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The impact of the COVID-19 pandemic on urban-rural outpatient primary care utilisation in Malaysia: a retrospective time series and spatiotemporal analysis

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Abstract

Background The COVID-19 pandemic significantly affected healthcare utilisation worldwide, underscoring the importance of monitoring it to indicate whether essential health services were maintained during crises. This study explored how the pandemic affected outpatient department (OPD) utilisation in public primary care facilities in Malaysia by analysing utilisation trends and comparing it across geographical regions, including urban-rural disparities.

Methods Monthly OPD attendance from 1,053 public primary care health clinics in Malaysia, from January 1, 2019, to June 30, 2021, was analysed. The study duration was divided into four distinct periods: pre-pandemic, pandemic with the first lockdown implementation, pandemic after the first lockdown was lifted, and pandemic with the second lockdown implementation. An interrupted time series analysis was conducted to assess the impact of different interventions at national, regional, urban-rural, and district levels. Data were then aggregated at the district level and the utilisation changes were visualised in a choropleth map. Additionally, simple linear regression (SLR) was performed to explore the association between utilisation changes and urbanisation rates of the district, for each period.

Results Nationally, OPD utilisation dropped by nearly 13% at the onset of the first lockdown and continued to decline by almost 24% monthly thereafter. In terms of urban-rural differences, urban areas in the Central and Eastern Regions showed greater fluctuations in OPD utilisation during different periods. Results from the SLR revealed that higher urbanisation rates were associated with more pronounced changes in utilisation, although the direction of these changes varied across time periods.

Conclusion The OPD utilisation was affected during the COVID-19 and sporadic urban-rural differences were observed in some areas of the country. This study offers important insights into the geographic and urban-rural patterns of healthcare utilisation during the pandemic, which are crucial in improving healthcare equity in Malaysia.

Keywords COVID-19, Primary care, Utilisation, Spatiotemporal analysis, Equity

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Background

The COVID-19 pandemic has cast a deep shadow on the global healthcare landscape, fundamentally changing the way people interact with their healthcare systems [1, 2]. In Malaysia, the COVID-19 pandemic has presented a similar formidable challenge, with its effects affecting every aspect of society. Beginning in late January 2020, COVID-19 in Malaysia evolved into a series of outbreak waves with cumulative confirmed COVID-19 cases reaching 751,979 with 5,179 deaths as of June 2021 [3]. Malaysia introduced various mitigation strategies to curb the spread of the disease including a series of national lockdowns and adjustment of health services delivery; such as redirection of health resources and downsizing of less-essential or non-urgent health services. Several healthcare facilities were transformed into COVID-19 centres, which redirected non-COVID cases to nearby facilities [4]. This response was reinforced by the legal framework supporting the Movement Control Order (MCO), which was implemented in phases starting March 18, 2020, under the Prevention and Control of Infectious Diseases Act 1988 [Act 342]. The MCO played a crucial preventive role, limiting movement and enforcing isolation in infected areas, and was essential in containing the virus's spread across Malaysia [5]. Similar to previous disease outbreaks, there was a general fear of contracting the disease which hinders the public from performing routine activities including accessing healthcare services [6, 7]. There was also general difficulty among the public to access healthcare services due to physical restrictions imposed nationally.

The World Health Organization suggested monitoring healthcare delivery during the pandemic using the utilisation of essential healthcare services indicator which indirectly measures a domain of access to healthcare [8]. Various efforts were employed by countries to balance between curbing the COVID-19 transmission and maintaining non-COVID essential healthcare services, ensuring communities receive adequate services during the pandemic. These efforts are aligned with the Sustainable Development Goal (SDG) 3 which seeks to ensure healthy lives and promote well-being for all. Nevertheless, all the changes in the demand and supply of healthcare services had inadvertently resulted in varying degrees of inaccessibility to non-COVID healthcare services worldwide including primary care services [9–11]. The impact of these disruptions varied across regions, influenced by geographical location, socioeconomic factors, availability of healthcare services, and access to health information, which are some of the well-established determinants of healthcare accessibility [12, 13]. Further exploration of how COVID-19 impacted healthcare access differently across geographical regions is crucial in understanding the determinants of equitable access during the pandemic, supporting the achievement of SDG 10 in reducing inequalities within the country. Time series analysis is often used to assess the impact of the COVID-19 pandemic on temporal changes in healthcare service utilisation [1, 14, 15]. Additionally, coupled with the use of Geographic Information System (GIS) enables geospatial analysis mapping of utilisation changes at the subnational level, has provided meaningful insights into how geographical location affects healthcare accessibility [16–19].

Primary healthcare in Malaysia plays a pivotal role in delivering accessible, comprehensive, and equitable healthcare services to the population [20, 21]. It is designed to serve as the first point of contact for individuals within the community, ensuring availability and accessibility for all. Malaysia's primary care system is anchored by a network of facilities from both public and private sectors. The Ministry of Health (MOH) primarily oversees public facilities that charge a nominal user fee [22] and provide sufficient coverage in both urban and rural areas. In contrast, private-sector healthcare services, driven by business and profit motives, are predominantly concentrated in urban areas. Although private clinics outnumber public clinics, they are generally less equipped with essential facilities and services [23]. The outpatient department (OPD) service is the most commonly provided service in all MOH primary care facilities, encompassing a range of services, including acute illness management, chronic disease management, and preventive care. Other services provided include maternal and child health services, women's health services, school health services, and others.

This study aimed to explore how the COVID-19 pandemic affected the utilisation of OPD services in MOH Malaysia's primary care facilities; by examining utilisation trends and comparing geographical regions, including urban-rural differences. The analysis provides valuable insights into how a health crisis affects healthcare access and service delivery, emphasising the role of geographical disparities. The findings highlight critical aspects of healthcare accessibility during the COVID-19 crisis, particularly in relation to OPD primary care services, and contribute to a deeper understanding of the country's health system during the pandemic. By addressing these disparities, this study supports the broader goals of SDG 3 and SDG 10, contributing to equitable healthcare access and reduced inequalities in Malaysia.

Methodology

This retrospective secondary data analysis examined the primary care OPD services utilisation at all MOH's primary care health clinics. A total of 1,053 health clinics were included based on data availability, which covered 99.7% of the total MOH's health clinics listed in 2021.

Outcome variable and data source

The main outcome variable used in measuring the utilisation of outpatient services was monthly attendance for each health clinic from January 2019 until June 2021 (30 months). The attendances to outpatient department in health clinics include diagnostic and treatment services for acute health problems, chronic diseases (such as hypertension, diabetes mellitus and dyslipidaemia), infectious diseases, and wellness programs such as medical check-ups. The data does not include COVID-19-related cases, or attendances to clinical support services such as radiology, laboratory, and pharmacy without a doctor's consultation.

The data on monthly OPD attendance for each health clinic was retrieved from the national administrative database of the Family Health Development Division, MOH Malaysia, which routinely received manual data submissions from each state health department. The aggregated data did not include individual patient information.

Statistical analysis

The data were processed and analysed using STATA 17 (Stata Corp, College Station, TX, USA). Data cleaning and integrity verification was performed prior conducting analysis by cross-checking with the official facility registry from the National Health Informatics Centre, which contains unique facility ID, urban-rural status, district, and region status. Any missing, inconsistent, or illogical data were manually reviewed and corrected as needed after verification with the data custodian. The urban-rural classification of the health clinic was determined by its specific location, in accordance with the Department of Statistics Malaysia; which defined an urban area as a gazetted area or any adjacent built-up areas within the defined boundary, with a combined population of 10,000 or more [24].

The 30-month temporal data for the outcome variable was categorised into four distinct periods: Pre-pandemic period (January 2019 – February 2020); Pandemic and first lockdown implementation period (March-May 2020); Pandemic and first lockdown lifted period (June – December 2020), and; Pandemic and second lockdown implementation period (January – June 2021).

Interrupted time series analysis (ITSA) was used to assess the impact of multiple interventions introduced during the study period on the OPD services utilisation. The analysis was performed using user-written *itsa* program in STATA, which based on the ordinary least square (OLS) regression method with Newy-West standard errors [25]. The programme estimated the effect of each intervention point on OPD utilisation while addressing potential autocorrelation and heteroskedasticity of the data. The OPD utilisation were log-transformed, and the coefficient produced from the ITSA were exponentiated so that the estimated could be expressed as percentage change [26]. The residual autocorrelation in the error distribution was then assessed using Cumby-Huizinga general test using a post-estimation program, *actest* [27]. If residual autocorrelation was present, the generalised least square method (Prais regression model) was reported as an alternative to OLS.

The first lockdown, introduced in March 2020, was considered as the first intervention, while its lifting in June 2020 was referred as the second intervention. The period from March to June 2020 corresponded to the official Movement Control Order (MCO) 1.0 and Conditional Movement Control Order (CMCO) 1.0 [4], during which Malaysia experienced its most stringent nationwide movement restrictions, in contrast to subsequent local movement control orders. The second lockdown, enforced in January 2021, was identified as the third intervention where MCO 2.0 was enforced in six out of 16 states in the country. Although not implemented nationwide, MCO 2.0 led to a noticeable decline in the population's average mobility trend at the national level [28] and was thus included as an interruption point in the analysis.

National and regional level analysis

The country consisted of 13 states and three federal territories, distinctively grouped into five regions; Northern, Central, Southern, East Coast, and Eastern Region. Single-group ITSA was performed to evaluate the impact of the pandemic on OPD utilisation at national and regional levels. A multiple-group ITSA was performed to compare the impact between urban and rural areas within the country and each respective region. This analysis focused only on comparing utilisation trend (slope) changes between urban and rural areas, rather than both the utilisation levels and trend changes. This is because it is expected that the utilisation levels differ significantly between urban and rural areas, making level comparisons less meaningful. To allow comparability of the baseline slope between the groups, the coefficients were standardised to percentage change [26]. Prior to the analysis, we also assessed the comparability of baseline slopes of utilisation changes between urban and rural groups based on the p-values for differences in the mean baseline slope ($\_z\_t$), where $p > 0.10$ was considered to satisfy the criteria for comparability [25]. In our case, the p-values for differences in the mean baseline slope at the national level and across all regions exceeded 0.10 (result not shown). The formulae and visual depiction for the single- and multiple-group regression model for the ITSA are as in Supplementary File 1.

District level analysis

On top of the temporal analysis that was conducted for national and regional levels, we include spatial analysis at the district level. Spatial analysis was conducted using Geographic Information Systems (GIS), which had emerged as a valuable tool for depicting changes and spatial patterns in healthcare utilisation, including urban-rural differences, during the pandemic [17]. Mapping of service utilisation helps to visualise the trends and disparities in healthcare access across different regions, thus identifying potential gaps in healthcare delivery. This approach enables targeted interventions to address barriers to healthcare access across different regions.

Data on OPD utilisation was aggregated at the district level ($n = 160$) and single-group ITSA was performed for each district. The coefficients (converted to percentage change, or also known as slope) from district-level ITSA were graphed against the respective district's urbanisation rate (refers to the percentage of the urbanites), based on Malaysia's population census 2020 [24]. The result was visualised as a bivariate choropleth map for each of the different time periods, generated using open-source software QGIS [29] to depict the variation of the impact of the pandemic on OPD utilisation trend (coefficients) across districts, accounting for the urbanisation rate of the district. In the bivariate choropleth map, both coefficients/slopes and the district's urbanisation rate were classified into three groups, resulting in a nine-colour (3×3) combination. Blue, grey and red indicate districts with a relative change in OPD utilisation of < 5% reduction, changes within ± 5% and > 5% increase, respectively, compared to the baseline level of each of the time period, while the colour intensity reflects the urbanisation rate. This approach allows for the simultaneous visualisation of OPD utilisation changes and urbanisation rate, revealing spatial patterns and associations, and highlighting areas with notable trends between the two variables.

Linear regression

Simple linear regression (SLR) analysis was conducted to further elucidate the association (at the district level) between coefficient/slope from the ITSA and urbanisation rate for each time period. Assuming the regression coefficient may vary across regions, the SLR were iterated for each region. The coefficient for ITSA was the outcome variable, the district's urbanisation rate as an independent variable, and the region as a confounding factor. For this analysis, the districts in Central and Southern Regions were combined due to low district count where $n > 25$ were required for a stable linear regression [30]. All statistical tests with $p < 0.05$ are considered statistically significant. A significant positive (or negative) coefficient suggests that districts with higher urbanisation rates experienced a greater increase (or decrease) in OPD attendance during the specified period.

Result

National and Regional Level

Descriptive

Table 1 summarises the distribution of health clinics and average monthly OPD attendance per clinic across all regions (unadjusted), categorised by urban and rural areas. Approximately 40% of the 1,053 health clinics were located in urban areas, despite urban areas accounting for about 75% of the population. This resulted in a higher facility-to-population ratio in urban areas, with generally higher monthly attendances per clinic compared to the rural counterparts. Monthly attendances were lowest during the first lockdown period (March – May 2020) in all regions except the Eastern Region, with reductions ranging from 21.8 to 34.8% compared to the previous period. The Eastern Region reported its lowest monthly OPD attendances per clinic during the second lockdown implementation (January – June 2021).

General

Figure 1 and Table 2 summarise the results from ITSA for national and regional level analysis. Overall, at the national level, OPD utilisation experienced an almost 13% drop in the level of utilisation and continued to reduce by 23.58% monthly (CI -29.79 to -16.83%) during the implementation of the first lockdown. The utilisation level rebounded by 83.56% in June 2020 as the first lockdown was lifted, and subsequently, no statistically significant changes were observed until June 2021.

At the regional level, the first lockdown implementation in March 2020 caused a reduction in OPD utilisation by 10.19 to 17.02% in all regions except the East Coast. Subsequently, all regions showed a decreasing trend from March until May 2020, ranging from 16.22 to 29.10% reduction per month. All regions experienced immediate increases in OPD utilisation as the first lockdown was lifted in June 2020, ranging from 41.81 to 120.91% increase. The Northern, Southern, and East Coast Regions showed no significant changes in subsequent months, while the Central and Eastern Regions experienced a brief reduction in January 2021 as the second lockdown was enforced.

Urban-rural difference

Table 3 presents the multiple-group ITSA, focusing solely on the trend for urban and rural areas during each period. At the national level, there is no difference in the trend of utilisation between urban and rural areas across the 30-month study period, indicating both areas are equally affected (or not) by the pandemic and its interventions. Zooming into specific regions, a similar pattern

Table 1 Descriptive statistics for population, health clinic, and average outpatient attendance at national and regional levels, by urban and rural

Region	Health Clinic		Population ('000)[1]		Health Clinic: Population ratio	Pre-pandemic (Jan 2019 – Feb 2020)	1st lockdown implementation (March – May 2020)		Lifting of 1st lockdown (June – Dec 2020)		2nd lockdown implementation (Jan – June 2021)	
	Count	Column %	Count	Column %		Attendance[2]	Attendance[2]	% Δ	Attendance[2]	% Δ	Attendance[2]	% Δ
National	1,053	100.0	32,447	100.0	1: 30,814	3,256	2,346	-27.9	2,531	7.9	2,434	-3.8
Urban	430	40.8	24,354	75.1	1: 56,637	5,917	4,156	-29.8	4,528	9.0	4,332	-4.3
Rural	623	59.2	8,093	24.9	1: 12,990	1,458	1,140	-21.8	1,187	4.1	1,128	-5.0
Northern	197	100.0	6,653	100.0	1: 33,772	4,290	3,150	-26.6	3,490	10.8	3,460	-0.9
Urban	109	55.3	4,996	75.1	1: 45,835	6,054	4,398	-27.4	4,952	12.6	4,900	-1.1
Rural	88	44.7	1,657	24.9	1: 18,830	2,131	1,653	-22.4	1,719	4.0	1,671	-2.8
Central	102	100.0	9,086	100.0	1: 89,078	7,006	4,590	-34.5	5,129	11.7	4,963	-3.2
Urban	88	86.3	8,794	96.8	1: 99,932	7,776	5,069	-34.8	5,681	12.1	5,492	-3.3
Rural	14	13.7	292	3.2	1: 20,857	2,169	1,579	-27.2	1,700	7.7	1,638	-3.6
Southern	182	100.0	6,208	100.0	1: 34,110	3,931	2,899	-26.3	3,138	8.2	3,020	-3.8
Urban	85	46.7	4,843	78.0	1: 56,976	6,270	4,535	-27.7	4,825	6.4	4,676	-3.1
Rural	97	53.3	1,365	22.0	1: 14,072	1,933	1,501	-22.3	1,661	10.7	1,569	-5.5
East Coast	243	100.0	4,533	100.0	1: 18,654	2,520	1,803	-28.5	1,962	8.8	1,821	-7.2
Urban	87	35.8	2,368	52.2	1: 27,218	3,688	2,554	-30.7	2,833	10.9	2,594	-8.4
Rural	156	64.2	2,165	47.8	1: 13,878	1,886	1,396	-26.0	1,498	7.3	1,395	-6.9
Eastern	329	100.0	5,968	100.0	1: 18,140	1,635	1,258	-23.1	1,249	-0.7	1,169	-6.4
Urban	61	18.5	3,353	56.2	1: 54,967	5,506	4,070	-26.1	3,995	-1.8	3,628	-9.2
Rural	268	81.5	2,615	43.8	1: 9,757	794	680	-14.4	645	-5.1	609	-5.6

Notes:

[1] Data were based on Population and Housing Census of Malaysia, 2020 [24]. Population count rounded to nearest thousand ('000).

[2] Average monthly outpatient attendance for each Health Clinic, during each period

Abbreviation: %Δ = percentage change, in relation to attendances during previous period. Negative values indicate reduction in OPD attendances.

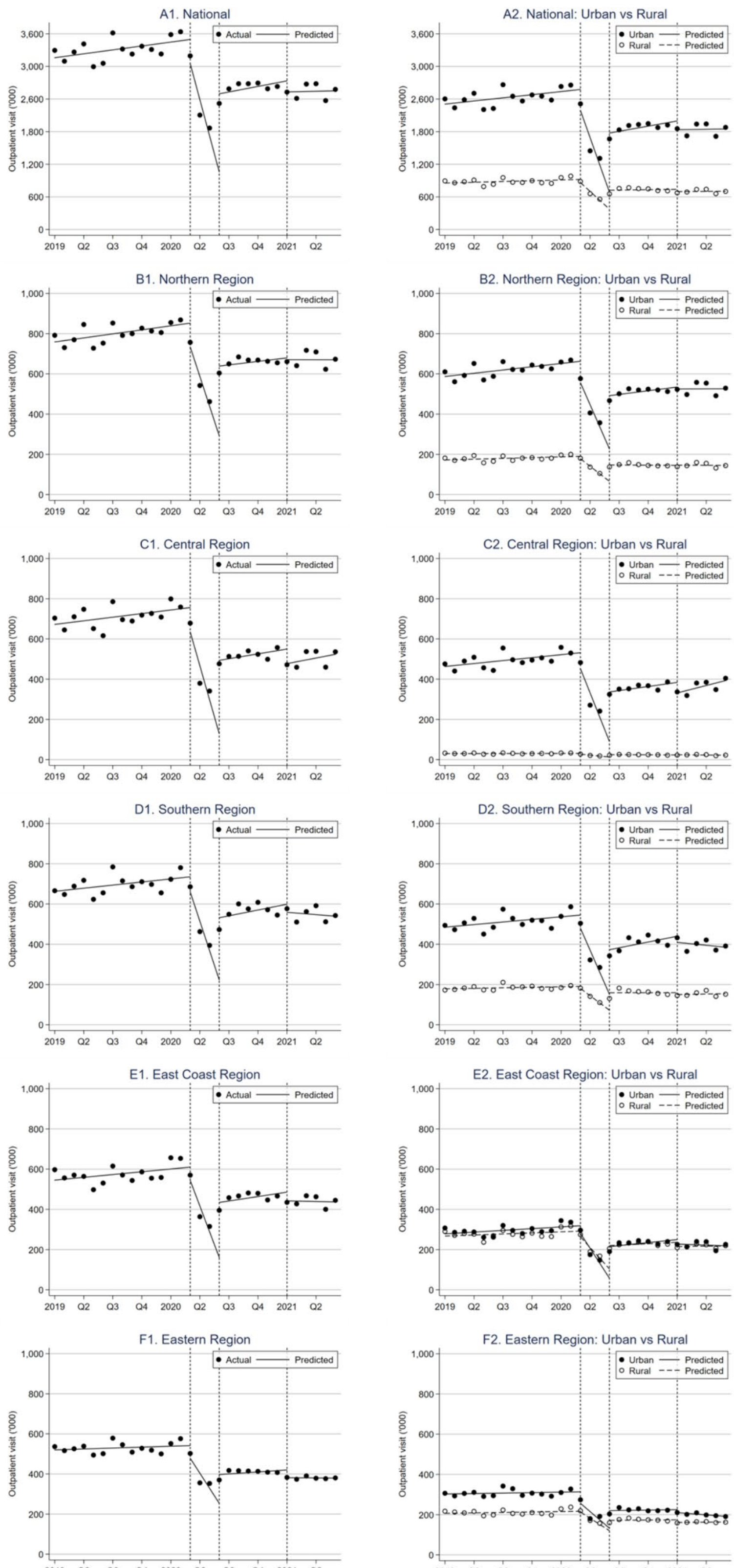

Fig. 1 Time series analysis through four distinct periods: pre-pandemic (Jan 2019 – Feb 2020), pandemic period and first lockdown implementation (Mar – May 2020), pandemic period and first lockdown lifted (June – Dec 2020), pandemic period and second lockdown implementation (Jan – June 2021) for outpatient attendance. (**A**) National level (**B**) Northern Region (**C**) Central Region (**D**) Southern Region (**E**) East Coast Region (**F**) Eastern Region

Table 2 Single-group interrupted time-series analyses (ITSA)[‡] for outpatient attendance at the national and regional level

Region	Pre-pandemic trend (Jan 2019 – Feb 2020)	Level change after 1st lockdown implementation (Mar 2020)	Trend after 1st lock-down implementation (Mar – May 2020)	Level change after lifting of 1st lockdown (June 2020)	Trend after lifting of 1st lockdown (June – Dec 2020)	Level change after 2nd lockdown implementation (Jan 2021)	Trend after 2nd lockdown implementation (Jan – June 2021)
	Coefficient (95% CI)	**Coefficient (95% CI)**	**Coefficient (95% CI)**	**Coefficient (95% CI)**	**Coefficient (95% CI)**	**Coefficient (95% CI)**	**Coefficient (95% CI)**
1. National	0.72%* (0.05 to 1.39%)	-12.97%* (-21.50 to -3.52%)	-23.58%*** (-29.79 to -16.83%)	83.56%*** (46.15 to 130.54%)	1.39% (-0.67 to 3.49%)	-7.76% (-15.65 to 0.87%)	0.14% (-1.25 to 1.55%)
2. Northern	0.84%** (0.33 to 1.36%)	-13.83%*** (-18.91 to -8.43%)	-21.87%*** (-25.64 to -17.91%)	81.91%*** (57.08 to 110.66%)	0.93% (-0.73 to 2.61%)	-1.51% (-8.95 to 6.55%)	-0.02% (-1.65 to 1.64%)
3. Central	0.85%* (0.16 to 1.53%)	-17.02%* (-29.73 to -2.00%)	-29.10%*** (-38.06 to -18.84%)	120.91%*** (62.83 to 199.70%)	1.56%* (0.24 to 2.90%)	-13.37%** (-21.45 to -4.46%)	1.86% (-0.25 to 4.01%)
4. Southern	0.74% (-0.03 to 1.51%)	-10.19%* (-18.02 to -1.61%)	-24.18%*** (-29.06 to -18.97%)	83.83%*** (45.31 to 132.57%)	1.87% (-1.81 to 5.69%)	-7.27% (-22.19 to 10.51%)	-0.70% (-2.36 to 0.98%)
5. East Coast	0.77% (-0.48 to 2.04%)	-10.89% (-21.82 to 1.56%)	-25.68%*** (-31.90 to -18.88%)	94.56%*** (51.72 to 149.50%)	1.72% (-0.87 to 4.37%)	-9.35% (-18.79 to 1.20%)	-0.26% (-1.95 to 1.45%)
6. Eastern	0.28% (-0.43 to 0.99%)	-12.13%* (-21.66 to -1.44%)	-16.22%** (-23.88 to -7.79%)	41.81%** (10.83 to 81.43%)	0.86% (-0.93 to 2.68%)	-9.35%** (-14.73 to -3.63%)	-0.10% (-0.44 to 0.25%)

Note:

[‡] Based on OLS regression method with Newey-West standard error except otherwise indicated

Statistical significance was denoted as follows: *$0.01 \leq p < 0.05$, **$0.001 \leq p < 0.01$, ***$p < 0.001$

Table 3 Multiple-group interrupted time-series analyses[‡] for outpatient attendance at national and regional levels, by urban and rural

Location	Pre-pandemic trend (Jan 2019 – Feb 2020)	Trend after 1st lockdown implementation (Mar – May 2020)	Trend after lifting of 1st lockdown (June – Dec 2020)	Trend after 2nd lockdown implementation (Jan – June 2021)
	Coefficient (95% CI)	**Coefficient (95% CI)**	**Coefficient (95% CI)**	**Coefficient (95% CI)**
1. National[¥]	0.72% (0.05 to 1.39%) *	-23.58% (-29.79 to -16.83%) ***	1.39% (-0.67 to 3.49%)	0.14% (-1.25 to 1.55%)
Urban	0.84% (0.25 to 1.44%) **	-25.74% (-31.46 to -19.54%) ***	1.54% (-0.38 to 3.49%)	0.16% (-2.27 to 2.64%)
Rural	0.52% (-0.13 to 1.38%)	-22.22% (-28.21 to -15.72%) ***	0.07% (-1.82 to 1.99%)	0.15% (-2.28 to 2.63%)
2. Northern	0.84% (0.33 to 1.36%) **	-21.87% (-25.64 to -17.91%) ***	0.93% (-0.73 to 2.61%)	-0.02% (-1.65 to 1.64%)
Urban	0.88% (0.42 to 1.35%) **	-21.32% (-26.03 to -16.30%) ***	1.24% (-0.30 to 2.81%)	0.04% (-1.37 to 1.47%)
Rural	0.72% (-0.10 to 1.54%)	-23.66% (-24.03 to -23.29%) ***	-0.17% (-2.08 to 1.77%)	-0.21% (-2.78 to 2.43%)
3. Central	0.85% (0.16 to 1.53%) *	-29.10% (-38.06 to -18.84%) ***	1.56% (0.24 to 2.90%) *	1.86% (-0.25 to 4.01%)
Urban	0.99% (0.39 to 1.60%) **	-29.31% (-37.81 to -19.66%) ***	1.92% (0.68 to 3.18%) **	3.47% (1.71 to 5.26%) ***
Rural	0.27% (-0.65 to 1.19%)	-18.57% (-21.19 to -15.87%) *** ^	-0.51% (-3.40 to 2.46%)	-1.81% (-4.96 to 1.44%) ^
4. Southern[¥]	0.74% (-0.03 to 1.51%)	-24.18% (-29.06 to -18.97%) ***	1.87% (-1.81 to 5.69%)	-0.70% (-2.36 to 0.98%)
Urban	0.81% (-0.03 to 1.66%)	-26.31% (-33.55 to -18.28%) ***	2.56% (-0.07 to 5.12%) *	-0.75% (-3.84 to 2.45%)
Rural	0.43% (-0.40 to 1.27%)	-24.38% (-31.81 to -16.14%) ***	-0.17% (-2.60 to 2.32%)	0.65% (-2.49 to 3.89%)
5. East Coast	0.77% (-0.48 to 2.04%)	-25.68% (-31.90 to -18.88%) ***	1.72% (-0.87 to 4.37%)	-0.26% (-1.95 to 1.45%)
Urban	0.94% (-0.31 to 2.19%)	-29.44% (-36.11 to -22.08%) ***	2.39% (-0.58 to 5.45%)	-0.81% (-2.90 to 1.33%)
Rural	0.60% (-0.64 to 1.86%)	-21.81% (-27.10 to -16.14%) ***	1.06% (-1.09 to 3.25%)	0.29% (-1.07 to 1.67%)
6. Eastern	0.28% (-0.43 to 0.99%)	-16.22% (-23.88 to -7.79%) **	0.86% (-0.93 to 2.68%)	-0.10% (-0.44 to 0.25%)
Urban	0.25% (-0.29 to 0.80%)	-16.44% (-26.89 to -4.49%) **	0.37% (-1.36 to 2.14%)	-1.85% (-2.30 to -1.40%) ***
Rural	0.33% (-0.72 to 1.39%)	-15.39% (-19.09 to -11.51%) ***	0.29% (-1.70 to 2.31%)	0.28% (-0.38 to 0.94%) ^

Note:

[‡] Based on OLS regression method with Newey-West standard error except otherwise indicated

[¥] Based on generalised least square regression

^ Statistically significant difference ($p < 0.05$) between urban and rural areas

Statistical significance was denoted as follows: *$0.01 \le p < 0.05$, **$0.001 \le p < 0.01$, ***$p < 0.001$

was observed in Northern, Southern, and East Coast Regions where urban and rural areas are equally affected by the pandemic.

The Central Region, however, showed significant urban-rural differences in OPD utilisation changes during the first and second lockdown implementation period. During the first lockdown, OPD utilisation in urban areas of the Central Region experienced a greater monthly reduction of 29.31% (CI -37.82 to -19.66%) compared to rural areas, which showed a smaller monthly reduction of 18.57% (CI -21.29 to -15.87%). During the second lockdown implementation, although there was no significant change at the regional level, urban areas in the Central Region showed a 3.47% (CI 1.71 to 5.26%) monthly increase in OPD utilisation, as compared to rural areas that were unaffected. In the Eastern Region, the only period when there was a significant difference between urban and rural areas was during the second lockdown implementation; urban areas had a 1.85% (-2.30 to -1.40%) monthly reduction whereas no significant trend was seen in rural areas.

District Level

Figure 2 visualised the trend of changes (slope) in OPD utilisation from single-group ITSA during the four time periods, mapped against the urbanisation rate for each district. During the pre-pandemic period, all districts were showing utilisation changes within ±5% from the baseline level. During the first lockdown implementation period, most of the districts experienced more than 5% reduction in OPD utilisation, except for a few districts in the Eastern Region with low to medium urbanisation rates that were less affected. Subsequently, as the first lockdown was lifted, all districts showed more than 5% increase in utilisation, except for one district with a medium urbanisation rate in the Eastern Region that experienced more than 5% reduction during this period. During the implementation of the second lockdown, most districts showed minimal changes in OPD utilisation trend (±5%), although there were pockets of areas with more pronounced changes (<-5% or >+5%), where districts with high urbanisation rates appeared to be more susceptible to reductions in OPD utilisation.

Our findings in Fig. 2 are supported and further enriched by the simple linear regression analysis presented in Table 4. The result showed higher urbanisation rate is associated with greater changes in utilisation; however, the directions of effects were different across time periods. During the first lockdown, districts with higher urbanisation rates in Central and Southern Regions experienced a greater reduction in OPD utilisation (-8.847, CI -16.703 to -0.991), and no significant association was observed in other regions. As the first lockdown was lifted, districts characterised by higher urbanisation

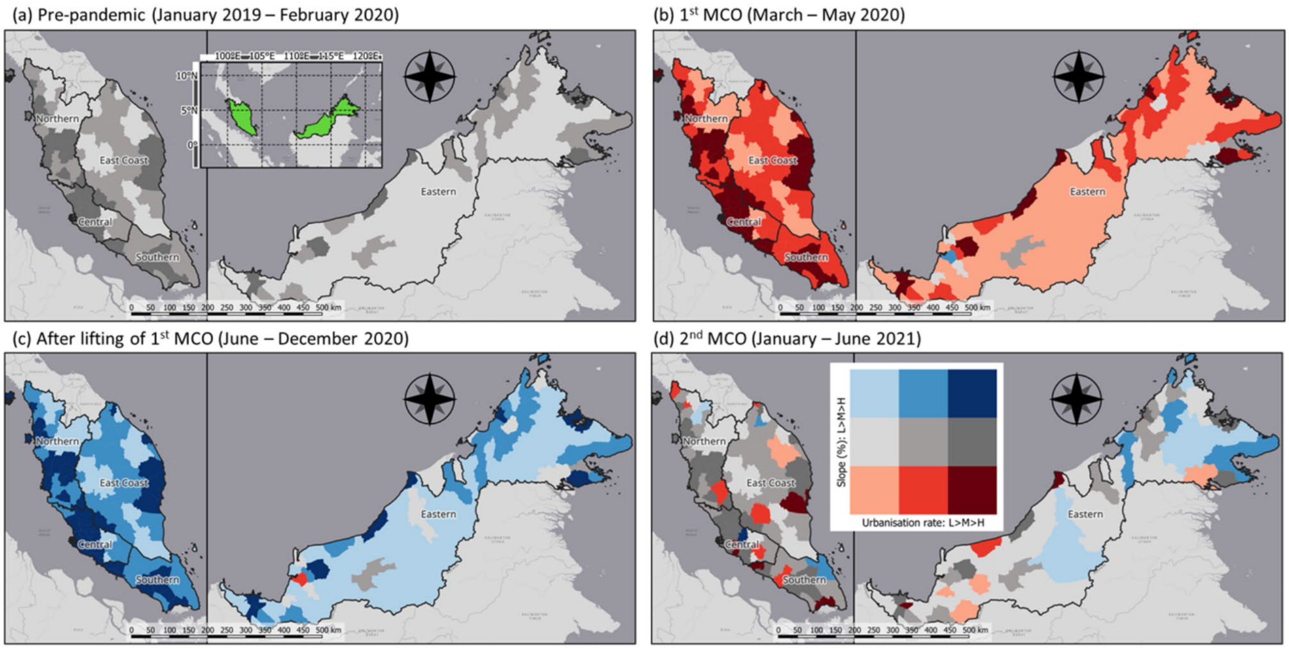

Fig. 2 Percentage change (slope) from interrupted time series through four distinct periods (**a**-**d**) vs. urbanisation rate, by districts, Malaysia. Miniature map within (**a**) indicates actual location of Peninsular Malaysia and Borneo Island (green)
Note: The slope (%) were grouped into three: L = <-5%; M = ±5%; H = >+5%; urbanisation rates were grouped into tertiles: L = low; M = medium; H = high. This bivariate choropleth map categorises data into nine groups based on slope (y-axis) and urbanisation rate (x-axis). Each colour block represents a unique combination of low, medium, or high values for both variables

Table 4 Simple linear regression of OPD utilisation changes and urbanisation rate at district level

Location	Pre-pandemic (Jan 2019 – Feb 2020)	1st lockdown implementation (Mar – May 2020)	Lifting of 1st lockdown (June – Dec 2020)	2nd lockdown implementation (Jan – June 2021)
	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)
1. National	0.310 (-0.099 to 0.720)	-8.520*** (-12.694 to -4.346)	16.159*** (9.657 to 22.660)	-2.380* (-4.360 to -0.399)
2. Northern	0.474 (-0.663 to 1.611)	7.915 (-1.528 to 17.358)	-10.849 (-29.101 to 7.403)	0.119 (-4.330 to 4.569)
3. Central & Southern	0.920 (-0.077 to 1.916)	-8.847* (-16.703 to -0.991)	16.054* (1.999 to 30.109)	-2.429 (-7.779 to 2.921)
4. East Coast	-0.003 (-0.834 to 0.829)	-8.225 (-16.586 to 0.137)	18.457* (3.445 to 33.468)	-5.389* (-9.944 to -0.834)
5. Eastern	-0.420 (-1.168 to 0.328)	-4.409 (-11.942 to 3.124)	11.179* (0.755 to 21.603)	-1.734 (-5.627 to 2.160)

Note:
Statistical significance was denoted as follows: *0.01 ≤ p < 0.05, **0.001 ≤ p < 0.01, ***p < 0.001

rates generally witnessed a more pronounced increase in OPD utilisation compared to those with lower urbanisation rates. This pattern was consistent across all regions, except for the Northern Region. During the second lockdown, a significant association between urbanisation and utilisation changes were seen at the national level and East Coast Region, where districts with higher urbanisation rates experienced greater reduction as compared to the lower ones.

Discussion

This study provides a broad overview of how COVID-19 impacted the utilisation of public primary care OPD services across Malaysia, from a national to a district level. The detailed urban-rural analysis allows further exploration of variation in primary care OPD services utilisation during the pandemic in a smaller geographical aggregation, which is important in understanding the landscape of healthcare equity in the country. This analysis provides a valuable perspective for policymakers in addressing these gaps and ensuring more equitable healthcare access across different geographical areas.

The generalised reduction of OPD services in Malaysia's primary care during the first lockdown implementation period was consistent with findings across the globe where many countries reported a reduction in primary care utilisation following the implementation of various measures to curb the spread of COVID [1, 2, 10, 31–33]. Our descriptive (unadjusted) findings on changes in OPD services utilisation showed a reduction of approximately 28% upon the pandemic hit and the first lockdown was implemented. A review study consolidated the early impact of the pandemic on outpatient care utilisation worldwide, reporting reductions ranging from 22 to 71%, with a median of 61% [31]. Separate studies in China reported varied reductions, ranging from 23 to 40% [1, 18], while a study in the Sub-Saharan Africa region documented a 27% decline. Some countries [15], however, reported only minimal reductions, such as Sweden (approximately 10%) [10] and Singapore (around 13%) [32]. Although these findings provide insight into the degree of impact on OPD utilisation, cross-country comparisons are not directly comparable due to differences in healthcare contexts, definitions of primary care services included in the measurement, and the timeframes analysed. Additionally, our study reports findings based solely on available data from public (MOH) primary care facilities, excluding the private sector, which generally accounts for about 51% of total outpatient visits [34]. This suggests that the actual impact of the pandemic on OPD services utilisation could be greater, as the private sector was estimated to have suffered financial losses ranging from 59 to 75% [35]. If these losses translated into visit reductions, the impact could be similar.

Compared to other primary care services in Malaysia such as maternal, women, and child health services [36]; a greater reduction was seen in OPD services, indicating that primary care services for general adults and chronic diseases were more affected. Since OPD services encompasses a wide range of healthcare needs, including routine medical check-ups and treatment for minor ailments, the general difficulties in accessing health services during the pandemic likely deterred people from seeking care for less essential or non-urgent conditions. This could also be attributed to differences in service delivery approaches, for instance, maternal and child health services in Malaysia's public primary care employed a more proactive defaulter tracing mechanism. Additionally, OPD services may have been more significantly impacted by changes in primary care service delivery such as compulsory appointment-based visits, rescheduling patients' appointments to longer appointment intervals and reducing appointment frequency, and deployment of public primary care resources to COVID-19 mitigation efforts, including quarantine and centralised response centres [4].

The decrease in OPD services utilisation may be due to the scaling back of less-essential healthcare services that were routinely used prior to the pandemic, as suggested by several literatures [14, 37, 38]. However, reductions were observed not only in visits for new cases but also in follow-up appointments, which may indicate a compromise in essential care for chronic diseases [39]. This raises concerns about the health outcomes of patients with chronic diseases, who constitute 50.8% of OPD services attendees at public primary care facilities [40]. Interestingly, a national audit program in public primary care reported improvements in glycaemic control among Type 2 Diabetes Mellitus (T2DM) patients attending these facilities. The proportion of T2DM patients achieving an HbA1c level $\leq$ 6.5% showed a modest increase during the pandemic years compared to pre-pandemic levels; 27.6% (2019), 30.7% (2020), 32.6% (2021), and 31.9% (2022) [41]. While these findings may present an encouraging trend, further exploration into the mortality and morbidity of chronic disease patients is crucial to comprehensively evaluate the impact of reduced OPD utilisation on patient outcomes, accounting for survival bias. The trend may also indicate improved awareness and propensity of seeking care after the pandemic, which could in turn improve disease screening and reporting. This was reflected in our findings, which showed a trend of surge increase in OPD utilisation after the first lockdown was lifted, particularly in urban areas. This represents a positive shift, as published studies have consistently highlighted that the COVID-19 pandemic typically led to detrimental effects on care-seeking behaviours, including missed medical follow-up appointments [42], largely driven by fear of getting infected especially in health facilities [43], which are perceived as places where sick individuals gather for treatment.

The urban-rural differences in utilisation of OPD services were significant only in specific areas of the country and did not manifest consistently throughout the study period. The different directions of effects indicate greater fluctuations in urban areas, where greater reduction was seen during MCO implementation, followed by a greater increase once the restrictions were lifted, as compared to the rural areas. A time-series study conducted in China, which included the first six months of the COVID-19 pandemic, reported similar findings during the implementation of the nationwide restriction. The study observed that more-developed regions experienced a greater reduction in healthcare service utilisation during the initial period of the pandemic compared to less-developed regions [1]. Similarly, another study in South African primary care clinics reported a more considerable decrease in utilisation among urban clinics for certain indicators compared to those in rural areas [44]. A study on cancer services in primary care settings reported a higher reduction of primary care contacts in least-deprived areas as compared to most-deprived areas [45]. In Malaysia, movement control orders aimed at mitigating virus transmission through physical contact were implemented with varying stringency at the local level, depending on the number of reported cases. A stricter Enhanced MCO (EMCO) was imposed in areas identified as high-risk or experiencing a sudden rise in new cases [46]. During the second quarter of 2020, several localised EMCOs were enforced in the Central and Southern Regions, likely contributing to the significant reduction in OPD attendance due to movement restriction or the deferral of non-emergency medical appointments.

The urban healthcare systems were also theoretically stretched thin during the crisis. While there is no clear quantification of healthcare human resource distribution between urban and rural primary care settings, it is evident that OPD attendance volumes were higher in urban areas, indicating a greater burden. Additionally, some medical staff were mobilised to COVID-19 Assessment Centres (CAC) and quarantine stations which were particularly located in urban areas that were equipped with better resources. This mobilisation posed challenges, including further reducing staff availability at health facilities [46]. Crowded and confined urban areas, with higher population density, were associated with a greater number of cases and higher cumulative case counts [47, 48]. This would partly explain why the stricter lockdown; the EMCOs, were more common in urban areas, which led to a greater reduction in OPD attendance. It is also evident that the urban population had high reliance on modern medicine, rather than self-medicating as compared to the rural population [34, 49], therefore any closures or movement restriction can have a big impact.

The greater fluctuations in urban areas may be attributed to more pronounced behavioural and social changes, such as job loss and disruptions in daily routines, as documented in a previous study [50]. Media coverage of COVID-19 prevention which predominantly focused on large urban cities with high population densities may have influenced rural residents to report less-positive attitudes toward the effectiveness of performing preventive behaviours [51]. Consequently, rural residents were less likely to engage in preventive practices such as avoiding gatherings, staying home as much as possible, and avoiding public transportation [51–53]. In contrast, urban populations exhibited heightened concern regarding social distancing and COVID-19 preventive measures [50], which likely contributed to their hesitance in seeking healthcare during the MCO period. Additionally, urban dwellers may have greater exposure to both information and misinformation, through various social media platforms. This likely inequality in media exposure between urban and rural areas may have acted as a protective factor for rural residents, where misinformation was less likely to spread widely, resulting in a lesser magnitude of reduction in healthcare utilisation compared to urban areas. Before the pandemic, rural residents often travelled to urban areas for more comprehensive primary care services; however, the interdistrict travel ban during the MCO likely hindered their ability to seek healthcare at urban facilities, which manifested as reduced utilisation of health facilities in urban areas [1]. Conversely, a greater rebound in OPD utilisation observed in urban areas following the lifting of lockdown measures can be attributed to the rapid adaptation of urban residents to the policy changes, facilitated by extensive media exposure and an increased necessity for mobility to return to work [46]. Public healthcare was utilised more in rural areas compared to their urban counterparts, as indicated by higher OPD visit rates to public facilities [34, 49]. Additionally, rural areas experienced a smaller magnitude of disruptions in OPD utilisation during the pandemic, suggesting that urban areas (which often are considered more resilient) may have been more compromised and vulnerable during the pandemic, in contrast to the common perception of rural areas as being more disadvantaged.

The findings from this study highlighted important points that could be used to improve existing policies towards strengthening primary healthcare in the country. Enhancing IT infrastructure could better support integrated virtual consultations and online appointment systems, ensuring continued access to healthcare during public health emergencies. Expanding digital health literacy programs and equipping healthcare providers with telemedicine tools, particularly in underserved communities, may help reduce healthcare inequalities. Updating standard operating procedures to reflect these adjustments could support long-term implementation. Additionally, leveraging public-private partnerships could enhance healthcare accessibility nationwide and contribute to improving the population's health, especially in reducing the burden of non-communicable diseases.

The study also raises an important question on how the reduction of primary care OPD services impacted the outcome of our patients, especially among chronic diseases. Future studies could include sensitive measurements such as disease-specific rate of hospital admission, development of disease complications, and disease-specific mortality rate. Additionally, the observed urban-rural differences, although not uniformly found across the nation, prompts the need for further exploration into healthcare equity in Malaysia during this health crisis. Understanding the specific factors that contribute to the resilience of certain regions can guide public health initiatives and policy decisions aimed at strengthening primary healthcare systems and ensuring equitable access for all populations, especially in times of crises.

Strengths and limitations

Dataset used for this study were collected from all MOH's health clinics nationwide, submitted manually to the administrative database MOH Malaysia. The dataset included a substantial period before and during the pandemic, allowing for meaningful insights into trends in outpatient service utilisation over time. With coverage of 99.7% of officially published facilities, the potential for underreporting is minimal. Although this data was verified and officially used for national health indicators, the manual submission process and quality checks limit the study's ability to provide real-time insights into OPD services utilisation throughout the pandemic period. Additionally, our study did not capture OPD attendance data from non-MOH primary care clinics, such as private general practitioner clinics, limiting our ability to present a complete picture of the utilisation changes, despite the private sector accounting for 51.1% of total outpatient service utilisation (though this figure encompasses all outpatient services at any facilities, including hospitals) [34]. This study did not obtain disaggregated data on the various reasons for OPD visits, limiting our ability to analyse how COVID-19 affected different disease groups. The data reported in this study also excludes outreach activities or consultations such as home visits, school health services, and virtual clinic consultations. After the onset of COVID-19, a nationwide virtual clinic initiative was implemented within public primary care clinics in Malaysia. However, the number of virtual clinic consultations remained significantly low during our study period, compared to the total OPD attendance [54, 55].

Current analyses may have oversimplified estimates for the Eastern Region by combining Sarawak, Sabah, and the Federal Territory of Labuan altogether. While the initial intention was to compare their distinct administration features due to their shared geographical proximity in Borneo Island, this approach might risk overlooking important local differences within the region. Our analysis did not incorporate other potential independent variables, such as curfew schedule, populations' mobility patterns, and COVID-19 case or mortality rates, which could influence health seeking behaviour and service utilisation. While we identified changes in OPD services utilisation associated with the pandemic and lockdown measures, other external factors may have contributed to the observed changes. The robustness of the multiple-group time-series model for comparability between the urban and rural groups could also be enhanced by applying a propensity score-based weighting or synthetic control approach, which requires consideration of additional covariates in the model estimation [25, 56]. Moreover, our time-series study was unable to account for subsequent interventions following the second lockdown, such as its lifting in March 2021 and the initiation of the third lockdown in June 2021, due to insufficient data points [57]. Despite these limitations, ongoing monitoring and analysis of essential health services utilisation in the post-pandemic period are crucial to ensure that all aspects of healthcare systems are recovering appropriately.

Conclusion

The findings from this study suggest that OPD services utilisation in public primary care in Malaysia was susceptible to disruptions during the COVID-19 pandemic. The disparities in utilisation changes between urban and rural areas were evident in certain areas of the country, with less pronounced fluctuations seen in rural areas. Understanding these patterns is essential in identifying specific areas that may require targeted interventions to address disparities in access to care, especially during public health emergencies. These findings highlight the potential value of continuous monitoring and immediate mitigation measures to sustain essential health services throughout a health crisis, thereby minimising adverse collateral damages from other diseases. Further research is needed to examine the effects of reduced OPD utilisation on patient outcomes and to explore protective factors contributing to the resilience of specific regions.

Abbreviations

MCO	Movement Control Order
MOH	Ministry of Health
OPD	Outpatient Department
ITSA	Interrupted Time Series Analysis
OLS	Ordinary least square
CMCO	Conditional Movement Controlled Order
SLR	Simple Linear Regression
T2DM	Type 2 Diabetes Mellitus
EMCO	Enhanced Movement Control Order

Supplementary Information

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Supplementary Material 1

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Author contributions

IRMU lead in designing the study, data acquisition, conducting the analysis, interpretating the results, and preparing the initial draft of the manuscript. JAH was involved in conducting the analysis. NH was involved in designing the study and data acquisition. AAAR and RS were involved in data acquisition. All authors participated in the writing of the first draft, process of revising the drafts of the manuscript, and have approved the final version of the manuscript.

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Data availability
The data that support the findings of this study are available from the Ministry of Health, Malaysia but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of the Ministry of Health, Malaysia.

Declarations

Ethics approval and consent to participate
Ethical approval for this study was granted by the Medical Research and Ethics Committee (MREC) of the Ministry of Health, Malaysia (KKM/NIHSEC/P20-1586).

Consent for publication
Not applicable. This publication presents aggregated data that does not contain any personally identifiable information.

Competing interests
The authors declare no competing interests.

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