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Impact of the COVID-19 pandemic on ophthalmic surgery at a tertiary hospital in South Africa

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Background: The coronavirus disease 2019 (COVID-19) pandemic impacted the provision of ophthalmic care.

Aim: This study aimed to quantify the pandemic on the number of ophthalmic surgeries.

Setting: The study was conducted at a South African tertiary academic hospital.

Methods: A retrospective comparative analysis of eye surgeries 1 year pre- and post- onset of the COVID-19 lockdown (27 March 2019 to 26 March 2021) was conducted. Theatre surgical records were analysed 1-year pre- and post-lockdown. All surgical procedures were recorded and subcategorised into cataract, cornea, glaucoma, oncologic, orbital, oculoplastic, strabismus, trauma, vitreoretinal, and other. Trauma surgeries in the post-pandemic year were sub-analysed based on the level alcohol restriction level.

Results: Total surgeries decreased from 3521 to 1551 ($P < 0.001$). Using multivariate analysis, the incidence rate ratio (IRR) for all surgeries during the pandemic was 0.47 ($P < 0.001$) with a significantly reduced IRR during the first wave of 0.427 ($P = 0.003$) and a non-significant change during wave two; IRR 1.25 ($P = 0.36$). All surgical subgroups decreased significantly except oncology, insignificant decrease from 211 to 180 ($P = 0.12$). Trauma significantly decreased during periods of total alcohol bans; IRR of 0.50 ($P < 0.001$). An insignificant decrease was found during periods of partial ban with an IRR of 0.83 ($P = 0.06$) compared with periods without alcohol restrictions.

Conclusion: Post lockdown, the total number of surgeries decreased in all subgroups except oncology. Alcohol bans significantly decreased trauma surgeries.

Contribution: This article provides valuable insight, which may inform public health policy.

Keywords: COVID-19; coronavirus; surgical procedures; ophthalmology; public health.

Introduction

On 11 March 2020, the World Health Organization (WHO) declared severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) linked disease (coronavirus disease 2019 [COVID-19]) a pandemic.[1] As cases rose, health systems worldwide were disrupted as resources were diverted to the COVID-19 response.[2] Globally, governments implemented lockdowns in various forms to mitigate the spread of the virus.[3] These lockdowns included measures such as restrictions on public gatherings, school closures, travel restrictions both local and international, workplace closures, stay at home orders, public event cancellations, and public transport closures. These policies were altered and eventually reversed at various stages in individual countries.[3] In South Africa, the first lockdown began at midnight on 26 March 2020.[4] The measures implemented were aimed at minimising community transmission as well as reducing the extra strain on the already overburdened healthcare system.

A controversial aspect of the COVID-19 response in South Africa was a restriction on the sale of alcohol. This is because of the high burden that alcohol abuse places upon healthcare services in South Africa. Annually, 63 000 South African adults die because of alcohol-related causes. Alcohol accounts for between 26% and 79% of trauma presentations at South African emergency departments, compared with an international estimate of 15%.[5] Alcohol restrictions were thus deemed necessary to mitigate the increased burden on healthcare resources posed by the COVID-19 pandemic.[5,6] These restrictions ranged from total to partial bans with various nuances during periods of the latter. This included variations on whether off-site consumption of alcohol was allowed compared with only being available for on-site consumption at licensed establishments. Restrictions also varied based on days of the week (usually Mondays to

Thursdays).[7] Studies in the provinces of KwaZulu-Natal and the Western Cape found a significantly decreased general trauma burden during alcohol restrictions.[5,7] The tangible cost of alcohol abuse was estimated at 1.6% of the 2009 South African gross domestic product or $5.3 billion.[2,6,8] Therefore, harmful alcohol use is a significant drain on the economy and healthcare system. An inevitable consequence of these lockdown measures was reduced utilisation of non-COVID-19 related services, which adversely affected the provision of universal healthcare services, including ophthalmic services, in low- and middle-income countries.[2]

The effects of the pandemic on ophthalmology led internationally to a paradigm shift in clinical practice, with measures including the cancellation of elective surgery, ophthalmologist redeployment, awareness of the increased occupational risk and changed procedures for consultations.[9,10] Ophthalmologists had to respond by making difficult choices to prevent permanent visual loss caused by treatment delays while cognisant of the risk COVID-19 posed to these often high risk patients while attending a healthcare facility.[11,12]

The American Academy of Ophthalmology on 18 March 2020 recommended that ophthalmologists provide only emergent or urgent care.[13] The Ophthalmological Society of South Africa (OSSA) on 23 March 2020, recommended all non-essential surgeries and outpatient visits be postponed or cancelled.[14] Nguyen et al. reported that 10 out of 12 major ophthalmic societies issued guidelines recommending postponement of non-urgent care as well as necessary safety measures.[15] This naturally led to less utilisation of ophthalmic services. Internationally, numerous studies have reported a decrease in ophthalmic surgical procedures during the pandemic.[13,16,17,18,19] Among studies in the USA reporting a decline in ophthalmic surgical numbers, Khersan et al. reported a decrease in surgical volume from 1107 cases in April 2019 to 117 in April 2020 at the Bascom Palmer Eye Institute in Miami Florida.[16] An analysis of a national database in the United States revealed that ophthalmic clinic visits decreased by 81% at the start of the pandemic. There were 3 583 231 procedures between 01 January 2018 and 30 June 2020 and elective procedures such as cataract surgery decreased significantly at the outset of the pandemic but returned to pre-pandemic levels by June 2020.[13,17] New Zealand, which initially had a similar lockdown approach to South Africa, saw elective surgical volumes decrease by 87.5% during the country's level four lockdown with volumes rapidly recovering post-lockdown.[18,20] A study of 10 European countries during the early pandemic found a decrease in both elective and emergency surgery with an estimate of an increased backlog of 50 000 cataract surgeries per month of lockdown in Italy.[19] In South Africa, this decreased utilisation of ophthalmic services and decreased surgical numbers added to the already overburdened waiting lists for patients.[21]

The study therefore attempted to quantify the direct effect of the COVID-19 pandemic on the rates of surgery at St John Eye Hospital, by comparing surgical numbers in the first year post-lockdown with the previous year. The study also assessed the effect of the alcohol bans on the numbers of patients with ocular trauma requiring surgery.

Methodology

A retrospective analysis was conducted at St John Eye Hospital (SJEH), Johannesburg, South Africa. St John Eye Hospital is the largest academic tertiary ophthalmology institute in sub-Saharan Africa located in Gauteng province. A review of all surgical procedures conducted at the operating rooms of SJEH between 27 March 2019 and 26 March 2020 (the pre-pandemic year) was compared with those performed between 27 March 2020 and 26 March 2021 (the first year of the pandemic in South Africa).

Information collected included the total number of surgical procedures performed monthly in each year. The total number of surgical procedures in each year was compared and served as the primary outcome. The data was also grouped according to subspeciality, that is, cataract (phacoemulsification, manual small incision cataract surgery, paediatric cataract, secondary intraocular lens insertion), cornea (amniotic membrane transplant, Descemet membrane endothelial keratoplasty, Descemet stripping endothelial keratoplasty, patch graft, penetrating keratoplasty, pterygium excision), glaucoma (incisional glaucoma surgery, glaucoma drainage devices, bleb needling, cyclodestructive procedures), oncology (ocular surface mass excision, enucleation for retinoblastoma, exenteration), orbits/oculoplastic (blepharoplasty, orbital decompression, lid reconstructive procedures, incision and drainage, ptosis repair), strabismus (muscle surgery and botulinum toxin injection), trauma (primary repair, evisceration, lid repair, fracture repair), vitreoretinal (pars plana vitrectomy, scleral buckling procedures and other) and other were further analysed. Trauma cases were additionally analysed according to periods that included the alcohol bans.

The study was conducted in accordance with the tenets of the Declaration of Helsinki. Approval for the study was granted by the Human Research Ethics Committee of the University of the Witwatersrand.

The primary objective was tested using a one-sample proportion test that compared the number of surgeries in each period as a proportion of the total number of surgeries over both periods. The null hypothesis in this instance was that the pre-pandemic year and the post-lockdown year should contribute equally, that is, 50% of the cases each. The number of surgeries in each subspeciality was tested, firstly using a one-sample proportion test to compare the two time periods as described for the primary objective above. Secondly, a two-sample proportion test was used to assess the proportion of surgery in each subspeciality against the total number of surgeries in either the pre-pandemic or post-lockdown time period. Univariate negative binomial regression models using the period of

the pandemic and COVID-19 waves as predictor variables were performed. Predictive margins were then generated from the model using the COVID-19 waves as predictors. Median splines and scatterplots were combined to graphically represent the number of surgeries performed over the 2 years.

For months with both partial and total bans, the type of ban present for over 15 days was used to represent the month. A *P*-value of <0.05 was considered significant. Data were stored on a password protected Microsoft Excel document. Data were analysed using Stata 16.1 (StataCorp™, College Station, Texas, USA).

Ethical considerations

Ethical clearance to conduct this study was obtained from the University of the Witwatersrand Human Research Ethics Committee (Medical) (No. M220421).

Results

Total ophthalmic surgical procedures

The change in the total number of ophthalmic surgeries and surgeries by subspeciality are summarised in Table 1. Of all the surgeries performed in the 2 years (n = 5072), 69.4% (95% confidence interval [CI]: 68.1–70.7; n = 3521) were performed in the pre-pandemic year and 30.6% (95% CI: 29.3–31.9; n = 1537) were performed in the post-lockdown year. The change in total surgical numbers during the 2 years is illustrated in Figure 1.

Ophthalmic surgical subgroups

A significant decrease was found in all subgroups apart from oncology. There were 391 oncology surgery cases performed over the 2 years, with 54% (95% CI: 49–59; n = 211) performed in the pre-pandemic year and 46% (95% CI: 41–51; n = 180) performed in the post-lockdown year. Cataract surgery, the most commonly performed procedure over the 2 years (n = 2096) significantly decreased, with 73.3% (95% CI: 71.4–75.2; n = 1537) of cases performed in the pre-pandemic year and 26.7% (95% CI: 24.6–28.6; n = 559) performed in the post-lockdown year. Table 1 summarises the change in each surgical subgroup with respect to the pandemic.

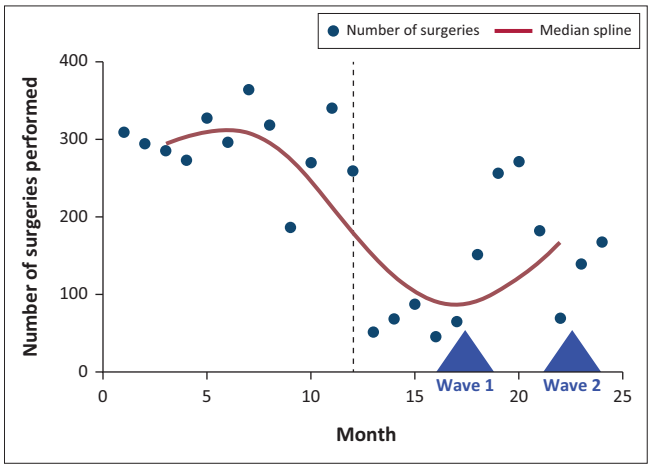

FIGURE 1: Median spline reflecting total surgeries performed in the pre- and post-pandemic year at a tertiary hospital in South Africa.

TABLE 1: Change in surgical numbers at tertiary hospital in the year pre-pandemic and the first year of the pandemic.

Surgery subtype	Year pre-pandemic		95% CI of proportion	Year post-pandemic		95% CI of proportion	*P**
	n	Proportion (%)		*n*	Proportion (%)		
All	3521	69.4	68.1 – 70.7	1537	30.6	29.3 – 31.9	<0.001
Cataract	1537	73.3	71.4 – 75.2	559	26.7	24.6 – 28.6	<0.001
Phacoemulsification	668	-	-	333	-	-	-
Manual small incision	523	-	-	114	-	-	-
paediatric	119	-	-	46	-	-	-
Cornea	264	74.4	69.8 – 79.0	91	25.6	21.0 – 30.2	<0.001
Glaucoma	189	57.6	52.3 – 62.7	139	42.4	37.3 – 47.7	<0.001
Incisional surgery	84	-	-	60	-	-	-
Glaucoma drainage device	13	-	-	3	-	-	-
Oncology	211	54.0	49.0 – 59.0	180	46.0	41.0 – 51.0	0.117
Enucleation	6	-	-	10	-	-	-
Exenteration	18	-	-	25	-	-	-
Ocular surface neoplasia excision	159	-	-	104	-	-	-
Orbits and oculoplastic	255	73.9	69.3 – 78.5	90	26.1	21.5 – 30.7	<0.001
Strabismus	299	1.00	1.00 – 1.00	1	0.00	0.00 – 0.00	<0.001
Trauma	378	60.1	56.3 – 63.9	251	39.9	36.1 – 43.7	<0.001
Open globe repair	160	-	-	101	-	-	-
Fracture repair	15	-	-	18	-	-	-
Lid repair	98	-	-	61	-	-	-
Vitreoretinal	264	60.3	55.7 – 64.9	174	39.7	35.1 – 44.3	<0.001
Pars plana vitrectomy	216	-	-	130	-	-	-
Scleral buckle	13	-	-	6	-	-	-
Unspecified	134	66.7	60.1 – 73.2	67	33.3	26.8 – 39.9	<0.001

CI, confidence interval.

*, One sample proportions test.

TABLE 2: Proportion of total surgery accounted for by each subgroup at a tertiary hospital in the year pre- pandemic and the first year of the pandemic.

Surgery subtype	Proportion (%) of surgery pre- pandemic year	95 (%) CI	Proportion (%) of surgery post- pandemic year	95 % CI	Proportion (%) change	CI [95%]	*P**
Cataract	43.6	42.0 – 45.3	36.0	33.7 – 38.4	−7.2	4.7 – 10.5	< 0.001
Cornea	7.5	6.6 – 8.4	5.9	4.7 – 7.3	−1.6	0.0 – 3.1	0.036
Glaucoma	5.4	4.6 – 6.1	9.0	7.5 – 10.4	+3.6	-5.2 – -1.99	0.006
Oncology	6.00	5.2 – 6.8	11.6	10.0 – 13.2	+5.6	-7.4 – -3.8	< 0.001
Orbits and oculoplastic	7.2	6.4 – 8.1	5.8	4.6 – 7.0	−1.4	0.00 – 2.9	0.06
Strabismus	8.5	7.5 – 9.4	0.00	0.00 – 0.01	−8.5	7.5 – 9.4	< 0.001
Trauma	10.7	9.7 – 11.8	16.2	14.4 – 18.0	+5.5	-7.5 – -3.3	< 0.001
Vitreoretinal	7.5	6.6 – 8.4	11.2	9.6 – 12.8	+3.7	-5.5 – -1.9	< 0.001
Unspecified	3.8	3.1 – 4.4	4.3	3.3 – 5.3	+ 0.5	-1.7 – 0.6	0.38

CI, confidence interval.

*, Two-sample proportions test.

TABLE 3: Negative binomial regression of all cases during post-pandemic year including COVID-19 waves.

Period	Incidence rate ratio	95% CI	*P*
Univariate analysis			
Pandemic	0.45	0.31 – 0.62	< 0.001
Wave one	0.27	0.15 – 0.48	< 0.001
Wave two	0.72	0.41 – 1.25	0.24
Multivariate analysis			
Pandemic	0.47	0.34 – 0.66	< 0.001
Wave one	0.47	0.28 – 0.78	< 0.001
Wave two	1.25	0.78 – 2.03	0.36

CI, confidence interval.

TABLE 4: Negative binomial regression of number of trauma cases during alcohol restrictions (univariate analysis).

Alcohol restriction	Incidence rate ratio	95% CI	*P*
Partial alcohol ban	0.83	0.68 – 1.00	0.06
Total alcohol ban	0.50	0.39 – 0.63	< 0.001

CI, confidence interval.

Strabismus surgery followed by cataract surgery saw the greatest decrease in terms of their contribution to the proportion of total surgical volume. Cataract surgery significantly decreased from 43.6% (95% CI: 42–45) of total surgical volume in the pre-pandemic year to 36% (95% CI: 33.7–38.4) in the post-lockdown year. Oncology surgery had the greatest increase with respect to proportion of total surgical volume, significantly increasing from 6% (95% CI: 4.5–6.0) in the pre-pandemic year to 11.6% (95% CI: 10.0–13.2) in the post-lockdown year. Proportionate changes of the various surgical subgroups with respect to the pandemic are summarised in Table 2.

Univariate negative binomial regression of all cases revealed a significant incidence rate ratio (IRR) during wave one of 0.27 (95% CI: 0.15–0.48; $P < 0.001$) and a non-significant IRR of 0.72 (95% CI: 0.41–1.25; $P = 0.24$) during wave two (Table 3).

Predicted margins showed an expected 241 (95% CI: 192–292; $P < 0.001$) surgeries per month during the pandemic with 66 (95% CI: 21–100; $P < 0.001$) cases per month during wave one and 174 (95% CI: 85–263; $P < 0.001$) during wave two. Multivariate negative binomial regression, after adjusting for the pandemic (see Table 3 for summary) similarly revealed a significant IRR of 0.47 (95% CI: 0.28–0.78: $P < 0.001$) for wave one and a non-significant IRR of 1.25 (95% CI: 0.78–2.03; $P < 0.36$) for the total number of cases during wave two.

Change in trauma surgery cases during alcohol restrictions

The post-lockdown year (during which alcohol was restricted) saw a significant decrease in trauma surgery with 60.1% (95% CI: 56.3–63.9; $n = 378$) of cases performed in the pre-pandemic year and 39.9% (95% CI: 36.1–43.7; $n = 251$) in the post-lockdown year. Univariate negative binomial regression found an insignificant decrease with an IRR of 0.83 (95% CI: 0.68–1.00; $P = 0.06$) during months with partial alcohol bans and a significantly decreased IRR of 0.50 (95% CI: 0.39–0.63; $P < 0.001$) during months with total bans (see Table 4 for summary).

Predicted margins showed an expected 32 (95% CI: 28–35) trauma surgery cases during months with no alcohol restrictions with 26 (95% CI: 22–30) cases during partial restrictions and 16 (95% CI: 12–19) during total bans.

Discussion

We analysed the effect of the COVID-19 pandemic on ophthalmic surgical practice at a tertiary referral centre in the most populous province of South Africa, Gauteng. South Africa is an upper middle income country of 59.2 million people, which in terms of economic distribution is one of the world's most unequal.[22] Pre-pandemic South Africa already faced a huge backlog for ophthalmic surgeries with an estimated 1789 patients at St. John Eye Hospital awaiting cataract surgery in 2015. The country never quite reached its recommended cataract surgery rate of 2000 per million population.[21,23] The South African healthcare system is divided between a state-provided service on which the majority of South Africans rely and a private service accessible to wealthier groups that can afford medical insurance. Healthcare resources are also asymmetrically shared with the majority of ophthalmologists working in the private sector.[24]

St John Eye Hospital is the largest subspecialist academic ophthalmology centre in South Africa responsible for a large proportion of the South African population while also providing services to patients in other provinces and beyond the country's borders. The results of this study were concordant with international studies which documented the drastic decrease in ophthalmic surgeries, illustrated by the

median spline in Figure 1, attributed to the COVID-19 pandemic (see Table 1 for summary of change in ophthalmic surgical numbers per year). Elective surgeries faced proportionate decreases in the post-lockdown year while surgical subgroups with emergent procedures such as trauma and oncology surgery saw proportionate increases (see Table 2 for summary of decrease as a function of proportion performed per year).

As St John Eye Hospital is an academic facility, not only do the decreased surgical numbers have a negative impact on healthcare provision but also on resident training. South African ophthalmology residents are expected to perform 300 cataract surgeries as part of their 4-year curriculum.[25] Thus, a large proportion of their training was impacted by the COVID-19 pandemic.

This study, in comparison to most others which looked at the initial stage of the pandemic, evaluated the entire first year. The first year of the pandemic included two waves and was a period in which vaccines were unavailable to the South African public. Vaccines were rolled out to healthcare workers in February 2021 and became available to the public in May 2021.[26,27] This allowed for a more thorough analysis of how surgical numbers changed through different phases of the pandemic over that first year with analysis including periods of harsher lockdowns as well as during the waves (wave one [original variant]: June to August 2020 and wave two [Beta variant]: November to January 2021) occurring in the year post pandemic.[28,29] This enabled the analysis of IRRs, which allowed comparison between the 2 years. In the multivariate analysis, the IRR while adjusting for the pandemic and the waves showed the incidence rate fell by 53% both during the pandemic and during wave 1. The change in incidence rate during wave two was not significant. Univariate analysis similarly revealed a recovery in wave two with predicted margins showing an expected number of surgeries during wave one at 66 compared with pre-pandemic at 241 and wave two at 174 cases (see Table 3 for summary of univariate and multivariate analysis). The recovery in surgical numbers in wave two reflects the healthcare system adapting to the challenges brought forth by the pandemic.

Cataract surgery after strabismus suffered the worst decline in the post-lockdown year. This is of particular concern as the vast majority of patients rely on the state sector and even pre-pandemic South Africa lagged behind peers with its cataract surgery rate.[30] The unfortunate result of the pandemic is an increased burden of preventable blindness and longer waiting lists for patients with an estimated 13 603 patients awaiting cataract surgery in the province of Gauteng as of September 2021.[30,31]

Glaucoma surgery significantly declined during the post-lockdown year albeit with the second smallest change in the subcategories examined. Holland et al. analysed the effect of COVID-19 pandemic on glaucoma surgical practice in the United Kingdom, and in concordance with this study found incisional glaucoma surgery as the most commonly performed procedure; however, their study found a change in practice favouring procedures such as diode lasers and glaucoma drainage devices, which require less postoperative visits.[11] Further study is required to determine if glaucoma surgical practice changed in this study setting.

Oncological surgery had the smallest change from pre- to post-pandemic years and this change was not statistically significant. This is reassuring as these are potentially lifesaving procedures. The authors believe that this reflects a successful aspect of the triage system. This is similar to the Brazilian experience where Fontes Junior et al. reported no significant change in ocular oncology surgeries performed at a referral centre for ocular oncology in Sao Paulo.[32]

Vitreoretinal surgical procedures saw a significant decline. The reasons for this are potentially decreased presentations because of containment and reduced risk factors as a result of a decreased incidence of cataract surgery and trauma.[33] Another factor accounting for the significant decrease is that in cases of tractional detachments caused by diabetic retinopathy, practice patterns may have changed to prognosticate patients with poorly controlled diabetics who are at high risk of COVID-19 sequelae such as severe disease and death.[34] A French study found a significantly decreased surgical volume for rhegmatogenous retinal detachment repairs during the country's 8 week lockdown with numbers decreasing by 41% as compared with 2019 with similar results seen in American and British studies. Interestingly, post-lockdown saw no compensatory increased number of procedures in France with a postulated reason being delayed- or non-presentation.[1]

Trauma surgery significantly decreased in the first year of the pandemic. This is concordant with studies performed in other specialities in South Africa.[5,6] The authors believe that the decrease in trauma surgery is multifactorial. The study has shown that the restriction on alcohol acted in synergy with the lockdowns, which included curfews and restrictions on public gatherings and played an important role in decreasing the trauma burden in ophthalmic surgery. Possible other reasons for the decrease in trauma could relate to the downturn in economic activity leading to less work-related injuries but this hypothesis would need to be further investigated. The effect of alcohol restrictions on trauma surgery incidence is statistically significant even when accounting for the pandemic. Negative binomial regression revealed that during total alcohol bans, the IRR decreased by 50% and during partial bans by 17% (see Table 4 for summary). Total alcohol bans resulted in a decreased burden of trauma surgeries when compared with partial bans. The predicted margins revealed an expected number of trauma cases during months with no alcohol ban at 32 cases. This contrasted with months with total bans at 16 cases and those with a partial alcohol ban at 26 cases. This highlights the deleterious effect that alcohol consumption has on the South African healthcare system.

The severe effect of the COVID-19 pandemic on ophthalmic surgery in a developing world setting is apparent from the decreased numbers and changed the proportionality of procedures, favouring emergent and urgent surgery. This impacts both patient care as well as resident and fellow training.

As a result of the retrospective nature of data collection that evaluated theatre records, data could not be ascertained on changes in surgical numbers caused by extenuating factors not related to the COVID-19 pandemic such as consumable shortages or equipment maintenance. In terms of trauma, records do not reflect whether alcohol consumption was a factor in individual cases.

Conclusion

In conclusion, ophthalmic surgical numbers in all subgroups decreased during the first year of the COVID-19 pandemic with elective procedures such as cataracts and strabismus surgeries facing the steepest declines. This change being as a result of the implications of the pandemic on surgical practice as well as resultant socioeconomic effects of political measures. This information is crucial in informing strategy for addressing the backlog as well as to prepare for the effect of possible future pandemics.

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Competing interests

The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.

Authors' contributions

I.M. was responsible for designing and writing the protocol, collecting data and writing the report and was also responsible for drawing tables. N.A. was responsible for designing the protocol, analysing data, interpreting results and writing the report and contributed to writing the methodology, conducting the statistical analysis and generating the splines. A.M. was responsible for the research topic choice, designing the protocol and editing the protocol and report.

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Data availability

There are no accession codes, unique identifiers or weblinks for publicly available datasets. The figures of raw data are from theatre books at St. John Eye Hospital, and the raw data are available as per permission from the Head of Department at St. John Eye Hospital and the Medical Advisory Committee at Chris Hani Baragwanath Academic Hospital.

Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of any affiliated agency of the authors.

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