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Trends in cataract surgery and healthcare system response during the COVID-19 lockdown in Malaysia: Lessons to be learned

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ABSTRACT

Background: Elective surgeries were suspended during the national lockdown in March 2020 to curb the spread of the COVID-19 pandemic in Malaysia. We sought to evaluate the impact of the lockdown on cataract surgeries and suggest lessons for future outbreaks.
Study design: We conducted an interrupted time series analysis to examine rates of cataract surgery before and during the lockdown.
Methods: We used national cataract surgical data between 2015 and 2021 from the Malaysian Cataract Surgery Registry. Segmented regression with a seasonally adjusted Poisson model was used for the analysis. Stratified analyses were performed to establish whether the effect of the lockdown on cataract surgeries varied by hospital designation, type of cataract service, sex, and age groups.
Results: Cataract surgeries began falling in March 2020 at the onset of the lockdown, reached a trough in April 2020, and subsequently increased but never recovered to pre-lockdown levels. Cataract surgical rates in December 2021 were still 43 % below the expected surgical volume, equivalent to 2513 lost cataract surgeries. There was no evidence of a differential effect of the lockdown between COVID-19 designated and non-COVID-19 designated hospitals. The relative decrease in cataract surgical rates appears to have been greatest in outreach services and in people 40 years and older.
Conclusions: The lockdown caused an immediate reduction in cataract surgical rates to nearly half of its baseline rate. Despite its gradual recovery, further delays remain to be expected should there be no redistribution or increase in resources to support backlogs and incoming new cases.

1. What this study adds

- Our research findings provide an insight into the delivery of cataract surgical services in a health system that designated hospitals for suspected and confirmed COVID-19 cases. Prior to this study there were no information about the organisation and delivery of elective services by COVID-19 hospital designation.
- These findings add to limited evidence base in low- and middle-income countries demonstrating that the COVID-19 lockdown had significant immediate and long-term effects on cataract surgical services. By stratifying across type of service and patient populations, we were able to identify subgroups that were more vulnerable to the impact of the lockdown.
- Our lockdown policies and approaches to lifting restrictions are rather different to China and India; thus, findings from our country will serve as an example of the impact of COVID-19-related policies to healthcare services, especially to countries with similar socio-economic backgrounds and COVID-19 resumption protocols for elective surgeries.

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2. Implications for policy and practice

- Both our findings and those of previous studies show that the COVID-19 pandemic resulted in a significantly reduced volume of cataract surgeries, and that recovery was uneven across regions, independent of country income status.
- These findings emphasise the crucial demand for timely governmental action and clear communication of public health policies to overcome the negative effects of a continued pandemic or similar epidemics in the future.
- Health systems may need redesigns or restructures to care for COVID-19 and non-COVID-19 patients in parallel, instead of simply triaging elective surgeries to non-COVID-19 designated hospitals to sustain volumes.

3. Introduction

The World Health Organisation's (WHO) declaration of the COVID-19 pandemic on March 11, 2020 has prompted the adoption of strict social containment measures worldwide, with devastating consequences to health systems, especially in low- and middle-income countries (LMICs) [1,2]. During the epidemic peak of COVID-19, healthcare services were instructed to cease all elective activities and postpone non-urgent outpatient clinics as much as possible to cope with the anticipated surge in intensive care needs [3].

In Malaysia, the government imposed a nationwide lockdown known as the Movement Control Order (MCO) on March 18, 2020 in an attempt to reduce the transmission of the virus [4]. Subsequently, recognising the need for strategic healthcare management, the Ministry of Health (MOH) implemented COVID-19 guidelines in April 2020, specifically addressing the triage of non-emergent and non-urgent surgical procedures. These guidelines involved the prioritisation of surgical activities based on their urgency, resulting in the cancellation or postponement of elective surgeries. The underlying rationale was to maximise the healthcare system's capacity for the potential surge in intensive care demand. As the COVID-19 pandemic evolved, the MOH released updated guidelines to guide the management of surgery through the different phases of the COVID-19 pandemic. These dynamic guidelines highlight the adaptive response required to navigate the unprecedented challenges posed by this public health crisis.

In response to the COVID-19 pandemic, as part of Malaysia's comprehensive preparedness plan [5], the MOH repurposed regional referral hospitals nationwide as COVID-19 designated hospitals. Each state in Malaysia designed at least one hospital as a COVID-19 designated hospital, serving as an admitting hospital for both suspected and confirmed COVID-19 cases. These COVID-19 designated hospitals played a crucial role in managing COVID-19 patients, while other public hospitals functioned as non-COVID-19 designated hospitals, primarily focusing on screening and triaging individuals for COVID-19. This strategic allocation allowed COVID-19 designated hospitals to redirect non-COVID-19 patients requiring admission to non-COVID-19 designated hospitals. Simultaneously, non-COVID-19 designated hospitals diverted COVID-19 patients to COVID-19 designated hospitals for targeted care.

We expect that the implementation of risk stratification and prioritisation protocols will result in severe disruption to scheduled elective surgeries from all disciplines. However, it is not known whether national policies are adopted in practice at the level of the health institution. Therefore, it is important to determine the extent to which lockdown restrictions reduced the use of elective hospital-based services, in particular, cataract surgery. We examined a series of three interrelated questions: 1) What was the magnitude of change in cataract surgical rates associated with the lockdown? 2) Did changes in cataract surgeries differ by hospital designation? We hypothesised that the lockdown would affect cataract surgical rates more strongly in COVID-19 designated hospitals as these hospitals were exclusively assigned to treat COVID-19 patients; and 3) Did changes in cataract surgeries associated with the lockdown return to pre-lockdown levels when lockdown restrictions were eased, and did patterns of recovery differ by hospital designation?

4. Methods

4.1. Study design and population

This was an uncontrolled, interrupted time series (ITS) analysis of the monthly number of cataract surgeries recorded by the Malaysian Cataract Surgery Registry (CSR) from January 2015 to December 2021. Included were patients of all ages who have undergone cataract surgery. Patients who have secondary implantation of intraocular lens in an eye previously operated for cataract are excluded.

The event of interest was the national lockdown imposed by the Malaysian government on March 18, 2020. Therefore, we defined the period between January 2015 and February 2020 as the pre-lockdown period, and the period between March 2020 and December 2021 as the lockdown period.

4.2. Data retrieval and processing

We retrieved fully de-identified, patient level data spanning years 2015–2021 from the CSR. Details of the design and conduct of the registry have been previously described [8]. Briefly, the CSR is a nationwide, ongoing, web-based patient registry initiated by the ophthalmology service of the MOH Malaysia. Commencing in 2002, the CSR systematically captures cataract surgeries performed not only by all ophthalmology departments within the MOH, but also, to a lesser extent, by ophthalmology departments at the Ministry of Defence, university hospitals, and private eye care providers. Presently, data on cataract surgeries is contributed by 121 centres to the CSR. Based on MOH census returns, 338,917 cataract surgeries were recorded between 2015 and 2021, while the CSR captured 343,225 cataract surgeries during the same period. Given that the CSR includes cataract surgeries from both MOH and non-MOH facilities, the coverage ranged from 96.9 % in 2016 to 111.3 % in 2021. Raw data are entered into the registry by designated staff in respective ophthalmology departments on a daily basis. This meticulous process ensures the accuracy and completeness of the data captured by the CSR.

Data retrieved from the CSR were checked for missing values, outliers, and duplicate records. We excluded records with missing data on age; and since missing data were less than 2 %; we did not impute data. Mid-year population estimates by sex and age groups were obtained from the Department of Statistics Malaysia [9].

4.3. Statistical analysis

Descriptive analyses were used to characterise differences before and during the lockdown. The impact of the lockdown on monthly cataract surgeries was modelled using a generalised linear model with a time series specification [6,7]. We proposed a level and trend change ITS model [6], assuming an immediate reduction and a subsequent ramp-up of surgical activities [4,10]. Monthly cataract surgical rates were calculated as the number of cataract surgeries per month divided by the population in the year, and then multiplying the resulting number by 100,000. The annual population size of Malaysia was used as an offset to model rates, accounting for seasonality and overdispersion. Model assumptions were assessed by visual inspection of residual plots, and autocorrelation and partial autocorrelation functions. Incidence rate ratios from regression models and their 95 % confidence intervals were reported. We estimated the extent of lost cataract surgeries—the differences between observed values under the full ITS model and the expected model assuming that the lockdown did not occur.

Stratified analyses were conducted to visualise whether changes in

cataract surgical rates varied by hospital designation (COVID-19 designated hospital, non-COVID-19 designated hospital), cataract service (hospital, outreach), sex, and age groups. All statistical analyses were conducted using Stata version 15 (StataCorp, College Station, TX, USA). A two-sided p-value of less than 0·05 was considered statistically significant.

5. Results

5.1. Unadjusted changes in cataract surgeries during the lockdown

A total of 343,225 cataract surgeries were performed between 2015 and 2021. Of these, 63,921 were performed after the implementation of the lockdown. Table 1 summarises the monthly number of cataract surgeries and the rates per 100,000 population before and during the lockdown. Overall, unadjusted monthly rates of cataract surgery decreased from 14·1 to 8·9 per 100,000 population during the lockdown.

5.2. Model-based estimates of changes due to the lockdown

The monthly time series data are depicted in Fig. 1. Over the period studied, the underlying trend was of a 0.5 % increase per month in cataract surgical rates (RR = 1·005, 95 % CI 1·002–1·008; p = 0.0010) before the lockdown. There was an immediate 54 % decrease in cataract surgical rates associated with the lockdown (RR = 0·462, 95 % CI 0·358–0·596; p < 0·001). We did not find evidence of a gradual effect of the lockdown, as there was no change in the underlying trend in cataract surgeries after March 2020 (p = 0·29). Visual inspection of the residual plots indicates no autocorrelation, as the residuals exhibit a random dispersion.

Results for the immediate and gradual effects of the lockdown stratified by pre-specified subgroups, are shown in Fig. 2 and Table S1. All results are concordant in suggesting a decrease in cataract surgical rates. Contrary to our hypothesis, stratified analyses showed no evidence of a differential effect of the lockdown by hospital designation. A 57 % decrease in cataract surgeries was observed in non-COVID-19 designated hospitals when the lockdown was implemented in March 2020, similar to the 51 % reduction in COVID-19 designated hospitals. Although larger decreases in cataract surgical rates were observed in outreach services compared to hospitals, and likewise, in people 40 years and over with senile cataract compared to those below 40 years, p-values for interaction terms were not statistically significant. Trends of cataract surgeries showed no significant change after the lockdown (Table S1) compared to the underlying (counterfactual) trend, both in the overall and stratified analyses.

Table 1
Mean monthly cataract surgical data for the duration of the time series.[a].

Population	Before lockdown (January 2015–February 2020)		During lockdown (March 2020–December 2021)	
	Monthly number of cataract surgeries	Monthly rate[b] of cataract surgeries	Monthly number of cataract surgeries	Monthly rate[b] of cataract surgeries
Total	4505 (776)	14·1 (2·3)	2906 (1206)	8·9 (3·7)
Sex				
Male	2140 (352)	13·0 (2·0)	1420 (597)	8·5 (3·6)
Female	2365 (428)	15·3 (2·6)	1485 (611)	9·4 (3·9)
Age group				
≥40 years (senile cataract)	4320 (723)	44·1 (3·7)	2820 (1174)	26·8 (11·2)
<40 years	98 (21)	0·4 (0·1)	86 (34)	0·4 (0·2)
Hospital designation				
COVID-19 designated hospital	2380 (363)	7·4 (1·1)	1474 (585)	4·5 (1·8)
Non-COVID-19 designated hospital	2125 (456)	6·6 (1·4)	1432 (631)	4·4 (1·9)
Cataract service				
Hospital	4232 (665)	13·2 (2·0)	2712 (1131)	8·3 (3·5)
Outreach	273 (150)	0·9 (0·5)	202 (103)	0·6 (0·3)

[a] All values reported are means (standard deviations).
[b] Rate per 100,000 population, calculated as number of cataract surgeries divided by the population then multiplied by 100,000.

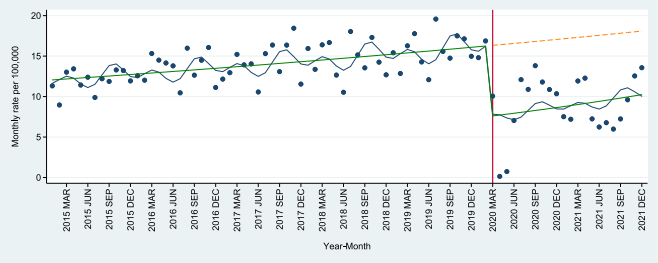

Figure. 1 Trends in monthly cataract surgical rates in Malaysian hospitals during the period 2015-2021.
The blue dots show observed rates and the blue lines indicate model-fitted (expected) rates. Green lines represent the deseasonalised trend before and during the lockdown. The red vertical line indicates the implementation of the lockdown. The orange dashed line represents the counterfactual rates had the lockdown not occurred.

5.3. Lost cataract surgeries

Table 2 shows the number of lost cataract surgeries by time from the start of the lockdown, based on predictions from pre-lockdown trends. At the point of lockdown in March 2020, there were 2920 fewer cataract surgeries than expected (95 % CI -3027, −2814). At 1-year post-lockdown, the number of cataract surgeries was 48 % lower than expected had the lockdown not occur, equivalent to more than 2500 lost cataract surgeries. There was a mere 0.9 % improvement per month (relative to the underlying trend) in the resumption of cataract surgeries after 21 months, and approximately 2500 surgeries remain lost. The number of cataract surgeries performed in non-COVID-19 designated hospitals were surprisingly much lower than expected compared to COVID-19 designated hospitals (−48 % vs. −39 % at 21 months post-lockdown) throughout the lockdown period. Similarly, the drop in the observed number of cataract surgeries compared to the expected number was larger in outreach services than in hospitals (−63 % vs. −42 % at 21 months post-lockdown). The observed and expected cataract surgeries by pre-specified subgroups are summarised in Tables S2–S5.

6. Discussion

6.1. Principal findings

This study demonstrated that cataract surgical services in Malaysia were substantially impacted by the COVID-19 lockdown. At the onset of the lockdown in March 2020, we observed an immediate reduction in cataract surgical rates to almost half of its baseline rate. After the initial decrease, there was a non-significant increase over and above the underlying trend in the rate of cataract surgeries by 0.9 % per month. The impact of the lockdown persisted into 2021, as cataract surgical rates in December 2021 were still 43 % below the expected volume. Contrary to our hypothesis, there was no evidence of a differential effect of the lockdown between COVID-19 designated and non-COVID-19 designated hospitals. The relative decrease in cataract surgical rates appears to have been greatest in outreach services and in people 40 years and older.

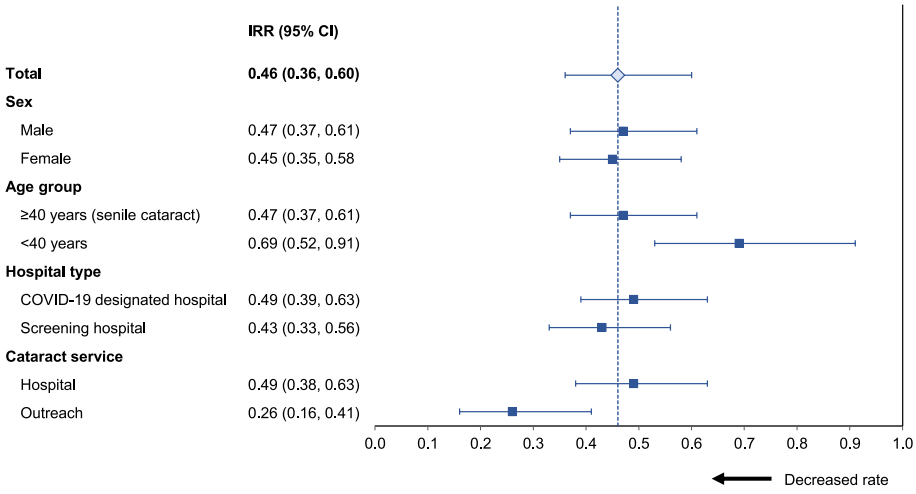

Figure. 2 Stratified analyses of the immediate effect of the March 2020 lockdown on monthly cataract surgical rates. Adjusted rate ratios and 95% confidence intervals for level change (change in cataract surgical rates between before and during the lockdown) are presented. All results are based on a level and trend model, adjusted for seasonality and overdispersion.
CI: confidence interval; IRR: incidence rate ratio

Table 2
Observed and expected cataract surgeries in the lockdown period based on pre-lockdown trends.

Time period	Observed[a]	Expected[b]	Lost cataract surgeries[c]	Percent lost cataract surgeries[d]
During lockdown	2550	5470	−2920	−53·4 %
3-months post-lockdown	2326	4854	−2528	−52·1 %
6-months post-lockdown	2977	6042	−3065	−50·7 %
9-months post-lockdown	2761	5450	−2689	−49·3 %
12-months post-lockdown	3028	5813	−2785	−47·9 %
21-months post-lockdown	3279	5792	−2513	−43·4 %

[a] Modelled counts adjusted for seasonality and overdispersion.
[b] Expected counts if there had not been a lockdown (i.e. the counterfactual).
[c] Lost cataract surgeries in a given month, calculated as Observed – Expected.
[d] Lost cataract surgeries expressed as a percentage of the expected number of cataract surgeries.

6.2. Comparison with other studies

The abrupt reduction in the rate of cataract surgeries by 54 % in Malaysian hospitals was attributable to national policies curtailing elective surgeries during the lockdown. Despite the gradual increase in cataract surgical activity over the course of the pandemic, the number of cataract surgeries still did not reach its pre-lockdown levels (as of December 2021). Our findings are consistent with a Polish study [11]. Similarly, other countries [12–17] reported drastic reductions in the usual volume of cataract surgeries or ophthalmic procedures by 67 %–99 % in the early phase of the pandemic. However, the recovery of cataract surgeries was uneven across regions, independent of country income status. Studies in some regions gathered similar results to ours [18–20]. In other regions [12,13,21], cataract surgeries returned to or exceeded pre-COVID-19 vol a few months after the initial cancellation of elective ophthalmic service during the pandemic.

In our study, trends in cataract surgery were similar in COVID-19 designated and non-COVID-19 designated hospitals. When resumptive protocols for elective surgeries were introduced by the MOH, we expected the number of cataract surgeries to increase more rapidly in non-COVID-19 designated hospitals compared to COVID-19 designated hospitals as non-COVID-19 designated hospitals would focus on the management of non-COVID-19 medical conditions. However, at 21 months after the lockdown, cataract surgical volumes in non-COVID-19 designated hospitals were at half of the expected surgical volume. These findings may be attributable to the unstandardised implementation of policies by local and state governments, and variation in the delivery of healthcare services among non-COVID-19 designated hospitals. Designation of hospitals may not be sustainable across the multiple pandemic waves [22] as non-COVID-19 designated hospitals redistribute intensive care services and workforce. Furthermore, surgical workforce shortages and facility capacity [20] across different surgical specialties, and the disproportionate prioritisation of other elective surgeries over cataract surgeries [23] may have impeded the ramp-up of cataract surgical volumes in non-COVID-19 designated hospitals.

By stratifying across cataract services, our study provides insights into the impact of the lockdown on outreach services. Compared to hospital services, outreach services were affected to a greater extent during the lockdown where there were zero surgeries in April 2020, compared to 269 in March 2020. Although outreach services are encouraged by the WHO as an adaptation mechanism to ensure the delivery of essential health services [24], these programs typically rely on coordination, partnership, and referral networks in the community. Given that outreach models vary greatly by the degree of resource intensity [25,26], context-specific adaptations with respect to restriction measures may be required to reverse the negative changes in the access to outreach teams.

In our study, the majority of patients who underwent cataract surgery were aged 40 years and above (98 %). However, during the lockdown, the number of cataract surgeries performed in older patients were relatively fewer than those in younger patients, which have been observed in studies in India [13] and Saudi Arabia [19]. Older age is an important risk factor for increased COVID-19 related morbidity and mortality [27] in all phases of the pandemic, which may have led to healthcare professionals postponing cataract surgeries in older patients, or patients themselves electing to defer their surgeries even if hospitals have resumed elective surgeries under strict infection control procedures [20].

The easing of lockdown restrictions might not lead to an immediate

rebound of cataract surgical volume towards pre-lockdown levels. There are several factors behind this phenomenon, involving institutional policies, patient preference, and clinical judgement. While national guidelines provided guidance for the resumption of elective surgeries, many hospitals continue to enforce restrictions due to uncertainties about infection transmission, testing protocols, and operating room capacity. These factors have been previously reported as barriers to increasing surgery volumes [20,23]. The resurgence of COVID-19 cases in late April 2021 [28] which led to another nationwide lockdown in June 2021 might have hampered the resumption of cataract surgeries. Patients' reluctance to visit a hospital and undergo cataract surgery driven by a fear of COVID-19,[29] coupled with transportation-related obstacles in part due to imposed restrictions on public mobility [29], and healthcare professionals' decision to postpone cataract surgeries for the elderly might have led to the delay in moving from a position of curtailment to the reopening of elective surgery.

Due to suspension of cases during the lockdown and incoming new cases that are performed below 100 % capacity (without a simultaneous increase in resources) during the recovery phase, a substantial cataract surgical backlog is likely. A study in India [14] estimated that it would take 10 months under the ambivalent scenario to reach pre-pandemic expected cataract surgical volumes once elective surgical suspension is lifted and surgeries resume, during which there would be a collective backlog of 11 months' worth of cases. In high income countries [10,30], the time estimated to revert to pre-pandemic volumes under the pessimistic scenario is shorter—approximately 6–7 months.

6.3. Strengths and limitations of the study

To our best knowledge, this is the first study evaluating the true magnitude of the impact of the COVID-19 lockdown on cataract surgeries in Malaysia. This was a large-scale, population-based study of more than 300,000 cataract surgeries over a 7-year period using a comprehensive clinical registry, which is routinely used to evaluate the delivery of cataract surgical services in the country. We quantified the impact of the lockdown using a robust ITS design. By modelling long-term underlying trends and adjusting for seasonality, we not only controlled for secular changes in practice and artefactual changes due to regression to the mean, but we also took into account most of the potential confounding effect of risk factors that change periodically in the year. Our research findings provide an insight to the pandemic lockdown response in which COVID-19 designation status of healthcare facilities may facilitate decisions about the organisation of pandemic-affected healthcare services, in particular elective surgeries, which add to the limited evidence base of the impact of the COVID-19 lockdown on cataract surgeries in LMICs.

Our study has several limitations. First, we did not account for second or other future waves of the pandemic, nor analysed changes during the post-vaccine release period. This would require a longer post-lockdown period of which additional data from the registry would be required. Moreover, we wanted to focus our analysis on the lockdown period that involve the entire country at the same time. Second, we were not able to add a control series to the ITS analysis to perform an intervention-control group comparison in addition to the before-after comparison. We could not identify a suitable control population as the lockdown was implemented nationally. However, temporal changes in the prevalence of individual risk factors (such as ocular and systemic comorbidities) are inherently taken into account in time series studies. Despite these limitations, our study provided an analysis of the association of the COVID-19 lockdown and cataract surgical volumes beyond 2020, and highlighted gaps in national policies that may inform institutional focus for cataract service recovery in the post-COVID-19 era.

6.4. Implications for clinicians and policymakers

Findings of this research are relevant to policymakers and healthcare providers involved in addressing the backlog for cataract surgery that has likely developed during the COVID-19 lockdown. Addressing the backlog would eventually require an increase in cataract surgical volume beyond pre-lockdown levels, necessitating the reorganisation of cataract care pathways to be both efficient and sustainable when the pandemic subsides.

Healthcare systems may need redesigns or restructures to care for COVID-19 and non-COVID-19 patients in parallel, instead of simply triaging elective surgeries to non-COVID-19 designated hospitals to sustain volumes. In order for MOH to optimise Malaysia's health delivery system during the pandemic, clear information of national policies should be communicated to local and state governments. By clearly delineating the roles and responsibilities of COVID-19 designated hospitals, the uncertainty blanketing hospitals can be eliminated and resources can be more efficiently allocated. Clinicians should prioritise patients on waiting lists for cataract surgery based on clinical urgency, and not focus solely on the magnitude of the backlog.

6.5. Unanswered questions and future research

Future research should aim to estimate the COVID-19 cataract surgical backlog and potential strategies to ramp-up surgical volume to reduce backlogs. The impact of the postponement of cataract surgeries on long-term clinical outcomes and health-related quality of life of patients may be studied in future studies.

7. Conclusion

In summary, the COVID-19 lockdown in Malaysia resulted in a significantly reduced volume of cataract surgeries which rebounded quickly but not to pre-lockdown levels. Further delays are only to be expected should there be no substantial increases or redistribution in resources to support the backlog and incoming new cases, despite the gradual recovery in cataract surgical activity. Our findings emphasise the crucial demand for appropriate health policies that are coordinated and communicated effectively to prevent complete disruption of cataract surgical services during the pandemic.

Ethical approval

The study was approved by the National Medical Research and Ethics Committee of the Ministry of Health Malaysia (KKM/NIHSEC/P20-1170).

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Declarations of interest

None.

Contributors

AWYL and CTL contributed substantially to the study concept and design. MAS provided the data as well as administrative support for the study. AWYL performed data cleaning and statistical analysis for the study, while CTL and YMFL verified the Stata commands. AWYL led the drafting of the manuscript, and CTL, MAS, YMFL, WJW, and WYH critically revised the manuscript for important intellectual content and gave final approval of the version to be published. The overall conduct of the study was supervised by WYH. All authors take public responsibility for appropriate portions of the content, and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and

resolved. All authors read and approved the final manuscript. AWYL and WYH had full access to the data analysed in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Data sharing statement

Data used in these analyses are held by the National Eye Database, of which the Cataract Surgery Registry is one of the clinical registries in the database. Data are only available on request to National Eye Database with appropriate ethical approval for use.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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