs were mostly used in the public sector, with the most notable changes occurring in drugs acting on the renin–angiotensin system (RAS), which saw a 44.9% decrease in utilisation rates in 2020 compared to 2019. However, it also shows a remarkable rebound in the subsequent years (43.1% increase in 2021 and 48.0% increase in 2022). In the private sector, there was a marked reduction in 2020 in the utilisation of cough and cold preparation (−30.2%), nasal decongestants (−28.1%), and antibacterials (−26.4%). However, these categories showed improvement in subsequent years, with large increments noted in 2022.

Impact of COVID-19 pandemic on drug utilisation

Table 3 presents the results of interrupted time-series analysis estimating changes in drug utilisation rates due to the COVID-19 pandemic. An immediate reduction in utilisation rates for all drugs was observed following the onset of the pandemic, as indicated by significant level changes in both public (−20.4%; $p = 0.043$) and private sectors (−22.4%; $p = 0.003$). However, the slope of the quarterly utilisation rates for all drugs did not change significantly, suggesting no change in the trend between the pre- and post-pandemic periods.

Analyses by individual therapeutic classes showed that the COVID-19 pandemic led to a significant level change in the utilisation rates of eight out of the 12 therapeutic classes included in the analysis across both the public and private sectors (Table 3). In the public sector, immediate reductions in utilisation rates were observed for the majority of the therapeutic classes, which ranged from −50.5% ($p < 0.001$) for parasitology preparations to −22.2% ($p = 0.002$) for cardiology drugs. Similarly, significant reductions in the level were observed in the private sector, with variations across therapeutic

Table 2. Annual percentage change in drug utilisation rates in public and private sector between 2018 and 2022, by specific drug categories.

		Public					Private				
		Units per 1,000	% change				Units per 1,000	% change			
		2018	2019	2020	2021	2022	2018	2019	2020	2021	2022
Drugs for cardiovascular system	C01 Cardiac Therapy	4047.4	6.4	1.1	−3.9	7.6	1010.7	3.4	−10.8	1.6	−1.9
	C02 Antihypertensives	2487.1	16.7	−1.9	3.8	−1.4	150.0	−7.0	−5.4	5.1	−3.3
	C03 Diuretics	4910.7	21.3	−3.3	0.4	−3.4	630.3	−3.0	−7.7	1.7	3.1
	C07 Beta-blocking agents	6921.4	−0.1	−5.7	4.8	−7.7	1922.3	−0.3	−11.7	12.9	0.1
	C08 Calcium antagonists	18788.5	10.0	0.6	4.0	4.8	2513.7	−7.0	5.9	14.2	0.8
	C09 RAS agents	11108.4	22.2	−44.9	43.1	48.0	4017.5	9.9	−1.6	9.8	10.3
	C10 Lipid modifying agents	7213.9	62.7	4.8	0.8	11.3	4164.2	3.1	−1.5	13.3	7.5
Drugs for diabetes	A10 Drugs used in diabetes	43009.1	5.8	−3.3	3.8	5.2	8307.1	2.8	4.0	9.0	5.5
Drugs for alimentary tract system	A02 Drugs for acid related disorders	4507.5	3.9	−43.6	3.7	16.5	4854.2	1.2	−6.7	13.4	11.4
	A03 Drugs for GI disorders	175.2	99.3	−7.6	−41.8	11.4	2481.1	3.1	−19.6	3.1	35.0
Vitamins	A11 Vitamins	10613.8	−22.4	17.2	7.0	12.9	17334.1	3.6	30.2	31.8	−20.7
Drugs for respiratory system	R01 Nasal decongestants	1875.8	2.8	−11.9	−37.5	67.7	8349.8	5.3	−28.1	11.4	30.2
	R03 Anti-asthma & COPD	17185.8	8.3	−6.1	−0.2	35.1	13481.0	8.4	−9.3	−15.7	23.6
	R05 Cough & cold preparations	3705.3	−8.4	−40.7	−64.5	260.2	15561.3	−2.4	−30.2	−6.7	106.0
	R06 Systemic antihistamines	3447.2	12.3	−42.8	−44.9	163.1	8704.2	5.4	−13.8	17.0	44.5
Systemic hormones	H02 Systemic corticosteroids	1205.1	30.7	−20.0	13.3	−13.6	3058.9	6.3	−19.1	15.6	38.7
	H03 Thyroid therapy	1589.2	−9.6	13.2	2.0	24.4	900.3	8.1	−2.9	16.8	2.7
Systemic anti-infectives	J01 Systemic antibacterials	3745.0	−10.6	−26.5	−36.5	69.4	6568.6	0.1	−26.4	−12.6	81.0
	J05 Systemic antivirals	308.8	26.8	−12.7	97.4	32.9	229.3	−13.6	−11.3	−14.0	27.1

(*Continued*)

Table 2. Continued.

		Public					Private				
		Units per 1,000	% change				Units per 1,000	% change			
		2018	2019	2020	2021	2022	2018	2019	2020	2021	2022
Immunosuppressants	L04 Immuno-suppressants	430.2	12.6	−9.2	9.2	4.8	84.5	4.0	3.8	5.2	11.3
Anaesthetics, analgesics, antipyretics & antirheumatic	M01 Anti-inflammatory and antirheumatic	1142.6	−1.3	−21.6	−48.2	102.1	4860.4	12.3	−18.8	13.3	20.8
	M01A Antirheumatic non-steroid	941.0	1.9	−24.7	−61.0	132.8	4827.0	12.3	−19.1	13.3	21.1
	M01C Specific antirheumatic	201.6	−16.0	−4.0	8.9	53.2	33.4	16.4	24.8	9.2	−1.8
	N01 Anaesthetics	1261.7	5.9	−20.2	−5.5	31.4	3104.9	−17.4	−43.8	−27.3	−17.8
	N02 Analgesics	11891.4	−1.5	−30.5	−14.0	52.2	12696.3	4.7	−22.3	19.2	107.3
Antiseptics & disinfectants	D08 Antiseptics, disinfectants	12425.2	−21.1	75.0	18.7	−57.7	40891.0	−12.0	36.0	−14.5	−43.7

Units are expressed as dosage units per 1,000 population. Mid-year population size of Malaysia was used as denominator. Abbreviations: COPD, chronic obstructive pulmonary disease; GI, gastrointestinal; RAS, renin-angiotensin system

Table 3. Interrupted time-series analysis for quarterly drug utilisation rates between pre-COVID-19 (January 2018–March 2020) and post-COVID-19 (April 2020–December 2022) in public and private sectors, by ATC group level 1.

	Public						Private					
			Level change		Slope change				Level change		Slope change	
ATC Group	Pre-COVID-19 slope	Post-COVID-19 slope	Coefficient	*p*-value	Coefficient	*p*-value	Pre-COVID-19 slope	Post-COVID-19 slope	Coefficient	*p*-value	Coefficient	*p*-value
All drug	1.52%	1.65%	**−20.41%**	**0.043**[a]	0.12%	0.980	1.52%	3.36%	**−22.39%**	**0.003**[a]	1.80%	0.062
A	0.37%	0.69%	−4.44%	0.659	0.32%	0.843	1.95%	2.04%	−4.94%	0.696	0.09%	0.990
B	2.36%	−5.32%	−13.15%	0.322	−7.51%	0.015[a]	0.59%	2.26%	−6.54%	0.516	1.65%	0.201
C	3.52%	2.34%	**−22.20%**	**0.002**[a]	−1.15%	0.350	1.41%	2.91%	−16.61%	0.095	1.48%	0.439
D	−1.08%	−3.39%	22.39%	0.562	−2.33%	0.834	1.58%	−3.16%	2.62%	0.971	−4.67%	0.065
G	0.96%	1.94%	**−27.85%**	**<0.001**[a]	0.97%	0.573	0.98%	3.30%	−16.60%	0.057	2.31%	0.117
H	10.62%	1.79%	−38.63%	0.058	−7.99%	0.474	0.92%	6.92%	**−29.89%**	**0.001**[a]	5.95%	<0.001[a]
J	−1.48%	5.30%	**−39.67%**	**0.016**[a]	6.87%	0.035[a]	0.59%	9.60%	**−53.58%**	**<0.001**[a]	8.96%	0.009[a]
L	1.38%	1.65%	−6.65%	0.609	0.27%	0.819	4.30%	4.81%	**−23.17%**	**0.028**[a]	0.49%	0.605
M	1.75%	2.96%	**−37.35%**	**0.008**[a]	1.19%	0.833	1.36%	5.14%	**−30.83%**	**<0.001**[a]	3.73%	0.012[a]
N	−0.23%	4.32%	**−35.10%**	**0.006**[a]	4.55%	0.090	1.51%	12.84%	**−51.38%**	**<0.001**[a]	11.16%	<0.001[a]
P	2.59%	−3.58%	**−50.5%**	**<0.001**[a]	−6.0%	0.040[a]	1.96%	−1.72%	−4.2%	0.834	−3.6%	0.200
R	1.70%	5.13%	**−39.62%**	**0.002**[a]	3.37%	0.211	1.47%	9.44%	−47.68%	0.001[a]	7.86%	0.015[a]
S	3.98%	3.51%	−49.83%	0.005[a]	−0.45%	0.608	1.58%	4.22%	−27.65%	<0.001[a]	2.59%	0.037[a]

[a]Indicates significant value ($p < 0.05$). Estimates for drug utilisation rates are in dosage units per population.

ATC group: A – alimentary tract and metabolism; B – blood and blood-forming organs, C – cardiovascular system, D – dermatological, G – genitourinary system and sex hormones, H – systemic hormonal preparations, J – general anti-infectives systemic, L – antineoplastic and immunomodulators, M – musculoskeletal system, N – nervous system, P – parasitology, R – respiratory system, S – sensory organs.

classes. Drugs commonly used for acute conditions, such as anti-infectives, musculoskeletal, respiratory, and neurological preparations, exhibited significant declines in utilisation immediately after the onset of the COVID-19, a pattern consistent across public and private sectors. Despite the immediate reduction in utilisation rates after the onset of COVID-19, the usage of systemic anti-infectives in the public sector showed an increasing trend of 5.3% during the post-COVID period, compared to a declining trend of −1.5% during the pre-COVID-19 period (slope change: 6.7%; $p = 0.035$). A similar was observed in the private sector, with greater reduction immediately following COVID-19 (level change: −53.6%; $p = <0.001$) and a steeper increasing trend thereafter (slope change: 8.96%; $p = 0.009$). An increasing trend in utilisation rate during the post-COVID-19 period (April 2020–December 2022) was also noted for neurological (N), systemic hormones (H), and respiratory (R) drugs in the private sector. Conversely, utilisation rates of drugs in the public sector showed that the trends for most therapeutic classes did not change substantially after COVID-19 pandemic, with the exceptions of systemic anti-infectives, blood and blood-forming organs, and parasitology preparations.

Estimates from the interrupted time-series analysis for specific subgroups are presented in Table 4. Among cardiovascular drugs, significant decreases in the level immediately after the onset of COVID-19 were noted for RAS agents (public: −47.4%, $p = 0.019$; private: −24.2%, $p = 0.034$), lipid modifying agents (public: −39.3%, $p = 0.001$), and diuretics (private: −13.1%, $p = 0.039$). The utilisation of drugs used for diabetes remained stable throughout the study period. Anaesthetics, analgesics, and anti-inflammatory experienced significant level decreases in both the public and private sectors, ranging from −30% to −60%. Although the immediate reduction in the utilisation rates occurred in April 2020 for the majority of these drugs, the post-COVID-19 period showed an upward trend with significant slope changes, especially in the private sector. Positive level changes in the utilisation of vitamins (public: 9.5%; private: 17.9%) and antiseptics–disinfectants (public: 76.6%; private: 25.5%) were observed, though these changes were not statistically significant. Therapeutic classes containing drugs used in the treatment of COVID-19, such as systemic corticosteroids, antibiotics, and antivirals showed an increasing trend during April 2020 to December 2022, although some slope changes were not statistically significant.

Discussion

This study provides a comprehensive assessment of the 5-year drug utilisation trends in Malaysia, covering the period before (2018–2019) and during the first 3 years of the COVID-19 pandemic (2020–2022), analysed by therapeutic classes and health sectors. Utilising drug sales data, our

Table 4. Interrupted time-series analysis for quarterly drug utilisation rates between pre-COVID-19 (January 2018-March 2020) and post-COVID-19 (April 2020–December 2022) in public and private sectors, by specific drug categories.

		Public						Private					
				Level change		Slope change				Level change		Slope change	
Category	Drug group	Pre-COVID-19 slope	Post-COVID-19 slope	Coefficient	*p*-value	Coefficient	*p*-value	Pre-COVID-19 slope	Post-COVID-19 slope	Coefficient	*p*-value	Coefficient	*p*-value
Drugs for cardiovascular system	C01 Cardiac Therapy	1.50%	0.47%	−12.88%	0.293	−1.01%	0.650	0.91%	0.77%	−18.15%	0.030[a]	−0.13%	0.834
	C02 Antihypertensives	2.83%	0.15%	−11.59%	0.332	−2.61%	0.275	1.05%	1.53%	−22.37%	0.201	0.48%	0.993
	C03 Diuretics	4.47%	−0.07%	−2.78%	0.712	−0.86%	0.665	−0.16%	1.16%	**−13.09%**	**0.039**[a]	1.32%	0.288
	C07 Beta-blocking agents	−0.07%	−0.93%	−2.78%	0.712	−0.86%	0.665	−0.60%	2.27%	−12.22%	0.408	2.88%	0.308
	C08 Calcium antagonists	2.33%	1.09%	−11.10%	0.325	−1.21%	0.634	0.50%	2.70%	−6.92%	0.682	2.19%	0.431
	C09 RAS agents	0.95%	10.80%	**−47.39%**	**0.019**[a]	**9.76%**	**0.028**[a]	3.30%	3.73%	**−24.17%**	**0.034**[a]	0.41%	0.884
	C10 Lipid modifying agents	15.35%	1.67%	**−39.28%**	**0.001**[a]	**−11.86%**	**<0.001**[a]	1.51%	3.56%	−15.64%	0.136	2.02%	0.247
	B01 Antithrombotic agents	3.33%	−14.33%	7.25%	0.975	**−17.09%**	**<0.001**[a]	1.49%	2.15%	−10.25%	0.272	0.65%	0.657
Drugs for diabetes	A10 Drugs used in diabetes	0.84%	0.22%	−4.02%	0.662	−0.61%	0.842	1.52%	2.81%	−11.15%	0.354	1.28%	0.558
Drugs for alimentary tract system	A02 Drugs for acid-related disorders	−2.62%	3.16%	**−38.32%**	**0.008**[a]	**5.93%**	**0.020**[a]	0.64%	3.75%	**−15.37%**	**0.003**[a]	**3.09%**	**0.001**[a]
	A03 Drugs for GI disorders	16.64%	−3.99%	**−56.36%**	**0.002**[a]	**−17.68%**	**0.003**[a]	1.32%	6.33%	**−38.08%**	**<0.001**[a]	**4.95%**	**0.008**[a]
Vitamins	A11 Vitamins	−0.98%	2.14%	9.51%	0.821	3.15%	0.260	3.46%	−0.16%	17.96%	0.389	−3.50%	0.287
Drugs for respiratory system	R01 Nasal decongestants	−0.70%	1.48%	−30.62%	0.165	2.19%	0.462	1.82%	8.59%	**−52.15%**	**<0.001**[a]	**6.65%**	**0.006**[a]
	R03 Anti-asthma & COPD	2.61%	4.38%	**−28.06%**	**0.014**[a]	1.73%	0.382	1.06%	2.36%	−25.42%	0.158	1.28%	0.681
	R05 Cough & cold preparations	−0.73%	12.54%	**−80.29%**	**0.001**[a]	13.36%	0.099	−0.04%	13.42%	**−59.17%**	**<0.001**[a]	**13.46%**	**0.001**[a]
	R06 Systemic antihistamines	1.34%	9.31%	**−71.73%**	**<0.001**[a]	7.86%	0.109	2.03%	9.72%	**−41.05%**	**<0.001**[a]	**7.55%**	**0.001**[a]

(*Continued*)

Table 4. Continued.

		Public						Private					
		Pre-COVID-19 slope	Post-COVID-19 slope	Level change		Slope change		Pre-COVID-19 slope	Post-COVID-19 slope	Level change		Slope change	
Category	Drug group			Coefficient	*p*-value	Coefficient	*p*-value			Coefficient	*p*-value	Coefficient	*p*-value
Systemic hormones	H02 Systemic corticosteroids	8.17%	−0.58%	**−36.48%**	**0.046**[a]	−8.09%	0.196	0.42%	8.20%	**−33.90%**	**0.001**[a]	**7.75%**	**<0.001**[a]
	H03 Thyroid therapy	2.93%	3.29%	−18.06%	0.324	0.35%	0.750	2.46%	2.76%	−15.08%	0.076	0.29%	0.842
Systemic anti−infectives	J01 Systemic antibacterials	−2.55%	4.00%	**−47.76%**	**0.016**[a]	6.72%	0.062	0.39%	10.0%	**−54.24%**	**<0.001**[a]	**9.58%**	**0.006**[a]
	J05 Systemic antivirals	4.11%	13.71%	−29.14%	0.156	**9.22%**	**0.001**[a]	1.53%	5.95%	**−51.30%**	**0.011**[a]	4.35%	0.518
Immuno-suppressants	L04 Immuno-suppressants	1.72%	1.05%	−11.52%	0.275	−0.66%	0.738	3.00%	3.50%	**−21.57%**	**0.040**[a]	0.48%	0.708
Anaesthetics, analgesics, antipyretics & antirheumatic	M01 Anti-inflammatory & antirheumatic	1.17%	5.73%	**−61.20%**	**0.011**[a]	4.51%	0.628	1.77%	5.42%	**−30.71%**	**0.006**[a]	3.59%	0.050
	M01A Anti-rheumatic non-steroid	1.62%	6.60%	**−69.95%**	**0.009**[a]	4.90%	0.831	1.73%	5.46%	**−30.87%**	**0.006**[a]	**3.67%**	**0.048**[a]
	M01C Specific antirheumatic	−2.69%	6.74%	−18.93%	0.908	9.69%	0.194	6.51%	1.78%	−12.79%	0.409	−4.44%	0.121
	N01 Anaesthetics	1.63%	4.26%	**−40.98%**	**0.015**[a]	2.59%	0.568	−3.76%	−4.18%	**−47.16%**	**0.004**[a]	−0.44%	0.178
	N02 Analgesics	−0.02%	6.44%	**−51.15%**	**<0.001**[a]	6.47%	0.070	3.03%	16.54%	**−58.03%**	**<0.001**[a]	**13.12%**	**<0.001**[a]
Antiseptics & disinfectants	D08 Antiseptics, disinfectants	−0.22%	−7.70%	76.56%	0.213	−7.50%	0.207	1.68%	−9.13%	25.52%	0.620	−10.63%	0.040

[a]Indicates significant value ($p < 0.05$). Estimates for drug utilisation rates are in dosage unit per population. Abbreviations: COPD, chronic obstructive pulmonary disease; GI, gastrointestinal; RAS, renin–angiotensin system.

findings provide important insights into the distribution and availability of drugs during a global pandemic. Overall, our study showed an immediate reduction in drug utilisation rates shortly after the onset of the COVID-19 pandemic in March–April 2020, with rates remaining low for several months thereafter. A gradual recovery in the drug utilisation rates was observed beginning in 2021, in line with the easing of COVID-19 restrictions in the country.

In this study, the impact of the COVID-19 pandemic on drug utilisation rates was evident, with most therapeutic classes showing a substantial decline in utilisation rates in 2020 compared with 2019. In contrast, an opposite trend was observed for dermatologicals, where both public and private sectors recorded surges in utilisation rates for 2020 and 2021. This phenomenon is expected, given the widespread infection which resulted in an increased demand for antiseptics and disinfectants, such as chlorhexidine, which constituted the vast majority of dermatological used in this period (Prajapati et al., 2022). Our data also showed an increased trend in utilisation of vitamins over this period, likely indicating heightened demand for vitamins during the COVID-19 pandemic (Arora et al., 2023). Our study also found that changes in the utilisation rates of chronic medications during the COVID-19 pandemic appeared to be less pronounced compared with those of acute medications. Various measures were implemented by healthcare facilities across Malaysia to ensure continuous care and access to medicines during the COVID-19 pandemic, including the adoption of telemedicine services and the provision of refill medications via mail delivery, locker, or appointment-based dispensing (Ng et al., 2022; Thong et al., 2021; Yeo et al., 2021).

In this study, we observed a marked reduction in the utilisation rates of RAS agents following the onset of COVID-19 pandemic. This pattern could potentially be explained by two factors. First, there may have been supply chain issues during COVID-19 lockdowns, which were known to affect many countries, especially during the early phase of the pandemic, as reflected in drug purchasing patterns (Sen-Crowe et al., 2021). Second, there could have been reduced demand for RAS agents during this period due to a decline in prescribing or dispensing rates. Early in the COVID-19 pandemic, there were concerns about possible associations of RAS-acting drugs with COVID-19 prognosis (Fang et al., 2020; Trifirò et al., 2020); however, these concerns were quickly dispelled, and evidence suggests that RAS can be safely used in patients with COVID-19, with patients advised to continue taking their medication as prescribed (European Society of Cardiology, March 13, 2020; Gnanenthiran et al., 2022). Several studies using interrupted time-series have reported shifts in RAS utilisation patterns during this period, which returned to normal in the subsequent years (Aboulatta et al., 2022; Enners et al., 2021; Guscoth & Hodgson, 2021). Some of these studies used prescription or dispensing data and were able to assess changes specific to

incidence or prevalence users of RAS agents (Aboulatta et al., 2022; Guscoth & Hodgson, 2021; Mathieu et al., 2022). Another time-series study that used drug purchase data reported a significant reduction in the purchase rate of cardiovascular drugs during April–August 2020 relative to the same period in the previous year, although they did not examine these changes by therapeutic subgroups (Suda et al., 2022). It is likely that these factors impacted the drug utilisation rates differently, but given the data used in this present study, we are unable to disentangle them. Our findings suggest that some disruptions occurred during this period, specifically affecting RAS agents, as other subgroups within the cardiovascular drug class did not exhibit such substantial reductions or compensatory increases in usage. Further study utilising patient-level data is therefore needed to understand treatment initiations or interruptions in the population.

Our findings on the decreased utilisation of antibiotics and respiratory medications during the COVID-19 pandemic are consistent with those reported in other studies. This decrease may be explained by the movement restrictions, social distancing, and reduced crowding during the pandemic, which resulted in fewer infections and other respiratory diseases (Nandi et al., 2023; Selke Krulichová et al., 2022). The reduction in surgeries and procedures conducted during the pandemic could potentially led to a rapid reduction in the use of nervous system drugs, such as anaesthetics, opioids, and other analgesics in 2020. This was reflected in our study, which showed a reduction in the usage of neurological drugs and the therapeutic subgroups (N01, anaesthetics; N02, analgesics) between 2019 and 2020, affecting both public and private sectors. This pattern is similar to the situation in Canada, where a substantial reduction in the prescription rates of opioids and analgesics was observed during the COVID-19 pandemic in 2020 (Aboulatta et al., 2022; Ontario Drug Policy Research Network, 2023). Similarly, Gomes *et al*. conducted time-series analysis on global sales data and reported a significant decline in the rate of opioid purchasing rates in April–May 2020 as an impact of the COVID-19 pandemic (Gomes et al., 2022). While several drugs have been repurposed for the treatment of COVID-19, we did not find an obvious trend of increased use during the study period.

Between the public and private sectors, we observed variations in terms of changes in drug utilisation rates and trends of certain therapeutic classes over the observation period. The COVID-19 pandemic resulted in a substantial reduction in the utilisation rates of most drug classes in the public sector and the lower rates persisting up to 2022 for certain categories. Although the private sector also recorded a decreased level of drug utilisation in 2020, it rebounded more quickly as the utilisation rates for most drugs started to increase again in 2021. This phenomenon reflects the utilisation of healthcare services during this period. As the public sector was overwhelmed by the continuous increase of COVID-19 cases and the prolonged duration of the

pandemic, patients may have opted to seek care and obtain their medications from private health facilities that were less crowded and more easily accessible at that point (Tan et al., 2021; Yunus et al., 2021). The drug utilisation in the public and private sectors mirrors the morbidity patterns in the respective health sectors with the public sector primarily managing chronic and complex diseases while the private sector manages more acute conditions and elective procedures (Ministry of Health Malaysia, 2021; Sivasampu et al., 2016). Future work could assess the utilisation and delivery of specific healthcare services in both sectors and the effectiveness of strategies deployed during the COVID-19 pandemic including long-term effects of missed and delayed care for better preparedness for any future pandemic.

There are several limitations to our study. We used pharmaceutical sales data as a proxy for medicine utilisation, which may overestimate actual consumption in the population since not all products being sold are necessarily prescribed, dispensed, or consumed. Nonetheless, this limitation is unlikely to significantly impact the observed trends over time. Additionally, we did not have access to individual patient-level data; hence, we are unable to assess patient factors, treatment episodes, or prescribing indications. Further research is needed for more detailed investigations and analyses in this area. Moreover, the data used in this study do not account for drugs supplied as investigational products or through an emergency fund or usage authorisations. Lastly, it is important to note that we are unable to make causal attribution of changes during this period solely to COVID-19, given the observational nature of our study design and the presence of other concomitant factors that were not accounted for. Nevertheless, this study uses a nationally representative database that includes public and private sectors across all levels of healthcare facilities. Thus, we are able to provide valuable insights into trends and sectoral differences across all therapeutic classes for monitoring estimated drug utilisation rates in the country.

Conclusion

This study analysed drug utilisation trends in Malaysia before and during the first 3 years of the COVID-19 pandemic. We observed a significant reduction in drug utilisation during the pandemic across both public and private sectors, followed by a gradual rebound beginning in 2022. These findings provide insights into shifting drug utilisation patterns during a period of disease outbreak which can inform future pandemic preparedness.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

Data availability statement

Data that support the findings of this study are available within the article and supplementary materials. Data used for analysis are not available for others and any request will be subjected to approval from the data custodians.

Ethical approval

This study was reviewed and approved by the Medical Research and Ethics Committee, Ministry of Health Malaysia (NMRR ID-23-00576-L5P). A waiver of informed consent was granted due to the use of aggregated data.

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