DILSON PALHARES FERREIRA

Impacto da pandemia de COVID-19 em nascimentos, partos vaginais, cesarianas, mortalidade materna, cirurgias eletivas, cirurgias de urgência e mortalidade pós-operatória em uma área metropolitana do Brasil: um estudo de coorte de séries temporais

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Tese apresentada para obtenção do título de doutor em Ciências da Saúde pelo Programa de Pós-Graduação em Ciências da Saúde da Universidade de Brasília.

Área de Concentração Fisiopatologia Médica

Orientador: Prof. Dr. Fábio Ferreira Amorim

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RESUMO

Introdução: A pandemia de COVID-19 provocou impactos profundos nos sistemas de saúde em todo o mundo, especialmente na assistência obstétrica e cirúrgica. As restrições impostas e a reorganização dos serviços afetaram tanto o acesso quanto os desfechos clínicos de pacientes internados para parto ou cirurgia.**Objetivos:** Avaliar o impacto da pandemia de COVID-19 sobre as taxas de partos vaginais, cesarianas, cirurgias eletivas e de urgência, bem como sobre a mortalidade materna e pós-operatória em hospitais públicos do Distrito Federal (DF), Brasil. Como objetivo secundário, analisaram se também as taxas de cancelamento no dia da cirurgia e as reintervenções cirúrgicas em um hospital público do DF.**Métodos:** Estudo de coorte com série temporal, incluindo dados de todos os pacientes admitidos para cirurgias eletivas ou de urgência, bem como de todas as mulheres admitidas para parto (vaginal ou cesariana) em hospitais e maternidades do Sistema Único de Saúde do Distrito Federal, Brasil, entre março de 2018 e fevereiro de 2022. Os dados foram extraídos do Sistema de Informações Hospitalares do Ministério da Saúde (SIH/DATASUS) em 30 de setembro de 2022. As análises estatísticas incluíram o uso do pacote CausalImpact (R) para modelagem de impacto causal e o software EZR para análise com escore de propensão (PSM). Também foi conduzido um estudo específico em um hospital terciário do DF.**Resultados:** Na área obstétrica, foram registrados 150.617 nascimentos. Embora o número total de partos não tenha apresentado variação significativa, observou-se aumento expressivo nas taxas de cesarianas durante a pandemia (efeito absoluto semanal: +18,1; IC95%: 11,9–23,9). A mortalidade materna aumentou significativamente no período pandêmico, com odds ratio de 3,22 (IC95%: 1,53–6,81), mesmo após o pareamento por escore de propensão, sugerindo impacto substancial na qualidade do cuidado materno. Na área cirúrgica, foram analisados 174.473 procedimentos, com redução significativa nas cirurgias eletivas (efeito absoluto semanal: -170,9; IC95%: -232,8 a -112,0) e de urgência (-57,7; IC95%: -87,5 a -27,7) durante o período pandêmico. Apesar do aumento proporcional das cirurgias de urgência (de 53,0% para 68,8%), não houve diferença estatisticamente significativa na mortalidade hospitalar pós-operatória (OR: 0,944; IC95%: 0,870–1,025; $p = 0,173$). Em um hospital terciário, observou-se uma redução significativa nas taxas de cancelamento no dia da cirurgia durante a fase inicial da pandemia (OR: 0,556; IC95%: 0,448–0,691; $p < 0,001$), bem como uma queda nas reintervenções cirúrgicas no período subsequente (OR: 0,534; IC95%: 0,390–0,733; $p < 0,001$), mantendo-se a segurança dos procedimentos realizados.**Conclusão:** A pandemia impactou negativamente os desfechos obstétricos, com aumento nas taxas de cesariana e da mortalidade materna. Os serviços cirúrgicos apresentaram redução significativa no volume de procedimentos, sem aumento da mortalidade pós-operatória. Esses achados reforçam a importância de implementar estratégias robustas que assegurem a continuidade e a segurança dos cuidados obstétricos e cirúrgicos em cenários de crise sanitária.

Palavras-chave: COVID-19; Cirurgias eletivas; Cirurgias de urgência; Parto cesariano; Parto vaginal; Cancelamentos de cirurgias.

ABSTRACT

Introduction: The COVID-19 pandemic had a profound impact on health systems worldwide, particularly in obstetric and surgical care. The restrictions imposed and the reorganization of services affected both access to care and clinical outcomes for patients admitted for childbirth or surgery.

Objectives: To evaluate the impact of the COVID-19 pandemic on birth rates, cesarean deliveries, elective and emergency surgeries, as well as maternal and postoperative mortality in public hospitals in the Federal District (DF), Brazil. As a secondary objective, surgery-day cancellations and surgical reinterventions were also analyzed in a tertiary public hospital in the DF.

Methods: This time-series cohort study included data from all patients admitted for elective or emergency surgeries, as well as all women admitted for childbirth (vaginal or cesarean delivery) in hospitals and maternity units of the Public Health System in the Federal District, Brazil, between March 2018 and February 2022. Data were extracted from the Brazilian Ministry of Health's Hospital Information System (SIH/DATASUS) on September 30, 2022. Statistical analyses included the CausalImpact package (R) for causal modeling and the EZR software for propensity score matching (PSM). A separate analysis was also conducted at a tertiary public hospital in the DF.

Results: A total of 150,617 births were recorded. Although the overall number of births did not vary significantly, a substantial increase in cesarean deliveries was observed during the pandemic (absolute weekly effect: +18.1; 95% CI: 11.9–23.9). Maternal mortality rose significantly during the pandemic, with an odds ratio of 3.22 (95% CI: 1.53–6.81), even after PSM, indicating a meaningful decline in the quality of maternal care.

A total of 174,473 surgical procedures were analyzed, showing a significant reduction in both elective surgeries (absolute weekly effect: −170.9; 95% CI: −232.8 to −112.0) and emergency surgeries (−57.7; 95% CI: −87.5 to −27.7) during the pandemic. Although the proportion of emergency surgeries increased (from 53.0% to 68.8%), there was no statistically significant change in postoperative hospital mortality (OR: 0.944; 95% CI: 0.870–1.025; $p = 0.173$).

In the tertiary hospital analysis, there was a significant reduction in same-day surgery cancellations during the initial phase of the pandemic (OR: 0.556; 95% CI: 0.448–0.691; $p < 0.001$), as well as a decrease in surgical reinterventions in the subsequent period (OR: 0.534; 95% CI: 0.390–0.733; $p < 0.001$), suggesting preservation of surgical safety.

Conclusion: The COVID-19 pandemic had a negative impact on obstetric outcomes, with increased rates of cesarean deliveries and maternal mortality. In contrast, surgical services experienced a substantial decline in volume without a corresponding rise in postoperative mortality. These findings underscore the need for robust strategies to ensure the continuity and safety of obstetric and surgical care during public health emergencies.

Keywords: COVID-19; Elective surgeries; Emergency surgeries; Cesarean section; Vaginal birth; Surgery cancellation.

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LISTA DE ABREVIATURAS E SIGLAS

ANVISA	Agência Nacional de Vigilância Sanitária
COVID-19	Doença do coronavírus 2019
SIH/DATASUS	Sistema de Informações Hospitalares do Departamento de Informática do Sistema Único de Saúde
DF	Distrito Federal
DP	Desvio padrão
EPI	Equipamento de proteção individual
HRS	Hospital Regional de Sobradinho
IC 95%	Intervalo de confiança 95%
IDH	Índice de Desenvolvimento Humano
IL	Interleucina
IQR 25%–75%	Intervalo interquartil 25-75%
ITS	Séries temporais interrompidas
MCP-1	Proteína quimiotática de monócitos-1
MERS	Síndrome respiratória aguda do Oriente Médio
MIP-1	Proteína inflamatória de macrófagos-1
OMS	Organização Mundial da Saúde
OR	Razão de chances
PCR	Proteína C Reativa
SARS	Síndrome respiratória aguda grave
SARS-CoV-2	Coronavírus da síndrome respiratória aguda grave 2
SDRA	Síndrome do desconforto respiratória agudo
SUS	Sistema Único de Saúde
TNF-α	Fator de necrose tumoral alfa
UTI	Unidade de terapia intensiva
VIF	Fator de inflação da variância

SUMÁRIO

1 INTRODUÇÃO

A pandemia da doença do coronavírus 2019 (COVID-19) representou um desafio significativo para os sistemas de saúde em todo o mundo. A infecção ocorreu de forma rápida, acometendo numerosos indivíduos e ocasionou mortes substanciais e problemas de saúde persistentes antes de as vacinas estarem disponíveis.[1] A sobrecarga nos sistemas de saúde para a gestão da COVID-19 levou a mudanças notáveis na prestação dos serviços de saúde. Dentre as várias readaptações, pode-se destacar a suspensão preventiva de cirurgias eletivas, procedimentos e consultas ambulatoriais, além do redirecionamento dos serviços de saúde para gerir os casos de COVID-19.[2,3] Há consenso de que a pandemia de COVID-19 pode ter impactado as condições de saúde da população, muitas vezes não diretamente ligadas à infecção pelo coronavírus da síndrome respiratória aguda grave 2 (SARS-CoV-2).[2]

Ocorreram inúmeras alterações nas rotinas existentes e na prática diária de profissionais de saúde em todo o mundo. Evidenciou se o despreparo dos sistemas de saúde em escala global, não apenas em países com recursos escassos, como foi o caso de epidemias anteriores, como o Ebola. Foi patente a constatação de que trabalhar em "silos profissionais" não era adequado para responder a uma crise desta dimensão. As estratégias educacionais tradicionais, o planejamento e a gestão da força de trabalho foram estressados, desafiados, testados e evidenciaram, em parte significativa dos países, insuficientes para a demanda que a epidemia determinou.[4]

Foi reveladora a constatação dos limites de elaboração de políticas públicas baseadas em interesses nacionais bem como a presença de desigualdades locais (dentro dos países), externas (entre países), raciais e de gênero.[5]

A pandemia de COVID-19 exigiu readaptações e mudanças em todas as áreas e em todos os níveis da força de trabalho da saúde. Houve necessidade de fortalecer a colaboração e a coordenação de todos os setores, com investimento e melhoria na educação e formação profissional.[6]

Na tentativa de garantir formas eficazes de implementar a proteção dos recursos humanos para a saúde foram necessárias ações para prevenir sofrimentos físicos, mentais e éticos dos profissionais envolvido, especialmente, aqueles menos qualificados que foram convocados a compor a força de trabalho, no cuidado de pacientes infectados.[7,8] Segundo dados da Organização Mundial da Saúde (OMS), a saúde dos trabalhadores da saúde foi responsável por 8% dos casos globais de COVID-19, e o risco de serem infectados foi mais do que o triplo

do risco da população em geral.[9]

Parte das medidas executadas nos momentos iniciais da COVID-19 foi com o objetivo de mitigar a contaminação da força de trabalho e o absenteísmo – isolamento de casos confirmados e suspeitos, criação de coortes de COVID-19, cancelamento e redução de tempo de internação e de procedimentos cirúrgicos eletivos, cancelamento de consultas ambulatoriais, cancelamentos de consultas de pré-natal, redução de trabalho de parto intra-hospitalar e teleatendimentos.[10]

Após a percepção da infectividade do vírus e a redução dos trabalhadores da saúde por contaminação, exacerbaram as medidas de isolamento e colapsaram os recursos disponíveis de equipamentos de proteção individual (EPIs).[4]

As experiências dos trabalhadores da linha de frente no Brasil[11] e em Bangladesh[12] fornecem insights mais profundos sobre as condições de trabalho sob a COVID-19, destacam o excesso de carga horária de trabalho, absenteísmos, infecção e óbito dos profissionais diretamente envolvidos.

Köppen, Hartl e Maier em seu estudo de caso na Alemanha, mostraram uma elevada variação na resposta às condições da COVID-19. Destacam a importância de integrar treinamento que garanta alto padrão de higiene, segurança, promoção de saúde psicológica aliada aos EPIs e enfoque nos trabalhadores mais expostos. Sublinham a importância de uma liderança transparente, flexível e situacional com grande habilidade gerencial.[13]

Na Alemanha, a pandemia de COVID-19 acelerou a procura por educação em saúde global.[14] Surgiram cursos técnicos, superiores e enfoque em cuidados em saúde nos níveis de ensino fundamental até a pós-graduação.

A pandemia por COVID-19 gerou maior demanda por competências em saúde pública conforme uma análise das ofertas de emprego nos Estados Unidos antes e durante a pandemia. Especialmente os jovens profissionais de saúde foram majoritariamente demandados e necessitaram adaptar-se e corresponder à demanda da pandemia com competências em saúde, de forma segura e com rígido conhecimento para minimizar a transmissão do vírus bem como reduzir o risco de se infectar.[15]

Nesse contexto a saúde materna e a fila de cirurgias eletivas são de grande interesse em todas as condições afetadas pela COVID-19, pois são indicadores indiretos da qualidade dos serviços de saúde de um país.[16-19] Entender a dinâmica e a disponibilidade desses serviços, bem como as barreiras à sua continuidade, permitem traçar um retrato das variações na qualidade dos serviços de saúde do país.[18]

Na saúde materna, à medida que a pandemia de COVID-19 continuou a se espalhar, registrou-se um aumento notável de casos de doença moderada a grave entre mulheres grávidas, levantando preocupações sobre a sua susceptibilidade à infecção e potenciais mortes.[16-23] Assim, além do medo da possibilidade de transmissão vertical, inicialmente foi dada atenção especial à compreensão dos efeitos diretos da COVID-19 na saúde materna. Notavelmente, a gravidade da infecção durante a gravidez constituiu a principal preocupação, especialmente em mulheres de grupos de alto risco, como aquelas com obesidade, hipertensão, diabetes e condições de imunossupressão.[1,18-23] Nesse aspecto, uma revisão sistemática com metanálise incluindo 42.754 pacientes grávidas infectadas mostrou um rápido aumento nas cesarianas, a tendência da mortalidade não foi claramente estabelecida, embora tenha sido observada uma taxa de mortalidade materna de 1,2% e aumento na prematuridade.[23]

É importante notar que o impacto da pandemia na saúde materna transcende os efeitos diretos das infecções individuais. Os efeitos indiretos, como a redução do acesso e da prestação de serviços de saúde materna e os níveis mais baixos da sua utilização devido ao medo de se infectar, podem levar a um impacto significativo na qualidade dos cuidados maternos.[17-23] Assim, para além dos efeitos diretos da COVID-19 na saúde materna, a interrupção da prestação de serviços de saúde materna durante a pandemia, quebrando a continuidade dos cuidados de saúde ao longo das fases pré-natal, intraparto e pós-natal, poderia afetar negativamente tanto a saúde materna como a neonatal, incluindo um aumento nos nascimentos prematuros e mortalidade materna.[17-24]

As adaptações feitas nos serviços pré-natais e pós-natais e as modificações na prestação de cuidados de maternidade também podem influenciar os serviços intraparto. Essas modificações podem envolver mudanças na assistência à gestante durante o trabalho de parto, inclusive nas práticas anestésicas e nas condutas obstétricas.[19,21,24-28] Em relação ao modo de nascimento, a maioria dos estudos têm se concentrado na avaliação de gestantes infectadas pela COVID-19.[26-27] Além disso, embora o contexto da pandemia de COVID-19 possa ter levado a um aumento de nascimentos induzidos pré-planejados e de cesarianas escolhidas em comparação com o parto vaginal, as evidências relativas ao impacto indireto da pandemia e das medidas de bloqueio no modo de nascimento são inconsistentes.[26,29-31]

Os países latino-americanos foram mais afetados pela COVID-19 do que o observado nos países desenvolvidos.[28,32] O Brasil foi um dos países mais afetados no mundo.[19,33-34] Após o primeiro caso de COVID-19 relatado em 26 de fevereiro de 2020, na cidade de São Paulo, a COVID-19 inicialmente se espalhou para as maiores áreas metropolitanas do Brasil no Sudeste.

Rapidamente migrou para outras regiões, começando pelo Norte e Nordeste, seguidos pelo Centro-Oeste e Sul. Em maio de 2020, o sistema público de saúde de Manaus, cidade do Norte com menos leitos de UTI, já havia entrado em colapso, antecipando a gravidade da crise sanitária no país desde o final de 2020 até o final de 2021.[35]

O foco da doença mudou durante a pandemia, resultando em três ondas significativas de infecções e mortes de março de 2020 a janeiro de 2022. Até o final de 2022, o Brasil havia registrado 36,3 milhões de casos confirmados de COVID-19, constituindo cerca de 5% dos casos globais. Ficou em segundo lugar em mortes entre os países, respondendo por cerca de 10% das mortes relacionadas à COVID-19 em todo o mundo.[33,34]

Os fatores que contribuíram para o grave impacto da COVID-19 no Brasil envolveram medidas de contenção inconsistentes, atrasos nas diretrizes para cuidados com a COVID-19, acesso restrito à saúde, disparidades entre populações vulneráveis e a pressão da pandemia sobre um país já tenso e subfinanciado no sistema público de saúde.[36,37]

Com relação à fila de cirurgias eletivas vários hospitais e unidades de saúde tiveram de suspender ou limitar cirurgias para priorizar recursos e direcionar insumos aos pacientes infectados pela pandemia da COVID-19.[38] Esta medida foi implementada para garantir a disponibilidade de leitos hospitalares, pessoal e equipamento de proteção individual para indivíduos afetados pela COVID-19.[38] Além disso, a implementação de medidas de confinamento e restrições de viagem reduziu o acesso aos serviços de saúde. O medo da exposição ao vírus pode ter levado os pacientes a adiarem a consulta médica, agravando os atrasos nos procedimentos de saúde, incluindo as cirurgias.[38,39] Consequentemente, a pandemia da COVID-19 impactou significativamente as cirurgias eletivas e de emergência em todo o mundo, levando a cancelamentos ou atrasos e os procedimentos, inicialmente considerados eletivos, podem ter transitado para situações emergenciais.[38-41]

Além das restrições de recursos durante a pandemia, as cirurgias normalmente envolvem um contato próximo entre pacientes e profissionais de saúde. Desta forma, o risco de transmissão da COVID-19 exigiu medidas de segurança adicionais, tais como testes, quarentenas pré-operatórias e protocolos de limpeza. Essas medidas, como a obrigatoriedade do teste de COVID-19 para pacientes assintomáticos no pré-operatório, agregaram complexidade e custo ao processo cirúrgico.[41-45] Notavelmente, houve aumento da mortalidade em cirurgia cardíaca nos Estados Unidos[46] e no Reino Unido durante a pandemia de COVID-19.[47] O impacto da pandemia da COVID-19 estendeu-se para além dos procedimentos eletivos, afetando significativamente as cirurgias de emergência.[38,48,49] Durante o confinamento da

COVID-19 na Itália foi relatada uma redução de 86% nas cirurgias de emergência.[48] Números semelhantes foram observados na Grécia[48], Estados Unidos[50], Espanha[49] e Alemanha.[40] Pelo contrário, observou-se um aumento de cirurgias de emergência em um hospital universitário na Arábia Saudita.[39]

Durante a pandemia de COVID-19, os sistemas de saúde enfrentaram restrições de recursos. Profissionais da saúde, equipamentos e suprimentos foram desviados para os esforços de resposta à COVID-19. As salas cirúrgicas foram reaproveitadas para unidade de terapia intensiva (UTI) ou áreas de tratamento da COVID-19, limitando a disponibilidade de instalações para cirurgias.[41,51]

Nesse cenário, o objetivo principal do estudo foi avaliar o impacto da pandemia de COVID-19 nas taxas de nascimento, parto vaginal, cesariana, cirurgias eletivas e de urgência. O objetivo secundário foi comparar a mortalidade materna antes e depois da pandemia bem como a mortalidade pós-operatória nas cirurgias eletivas e de urgência antes e durante a pandemia.

2 REFERENCIAL TEÓRICO

A história do coronavírus destaca três grandes surtos de coronavírus nos anos de 2002, 2012 e 2019. O primeiro ocorreu em Guangdong, China com 8000 casos confirmados e 774 mortes. Em 2012 houve a pandemia da síndrome respiratória aguda grave do Oriente Médio (MERS). O primeiro caso foi reportado em Jeddah, Arábia Saudita. Nessa pandemia houve disseminação do vírus para 27 países, com 2500 casos e 858 mortes.[52]

Em dezembro de 2019, foram descritos casos de síndrome respiratória aguda grave causada por um novo coronavírus na cidade de Wuhan, província de Hubei, China. Posteriormente o Comitê de Taxonomia de Vírus o nomeou como coronavírus associado ao SARS- CoV-2 e à COVID-19.[53,54]

Em 30 de janeiro de 2020, a OMS declarou uma emergência global devido ao novo surto de coronavírus que foi identificado na China.[53]

Em 24 de fevereiro de 2020, a OMS reconheceu que o SARS-CoV-2 tem o potencial de se espalhar globalmente e causar um surto pandêmico. Subsequentemente, em 11 de março de 2020, a OMS declarou a COVID-19 uma pandemia.[53]

O período de incubação do vírus varia entre 2 e 7 dias e a média de dias entre os sintomas e o óbito foi de 16 dias. A letalidade do SARS-CoV-2 variou entre os diferentes países. Porém, foi majoritariamente menor que a letalidade da síndrome respiratória aguda grave (SARS) anterior (9,4%) e MERS (34,4%).[55] Febre, tosse seca, dispneia, rouquidão, fadiga, mialgia, dessaturação com leucopenia e linfopenia são algumas das manifestações da infecção pelo SARS-CoV-2.[56]

A maioria dos pacientes apresentam pneumonia bilateral. Além disso, os biomarcadores podem vir alterados. Dentre estes a interleucina 6 (IL-6), proteína C reativa (PCR) e diminuição de linfócitos.[57]

Além dos sintomas respiratórios, os pacientes podem apresentar sintomas gastrointestinais como diarreia, vômitos e náuseas.[58]

A fase aguda é caracterizada por doença pulmonar que é manifestada por sintomas como dispneia, tosse produtiva com evidência de exame de imagem de opacidade em vidro fosco ou consolidação no pulmão. Dano alveolar difuso, descamação de pneumócitos e formação de membrana hialina são observadas durante o desenvolvimento da síndrome do desconforto respiratório agudo (SDRA) associado à COVID-19.[59] O aumento da permeabilidade vascular pulmonar ocasiona um prejuízo na difusão de oxigênio e contribui para o desfecho fatal. As

etiologias que ocasionam o aumento da permeabilidade vascular pulmonar são multifatoriais: (1) Efeitos citopáticos direto do coronavírus em no endotélio dos pacientes infectados resultando em endotelite generalizada.[60] (2) A redução da atividade da enzima conversora da angiotensina 2 pelo SARS-CoV-2 e subsequente aumento da angiotensina. Assim aumenta se, indiretamente, a via da calicreína-bradicina, que promove a permeabilidade vascular.[61] (3) As citocinas inflamatórias e os mediadores vasoativos são secretados por células imunológicas, como neutrófilos ativados e induzem a contração das células endoteliais. Este processo tende a afrouxar as junções estreitas endoteliais maximizando o efeito de permeabilidade vascular. (4) Retenção de líquidos devido à degradação do glicocálice e deposição de ácido hialurônico na matriz extracelular.[62] Esse aumento da permeabilidade vascular pulmonar resulta em comprometimento da função pulmonar. Por conseguinte, ocorre a diminuição da oxigenação sanguínea e esse fato é um marcador de gravidade da doença.[62]

A fase virêmica começa quando o vírus atinge o sangue periférico. Os mecanismos moleculares da viremia na COVID-19 ainda são mal compreendidos, no entanto, a entrada independente do vírus pela enzima conversora de angiotensina 2 em monócitos periféricos demonstrou promover células piroptóticas com morte celular e piora da gravidade da doença.[63] A viremia e o hospedeiro subsequente contribuem para múltiplas inflamações sistêmicas e falência de múltiplos órgãos. A resposta inflamatória durante fases graves da COVID-19 é mediada por um aumento simultâneo de múltiplas citocinas inflamatórias, como IL-1a, IL-1b, IL-6, IL-8, IL-12, IL17, fator de necrose tumoral alfa (TNF-α), proteína quimiotática de monócitos-1 (MCP-1) e proteína inflamatória de macrófagos-1 (MIP-1), tornando difícil identificar o mediador específico da resposta inflamatória.[64] Além disso, a resposta inflamatória precoce pode ajudar o hospedeiro a limitar a replicação viral, complicando ainda mais o papel de citocinas em COVID-19. Não é de surpreender que as terapias visando citocinas específicas, como IL-6 ou TNF-α, levou a resultados conflitantes.[63,65] A fase letal da COVID-19 é mediada por uma doença persistente que, inicialmente, manifesta-se localmente e evolui sistemicamente. A resposta inflamatória ocorre na forma de tempestade de citocinas e fatores de coagulação e é mais incidente nos casos graves.[66] Nesta fase, neutrófilos, células T auxiliares CD4 e as células T citotóxicas CD8 são sequestradas no tecido pulmonar.[67] As células hospedeiras sofrem apoptose persistente, necrose ou piroptose, o que pode amplificar o dano tecidual. Além disso, o ambiente inflamatório desencadeia a expressão de ativado fator tecidual em células endoteliais, macrófagos e neutrófilos. Todos estes fatos aumentam a ativação da cascata de coagulação nos pulmões. Marcadores da via de coagulação, como a positividade do Dímero D

estão presentes nesta fase.[68]

Em um estudo de autópsia, Wichmann et al. demonstraram que 58% dos pacientes com COVID-19 têm uma simultaneidade de trombose venosa profunda, e 1/3 das mortes foram diretamente causadas por embolia pulmonar aguda.[69] O papel potencial de trombose nas veias pulmonares distais ao leito capilar alveolar, que deveriam atuar como filtros de coágulos, foi apontado, como possível vasculite relacionada ao SARS-CoV-2, responsável pela manifestação de isquemia em vários órgãos.[70] Por esta razão, a COVID-19 grave não se restringe ao sistema respiratório, mas é uma doença multissistêmica, incluindo o desenvolvimento de várias manifestações cardiovasculares com lesão miocárdica, arritmia, síndrome coronariana aguda e tromboembolismo venoso. Essas manifestações estão intimamente relacionadas com a gravidade da doença e progressão para doença fatal.[71]

Assim, a terapia anticoagulante e agentes imunomoduladores poderiam, em potencial, ser necessários para atenuar o quadro hiperinflamatório e estados pró-trombóticos nestes pacientes.[72]

Apesar da óbvia contribuição das vias de coagulação nas doenças vasculares, o uso da terapia anticoagulante teria, em potencial, o risco de aumento de sangramento. Por outro lado, trombos microcirculatórios em capilares e vasos de grande porte já podem causar grandes danos. Logo, a administração de terapia anticoagulante não lograria benefício, se administrado tardiamente.[73]

2.1 PANDEMIA DE COVID-19 E IMPACTO NOS SERVIÇOS DE SAÚDE

A necessidade de enfrentamento mundial à pandemia da COVID-19 apresentou as mais variadas respostas. Incluiu bloqueios completos, medidas de distanciamento social com políticas de triagem populacional ou, ainda, nenhuma das opções anteriores.[74] A rápida disseminação da doença continuou a exercer pressão nos sistemas de saúde além da capacidade. Revelou, assim, uma falta de preparação e infraestrutura para proteger o público e os profissionais de saúde, em todo o mundo. Foi patente a escassez de insumos médicos de emergência.[74] A pandemia de COVID-19 provou ser difícil de controlar em comparação com surtos anteriores. Parte justificou-se pela transmissão e rápida disseminação. Por outro lado, os recursos de saúde, relativamente limitados, e a indisponibilidade de kits de testes e a interrupção de insumos na China contribuíram para o caos no controle da pandemia.[75,76]

Países que aplicaram medidas de saúde pública desde o início, durante a progressão do

seu surto nacional, tiveram melhor desempenho e gastaram menos tempo no controle da propagação do vírus em comparação com outros países que não o fizeram.[77] Além disso, as respostas à implementação da vacina foram amplamente variáveis. Diversos países, como China, Rússia, Índia, Estados Unidos da América, Reino Unido e Brasil estiveram diretamente envolvidos na produção de vacinas. Destaca-se que no Brasil o Instituto Butantan produziu e foi liberada para uso pela Agência Nacional de Vigilância Sanitária (ANVISA) em 17 de janeiro de 2021. Vários outros países, em vez disso, conduziram ensaios clínicos randomizados testando sua segurança e eficácia das mesmas.[78]

Vale exemplificar como alguns países responderam à demanda da pandemia. A Turquia destinou 563 hospitais exclusivos ao tratamento de pacientes com COVID-19, em novembro de 2020. Além disso, 1.200 hospitais prestaram, parcialmente, o atendimento aos casos de COVID-19. Havia 25.000 leitos de UTI antes da pandemia. A Turquia construiu dois novos hospitais de campanha com capacidade para 1.000 leitos. O Egito destinou 750 hospitais, com 35.152 leitos, 2.218 ventiladores e 3.539 leitos de cuidados intensivos, exclusivos para o cuidado aos pacientes com COVID-19, outubro de 2020. A Ucrânia aumentou o quantitativo de leitos disponíveis para pacientes com COVID-19. Saiu de 12.000 leitos para 53.445, em 582 hospitais, em novembro de 2020. A Polônia destinou 8.000 leitos e 800 respiradores, em outubro de 2020, para atendimento aos pacientes com COVID-19.[79]

A manutenção da força de trabalho em saúde foi o maior desafio nesses países exemplificados. As estratégias para manter a força de trabalho foram: mudança de tarefas, financiamentos, incentivos e prestação de cuidados psicossociais.[79]

Os esforços no enfrentamento envolveram profissionais de saúde e militares aposentados, estudantes de medicina e odontologia, além dos médicos residentes na resposta à COVID-19.[79] Vários países apresentaram escassez de EPIs e de insumos para teste de COVID-19. As estratégias para mitigar essa carência foram solicitações à OMS, ajuda da comunidade europeia e produção local de insumos.[79]

2.2 PANDEMIA DE COVID-19 E CIRURGIAS

A influência da pandemia nas cirurgias de urgência e eletiva retratou uma das alterações que os serviços de saúde necessitaram realizar para acomodar os casos de COVID-19 intrahospitalar.[80]

Dado a escassez de leitos de enfermaria e de UTI os procedimentos eletivos foram

cancelados. Cirurgias eletivas foram desmarcadas para que o centro cirúrgico pudesse assistir pacientes graves com COVID-19. Além disso, os leitos de enfermaria destinados ao paciente cirúrgico foram ocupados por portadores de COVID-19.[47] A estimativa de cancelamentos de cirurgias eletivas, no primeiro ano da pandemia, no mundo, foi de 72,3%.[81]

Situação semelhante ocorreu com as cirurgias de emergência. Nesta situação uma das explicações foi o "lockdown" imposto em vários locais. Além disso, diante do medo de contaminação, a população retardou ao máximo a busca por atendimento médico, mesmo sob risco de desfechos cirúrgicos piores. Inclusive o aumento de internação hospitalar nestes pacientes foi retratado justificado pela demora em procurar o primeiro atendimento.[82]

As especialidades cirúrgicas com queda mais relevante, em ordem decrescente, foram: cirurgia geral, trauma e ortopedia.[83] A Itália, no mês seguinte ao lockdown, apresentou uma redução de 86% nas cirurgias de emergência. Na Alemanha a porcentagem de redução de cirurgias de emergência ultrapassou 80%.[84] No Brasil houve queda de 63,16% nas cirurgias eletivas de hernioplastia e colecistectomia.[85]

Outra característica relevante é que em pandemias anteriores, como a epidemia do Ebola, não houve redução de cirurgias de emergência. Dentre as explicações para essa redução estão a queda do poder econômico para a realização da propedêutica adequada, a indisponibilidade de clínicas para realizar a propedêutica por lockdown e a dificuldade de atendimento na atenção primária.[86]

Subgrupos específicos como os idosos, apresentaram aumento nas cirurgias de trauma devido à queda em domicílio. Neste caso a explicação aventada foi a restrição domiciliar e a sarcopenia como consequência da necessidade do lockdown.[87]

Com relação aos tipos de cirurgias realizadas pré pandemia e durante a pandemia, houve diferenças. No período anterior à pandemia de COVID-19, as principais cirurgias realizadas foram: apendicectomia, ressecção gastrointestinal e colorretal por abdome obstrutivo, hernioplastia e infecção de partes moles. Durante a pandemia as cirurgias foram: ressecção gastrointestinal e colorretal, drenagem de abscesso e adesiólise.[88]

A avaliação de desfecho mortalidade nas cirurgias, ao se comparar período pré pandemia e pandemia, apesar de resultados conflitantes na literatura, não evidenciaram diferença nos dois períodos no mundo.[80] No Brasil a mortalidade em cirurgias de hernioplastia e colecistectomia na pandemia aumentaram de 1,3 para 6,5% com mortalidade de pacientes que foram diagnosticados com COVID-19 no pós operatório de 83,3%.[85] O tempo de infeção por SARS-CoV-2 e a necessidade de realizar grande cirurgia eletiva esteve diretamente relacionado

ao desfecho. Aqueles que realizaram cirurgias até 8 semanas após infeção por COVID-19 complicaram mais no pós-operatório, com infeção por pneumonia. Após 8 semanas da infeção, não houve aumento em complicações pós-operatórias comparado à população sem COVID-19 diagnosticada.[89]

Importante destacar que o tempo de internação hospitalar para cirurgias eletivas e de urgência aumentou no Brasil e foi variável em outros países. No caso do Brasil, a justificativa foi a piora da morbidade com necessidade de suporte de UTI por complicações relacionadas às cirurgias e a coinfecção por COVID-19. Fouad et al destacou o aumento de tempo de permanência hospitalar em colecistectomias realizadas na pandemia. Neste caso, variou de 2,6 para 13,5 dias.[82]

2.3 PANDEMIA DE COVID-19 E PARTOS/SAÚDE MATERNA

O impacto da COVID-19 na saúde materna e período perinatal foi além da morbimortalidade pelo SARS-CoV-2. Redução ou fechamento de serviços obstétricos de pré natal, lockdown, medo de se infectar ou infectar o feto ao procurar assistência de saúde, interrupção na linha de cuidado materna e dúvidas com relação à via de parto menos arriscada em risco de infecção pela pandemia foram algumas das situações que as gestantes e puérperas vivenciaram.[90,91] Aumento de nascimentos pré termo ou de natimortos foi observado no início da pandemia e a queda na assistência à saúde materna foi sugerida como a principal causa desta constatação.[92]

Na revisão sistemática de Chmielewska et al. (2021) destacam aumento da mortalidade materna bem como de natimortos, aumento de gravidezes ectópicas e aumento do estresse materno comparado ao período pré pandemia.[20] Durante a primeira onda da COVID-19, foi registrado uma mortalidade de 9,9 para cada 100.000 gestantes (comparado com 9,7 para cada 100.000 casos no período anterior a pandemia de COVID-19).[93]

A prática do parto cirúrgico (cesariana) durante a pandemia e, especialmente, durante a primeira onda, justificou-se por vários fatores. Pode se destacar: falta de conhecimento sobre a pandemia e medo do desconhecido por parte dos pacientes e dos profissionais de saúde; definição da via de parto pelo obstetra e vulnerabilidade da gestante no momento da pandemia e parto; parto vaginal não ser ativamente promovido e, em situações novas como a pandemia, a equipe de assistência à saúde optar por resolução rápida do parto com a via de parto cirúrgica.[94]

A despeito da orientação dos *guidelines* da OMS de que a via de parto, nos pacientes com COVID-19 deveriam seguir critérios obstétricos e não se basear em infecção por COVID-19 é patente perceber revisão sistemática mostrando que 90 % dos partos, na vigência da pandemia, ocorreram por via de parto cirúrgico.[95]

3 JUSTIFICATIVA

A pandemia por COVID-19, à semelhança de outras pandemias, obrigou a mudanças nos serviços de assistência à saúde. Dentre as várias adaptações ocorreram suspensões de procedimentos ambulatoriais e intra-hospitalares. Cancelamentos de consultas ambulatoriais, procedimentos de pequena cirurgia e cuidados em atenção primária ocorreram logo na primeira onda da pandemia. No mesmo sentido, a suspensão de cirurgias eletivas e redirecionamento da força de trabalho e do centro cirúrgico foram sentidos nos serviços de saúde. Assim, surge a dúvida com relação ao impacto da COVID-19 nos procedimentos cirúrgicos e nos partos.[34] Nesse sentido, este estudo buscou avaliar o impacto da pandemia por COVID-19 em procedimentos cirúrgicos (eletivos e de urgência) e partos (vaginais e por cesariana) em uma região metropolitana brasileira. A compreensão do impacto da COVID-19 e suas consequências para os serviços de saúde poderá auxiliar em políticas públicas a serem adotadas em eventos de saúde pública futuros, como pandemias.

4 OBJETIVOS

4.1 OBJETIVO PRIMÁRIO

Avaliar o impacto da pandemia de COVID-19 nas cirurgias (eletivas e de urgência) e na quantidade de partos (vaginal e por cesariana) no Distrito Federal.

4.2 OBJETIVOS SECUNDÁRIOS

- Avaliar o impacto da pandemia de COVID-19 na mortalidade pós-operatória no Distrito Federal.
- Avaliar a associação da pandemia de COVID-19 com o cancelamento no dia da cirurgia em cirurgias eletivas previamente agendadas em um hospital público de saúde do Distrito Federal.
- Avaliar a associação da pandemia de COVID-19 com a necessidade de reintervenções em cirurgias eletivas realizadas em um hospital público de saúde do Distrito Federal.
- Avaliar o efeito da pandemia de COVID-19 na mortalidade materna no Distrito Federal.

5 MÉTODOS

5.1 TIPO DE ESTUDO

Estudo de coorte de séries temporais incluindo todas as pessoas que realizaram cirurgias (eletiva ou de urgência) nos hospitais públicos e as mulheres que realizaram partos (parto normal ou cesariana) nas maternidades do Sistema Único de Saúde (SUS) do Distrito Federal (DF), Brasil, entre março de 2018 e fevereiro de 2022, sendo os dados obtidos do Sistema de Informações Hospitalares do Departamento de Informática do SUS (SIH/DATASUS), um banco de dados nacional auditado com informações sobre todas as internações hospitalares, realizadas nos serviços de saúde, afiliados ao sistema público de saúde brasileiro (SUS).[96,97] O conjunto de dados foi extraído do SIH/DATASUS em 30 de setembro de 2022.

Em uma segunda fase, foi realizada um estudo de coorte retrospectivo que incluiu todas as pessoas acima de 18 anos que tiveram marcação de cirurgias, realizadas ou não, no centro cirúrgico do Hospital Regional de Sobradinho (HRS) no período de 01 de janeiro de 2018 a 31 de dezembro de 2022, sendo os dados obtidos do prontuário eletrônico do Sistema Público de Saúde do DF e dos livros de registros de marcação de cirurgias do HRS.

5.2 LOCAL DO ESTUDO

O DF é uma das 27 unidades federativa brasileiras, possuindo 2.469.489 habitantes e inclui a cidade de Brasília, capital do Brasil. Possui o maior Índice de Desenvolvimento Humano (IDH) do país. O Governo do DF estabeleceu as primeiras medidas de distanciamento social devido a pandemia de COVID-19 em 18 de março de 2020, quando havia 36 casos confirmados e outras 174 notificações a serem avaliadas. As medidas de lockdown incluíram a suspensão de atividades não essenciais e o fechamento de academias, escolas e centros comerciais, restringindo a movimentação das pessoas e diminuindo a transmissão do vírus. Assim, neste estudo, o período pré-COVID-19 foi definido como março de 2018 a fevereiro de 2020, e o período pós-COVID-19 como março de 2020 a fevereiro de 2022.

5.2.1 Sistema Único de Saúde do Distrito Federal

O sistema público de saúde do DF compreende 16 hospitais, uma casa de parto e 13 unidades de emergência.

5.2.2 Hospital Regional de Sobradinho

O HRS possui um centro cirúrgico com oito salas cirúrgicas, um centro obstétrico com duas salas para cirurgias obstétricas e seis para partos vaginais. Realiza cirurgias ortopédicas, cirurgia geral, urológicas, vasculares, cirurgias plásticas reconstrutivas, buco maxilo, pequenas cirurgias, ginecológicas, obstétricas e otorrinolaringológicas. Possui 20 leitos de maternidade e 20 cirúrgicos.

Apresenta média de 1100 atendimentos/mês na unidade de cirurgia geral, 1600 atendimentos/mês na unidade de ginecologia/obstetrícia e 3200 atendimentos/mês na unidade ortopedia e traumatologia, realizando aproximadamente 350 cirurgias mensais: em torno de 60 eletivas e 290 de urgência.

5.3 PARTICIPANTES

5.3.1 Sistema Único de Saúde do Distrito Federal

Foram incluídas todas as pessoas que realizaram cirurgias (eletiva ou de urgência) nos hospitais públicos e as mulheres que realizaram partos (parto normal ou cesariana) nas maternidades da SUS do DF, Brasil, entre março de 2018 e fevereiro de 2022

Como todas as informações sobre internações e procedimentos realizados nos serviços de saúde do SUS do DF precisam ser fornecidas ao SIH/DATASUS para reembolsar os procedimentos hospitalares, espera-se que o estudo tenha incluído todos as pessoas que realizaram cirurgias ou partos nos hospitais ou maternidades públicas do DF entre março de 2018 e fevereiro de 2022, sendo incluídos os procedimentos informados no SIH/DATASUS até 30 de setembro de 2022. Não foram aplicados critérios de exclusão.

5.3.2 Hospital Regional de Sobradinho

Foram incluídos de forma consecutiva todas as pessoas acima de 18 anos que foram submetidas ou agendadas para a realização de procedimentos cirúrgicos (eletivos ou de urgência) no hospital participante do estudo no período de 01 de março de 2018 a 28 de fevereiro de 2022.

Dessa forma, os critérios de inclusão foram possuir acima de 18 anos, e ter tido procedimento cirúrgico agendado, realizado ou não, no centro cirúrgico do Hospital Regional de Sobradinho durante o período do estudo. Não foram aplicados critérios de exclusão.

5.4 COLETA DOS DADOS

O SIH/DATASUS desempenha um papel fundamental no processamento e vigilância das internações hospitalares nos serviços públicos de saúde do Brasil. Seu banco de dados contém informações parametrizadas relevantes, incluindo código do procedimento, identificação do hospital e informações do paciente, como idade, sexo, cidade de residência, data de admissão e alta, e status de alta. Portanto, o SIH/DATASUS é amplamente utilizado em estudos epidemiológicos no Brasil.[96,97]

Os dados referentes aos procedimentos cirúrgicos programados no HRS foram coletados do prontuário eletrônico da Secretaria de Saúde do Distrito Federal e dos livros de registros de programações de procedimentos no Centro Cirúrgico HRS.

5.5 VARIÁVEIS E DESFECHOS

5.5.1 Partos realizados no Sistema Único de Saúde do Distrito Federal

As variáveis coletadas do SIH/DATASUS foram idade materna, modo de parto (parto normal ou cesariana), cidade de residência, data de admissão e alta materna, tempo de permanência na maternidade e status de alta (sobrevivente ou não sobrevivente).

5.5.2 Cirurgias realizadas no Sistema Único de Saúde do Distrito Federal

As variáveis coletadas do SIH/DATASUS foram idade, sexo, tipo de cirurgia (emergência ou eletiva), local da cirurgia (digestiva, ortopédica/trauma, ginecológica/mamária, renal/trato urinário, pele/tecido mole, cabeça/pescoço, neurológica, torácica, cardiovascular, transplante e endócrina), data de admissão e alta, tempo de permanência hospitalar e status de alta (sobrevivente ou não sobrevivente).

5.5.3 Cirurgias realizadas no Hospital Regional de Sobradinho

As variáveis coletadas do prontuário eletrônico e dos livros de registros de procedimentos cirúrgicos foram idade, sexo, tipo de cirurgia (eletiva/urgência), status da cirurgia (realizada/cancelada), local, especialidade da cirurgia, local e tipo de cirurgia, necessidade de reintervenção cirúrgica (sim/não), e status de alta (sobrevivente ou não sobrevivente).

5.6 ANÁLISE ESTATÍSTICA

A distribuição e a normalidade das variáveis foram verificadas utilizando o teste de Shapiro-Wilk. Os dados quantitativos são expressos como média ± desvio padrão (DP), mediana e intervalo interquartil 25-75% (IQR 25%–75%), e as variáveis categóricas são expressas como números e porcentagens.

As análises estatísticas foram realizadas utilizando o IBM Statistical Package for the Social Sciences versão 20.0 para Mac (SPSS 20.0 Mac, SPSS Inc., Chicago, Illinois, Estados Unidos), Jamovi 2.3.24 (https://www.jamovi.org) e o software estatístico R versão 4.2.3 (https://www.r-project.org/). Significância estatística foi estabelecida em um valor de p bilateral $\leq 0,05$.

5.6.1 Partos realizados e mortalidade materna no Sistema Único do Distrito Federal

5.6.1.1. Análise do total de partos, partos normais e partos por cesariana

Inicialmente, o total de partos, partos normais e cesarianas foi calculado para cada

semana epidemiológica entre março de 2018 e fevereiro de 2022. A tendência dos nascimentos, partos normais e cesarianas ao longo das semanas epidemiológicas durante o período do estudo foi inicialmente avaliada utilizando análise de regressão linear univariada. O teste de tendência de Cochran-Armitage para proporções também foi realizado para comparar preliminarmente o número de partos normais e cesarianas entre março de 2018 e fevereiro de 2019, março de 2019 e fevereiro de 2020, março de 2020 e fevereiro de 2021, e março de 2021 e fevereiro de 2022. O teste de tendência de Cochran-Armitage para proporções também foi realizado para comparar preliminarmente o número de cirurgias eletivas e de emergência entre março de 2018 e fevereiro de 2019, março de 2019 e fevereiro de 2020, março de 2020 e fevereiro de 2021, e março de 2021 e fevereiro de 2022.

Em seguida, os efeitos causais do início da COVID-19 nas taxas de nascimentos, partos normais e cesarianas foram avaliados usando análise de impacto causal com o pacote Causal Impact do R, que aplica um modelo bayesiano de séries temporais estruturais com conjuntos de dados preditores para determinar a trajetória provável de uma linha de tendência caso um determinado evento não tivesse ocorrido (a pandemia de COVID-19) e, em seguida, calcula a diferença entre essa linha de tendência contrafactual projetada (se a pandemia de COVID-19 não tivesse ocorrido) e a linha de dados reais (após o início da COVID-19).[98] Como variáveis de controle no modelo, a análise de impacto causal da pandemia de COVID-19 nos nascimentos foi ajustada pela população estimada do DF em cada semana epidemiológica, e a análise de impacto causal da pandemia de COVID-19 nas cesarianas foi ajustada pelo total de nascimentos em cada semana epidemiológica.

A análise de impacto causal estende a análise tradicional de séries temporais interrompidas (ITS) ao incorporar modelos bayesianos de séries temporais estruturais para ajustar a sazonalidade e outros fatores. Assim, quando uma intervenção ou evento ocorre, o método estima o efeito causal comparando os dados observados com o que seria esperado com base nas previsões do modelo. Enquanto a análise ITS geralmente se concentra em identificar o impacto imediato de uma intervenção em um conjunto de dados de séries temporais, a análise de impacto causal não apenas quantifica o efeito imediato da intervenção, mas também fornece uma previsão contrafactual pós-intervenção, permitindo uma avaliação mais robusta do efeito causal. Nesse aspecto, a análise de impacto causal considera vários fatores, incluindo sazonalidade, modelando o período pré-intervenção usando um modelo bayesiano de séries temporais estruturais. Assim, componentes sazonais, tendências e outros covariáveis e padrões variáveis ao longo do tempo são capturados no modelo.[98,99]

5.6.1.2. Análise da mortalidade materna

Como o número de mortes maternas foi muito baixo durante o período do estudo, o que representa desafios para a realização de uma análise de inferência causal significativa para a mortalidade materna na maternidade, impactando a viabilidade, confiabilidade e interpretabilidade da análise de inferência causal, foi optado por não usar a análise de impacto causal para avaliação da mortalidade materna. Nesse sentido, foi optada pela análise de pareamento por escore de propensão para avaliar o efeito da pandemia de COVID-19 na mortalidade materna.[98,99] Inicialmente, para avaliar as covariáveis consideradas para o pareamento por escore de propensão, foi realizada uma análise univariada usando o teste t de Student ou o teste de Mann-Whitney para avaliar variáveis quantitativas associadas à mortalidade materna na maternidade, conforme apropriado, e o teste do qui-quadrado de Pearson (χ^2) foi usado conforme necessário para variáveis categóricas.

Então, uma análise de regressão logística binária pelo método de entrada foi utilizada para avaliar fatores independentes associados à mortalidade materna na maternidade, incluindo variáveis não colineares associadas ao desfecho com valor de $p < 0,05$ na análise univariada e os fatores de confusão de acordo com o conhecimento prévio com valor de $p < 0,20$ na análise univariada. A não colinearidade foi aceita quando a tolerância foi maior que 0,10 e o fator de inflação da variância (VIF) foi menor que 10,0. A razão de chances (OR) expressou os resultados com seu respectivo intervalo de confiança de 95% (IC 95%).

Finalmente, um pareamento por escore de propensão para mortalidade materna na maternidade aplicando um modelo de regressão logit, ajustado para os fatores independentemente associados na análise de regressão logística com a mortalidade materna, foi realizado para avaliar o efeito da COVID-19 usando o software Easy R (EZR) versão 1.54 (Saitama Medical Center, Jichi Medical University, Japão) com uma proporção de pareamento de 1:1 sem reposição no logit do escore de propensão aplicando um caliper de 0,2 de largura. A OR e o IC 95% do efeito da COVID-19 na mortalidade materna na maternidade foram calculados na amostra após o pareamento e apresentados em um gráfico de floresta.

Para análise de sensibilidade do efeito do período pós-início da COVID- 19 na mortalidade materna após o pareamento por escore de propensão, o E-valor foi usado para medir a robustez da associação quanto a fatores de confusão não medidos ou não ajustados, ou seja, esta é uma ferramenta para avaliar a força de efeito necessária que outra variável não

medida deveria possuir para potencialmente anular uma estimativa de efeito observada devido a confusão não medida ou residual. O E-valor foi calculado por uma calculadora online (https://www.evalue-calculator.com/).[100,101]

5.6.1.3. Análise da idade materna e do tempo de permanência na maternidade

Para comparar a idade e o tempo de permanência na maternidade entre os períodos pré e pós-COVID-19, o teste t de Student ou o teste de Mann-Whitney foi realizado para avaliar as variáveis quantitativas, conforme apropriado, e para comparar o sexo entre os períodos pré e pós COVID-19, o teste do qui-quadrado de Pearson (χ^2) foi utilizado para variáveis categóricas.

5.6.2 Cirurgias realizadas no Sistema Único do Distrito Federal

5.6.2.1. Análise do total de cirurgias, cirurgias eletivas e cirurgias de urgência

O teste de tendência de Cochran-Armitage para proporções foi realizado para comparar preliminarmente o número de cirurgias eletivas e de emergência entre março de 2018 e fevereiro de 2019, março de 2019 e fevereiro de 2020, março de 2020 e fevereiro de 2021, e março de 2021 e fevereiro de 2022.

Em seguida, a quantidade de cirurgias eletivas, de urgência e totais foram agrupadas em semanas epidemiológicas, e a tendência das cirurgias ao longo das semanas epidemiológicas durante o período do estudo foi inicialmente avaliada usando análise de regressão linear. Por fim, uma análise de impacto causal foi realizada utilizando o pacote Causal Impact do R para estimar o efeito causal do início da COVID-19 na série temporal de cirurgias eletivas, de emergência e totais, assim como na mortalidade. Como uma variável de controle no modelo, houve ajuste para a população estimada do DF em cada semana epidemiológica.

5.6.2.2. Mortalidade cirúrgica intra-hospitalar

A quantidade de óbitos pós-operatórios durante a internação hospitalar foi agrupada em semanas epidemiológicas, e sua tendência ao longo das semanas epidemiológicas durante o período do estudo foi inicialmente avaliada usando análise de regressão linear. Por fim, uma análise de impacto causal foi realizada utilizando o pacote Causal Impact do R para estimar o

efeito causal do início da COVID-19 na série temporal de cirurgias eletivas, de emergência e totais, assim como na mortalidade. Como uma variável de controle no modelo, a análise de impacto causal da pandemia de COVID-19 nas cirurgias eletivas, de emergência e totais, assim como na mortalidade, foi ajustada pela população estimada do DF em cada semana epidemiológica.

Nesse sentido, foi optada pela análise de pareamento por escore de propensão para avaliar o efeito da pandemia de COVID-19 na mortalidade materna.[98,99] Inicialmente, para avaliar as covariáveis consideradas para o pareamento por escore de propensão, foi realizada uma análise univariada usando o teste t de Student ou o teste de Mann-Whitney para avaliar variáveis quantitativas associadas à mortalidade materna na maternidade, conforme apropriado, e o teste do qui-quadrado de Pearson (χ^2) foi usado conforme necessário para variáveis categóricas.

Então, uma análise de regressão logística binária pelo método de entrada foi utilizada para avaliar fatores independentes associados à mortalidade materna na maternidade, incluindo variáveis não colineares associadas ao desfecho com valor de $p < 0,05$ na análise univariada e os fatores de confusão de acordo com o conhecimento prévio com valor de $p < 0,20$ na análise univariada. A não colinearidade foi aceita quando a tolerância foi maior que 0,10 e o fator de inflação da variância (VIF) foi menor que 10,0. A razão de chances (OR) expressou os resultados com seu respectivo intervalo de confiança de 95% (IC 95%).

Finalmente, foi também realizado pareamento por escore de propensão para mortalidade cirúrgica intra-hospitalar aplicando um modelo de regressão logit, ajustado para os fatores independentemente associados na análise de regressão logística com a mortalidade cirúrgica intra-hospitalar, foi realizado para avaliar o efeito da COVID-19 usando o software Easy R (EZR) versão 1.54 (Saitama Medical Center, Jichi Medical University, Japão) com uma proporção de pareamento de 1:1 sem reposição no logit do escore de propensão aplicando um caliper de 0,2 de largura. A OR e o IC 95% do efeito da COVID-19 na mortalidade cirúrgica intra-hospitalar foram calculados na amostra após o pareamento e apresentados em um gráfico de floresta.

5.6.3 Cirurgias realizadas no Hospital Regional de Sobradinho

O teste Cochran-Armitage para tendência em proporções foi utilizado para comparar a proporção de cirurgias eletivas e a mortalidade hospitalar em relação ao total de cirurgias

realizadas, assim como a proporção dos cancelamentos no dia da cirurgia, necessidade de reintervenções cirúrgicas e mortalidade hospitalar entre as cirurgias eletivas entre os períodos antes e após a pandemia de COVID-19.

Para avaliações dos fatores associados ao cancelamento de cirurgia no dia da cirurgia, necessidade de reintervenção cirúrgica e mortalidade intra-hospitalar, inicialmente foi realizada uma análise univariada usando o teste t de Student ou o teste de Mann-Whitney para variáveis quantitativas e o teste do qui-quadrado de Pearson (χ^2) para variáveis categóricas. Em seguida, foi realizada análise de regressão logística binária pelo método Enter para avaliação dos fatores independentes associados a cada desfecho avaliado, incluindo variáveis não colineares associadas ao desfecho com valor de $p < 0,05$ na análise univariada, bem como fatores de confusão de acordo com o conhecimento prévio com valor de $p < 0,20$ na análise univariada. Colinearidade foi aceita quando a tolerância foi maior que 0,10 e o fator de inflação da variância (VIF) foi menor que 10,0. A razão de chances (OR) expressou os resultados com seu respectivo intervalo de confiança de 95% (IC 95%).

5.7 CONSIDERAÇÕES ÉTICAS

O estudo seguiu os princípios delineados na Declaração de Helsinque. Estudos realizados com dados coletados do SIH/DATASUS são dispensados de análise por Comitê de Ética em Pesquisa, uma vez que os dados são provenientes de uma base de dado pública e anonimizada. Para o estudo dos dados coletados das pessoas com programação de cirurgias no HRS, o projeto do estudo foi submetido e aprovado pelo Comitê de Ética em Pesquisa da Fundação de Ensino e Pesquisa em Ciências da Saúde - Número do Parecer: 6.092.322, com dispensa de assinatura de termo de consentimento livre e esclarecido.

6 RESULTADOS

6.1 ARTIGO 1 – IMPACTO DA PANDEMIA DE COVID-19 NOS NASCIMENTOS, PARTOS VAGINAIS, CESARIANAS E MORTALIDADE MATERNA EM UMA ÁREA METROPOLITANA BRASILEIRA: UM ESTUDO DE COORTE DE SÉRIE TEMPORAL

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ORIGINAL RESEARCH

Impact of the COVID-19 Pandemic on Births, Vaginal Deliveries, Cesarian Sections, and Maternal Mortality in a Brazilian Metropolitan Area: A Time-Series Cohort Study

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Purpose: The COVID-19 pandemic posed a worldwide challenge, leading to radical changes in healthcare. The primary objective of the study was to assess the impact of the COVID-19 pandemic on birth, vaginal delivery, and cesarian section (c-section) rates. The secondary objective was to compare the maternal mortality before and after the pandemic.

Patients and Methods: Time-series cohort study including data of all women admitted for childbirth (vaginal delivery or c-section) at the maternities in the Public Health System of Federal District, Brazil, between March 2018 and February 2022, using data extracted from the Hospital Information System of Brazilian Ministry of Health (SIH/DATASUS) on September 30, 2022. Causal impact analysis was used to evaluate the impact of COVID-19 on birth, vaginal delivery, and c-section using the CausalImpact R package, and a propensity score matching was used to evaluate the effect on maternal mortality rate using the Easy R (EZR) software.

Results: There were 150,617 births, and considering total births, the effect of the COVID-19 pandemic was not statistically significant (absolute effect per week: 5.5, 95% CI: −24.0−33.4). However, there was an increase in c-sections after COVID-19 (absolute effect per week: 18.1; 95% CI: 11.9−23.9). After propensity score matching, the COVID-19 period was associated with increased maternal mortality (OR: 3.22, 95% CI: 1.53−6.81). The e-value of the adjusted OR for the association between the post-COVID-19 period and maternal mortality was 5.89, with a 95% CI: 2.43, suggesting that unmeasured confounders were unlikely to explain the entirety of the effect.

Conclusion: Our study revealed a rise in c-sections and maternal mortality during the COVID-19 pandemic, possibly due to disruptions in maternal care. These findings highlight that implementing effective strategies to protect maternal health in times of crisis and improve outcomes for mothers and newborns is crucial.

Keywords: COVID-19, cesarean section, maternal health services, maternal mortality

Introduction

The COVID-19 pandemic posed a significant challenge for healthcare systems worldwide, rapidly infecting numerous individuals and causing substantial fatalities and persistent health issues before vaccines were available.[1] The burden to manage COVID-19 led to notable changes in healthcare system provision, including the preventive suspension of

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elective surgeries, procedures, and outpatient appointments, along with redirecting healthcare services to manage COVID-19 cases.[2,3] There is a consensus that the COVID-19 pandemic may have impacted population health conditions often not directly linked to the SARS-CoV-2 infection. Maternal health is of great interest in all conditions impacted by COVID-19 as it is a proxy indicator of the quality of a country's healthcare services.[4–7]

As the COVID-19 pandemic continued to spread, there was a notable rise in cases of moderate to severe illness among pregnant women, leading to concerns about their susceptibility to infection and potential fatalities.[4–6,8–11] Thus, beyond the fear of the possibility of vertical transmission, special attention was initially given to understanding the direct effects of COVID-19 on maternal health. Notably, the severity of infection during pregnancy was a primary area of concern, especially in women from high-risk groups, such as those with obesity, hypertension, diabetes, and immunosuppression conditions.[1,6–11] In this aspect, a systematic review with meta-analysis including 42,754 infected pregnant patients showed a rapid increase in cesarian sections (c-sections); the mortality trend was not elucidated with a maternal mortality rate of 1.2% and a rise of preterm births.[11]

It is important to note that the impact of the pandemic on maternal health transcended the direct effects of individual infections. The indirect effects, such as the reduced access to and provision of maternal healthcare services and lower levels of their utilization due to fear of being infected, may lead to a significant impact on the quality of maternal care.[5–12] Thus, apart from the direct effects of COVID-19 on maternal health, the interruption of maternal healthcare services provision during the pandemic, breaking the continuum of healthcare throughout antenatal, intrapartum, and postnatal stages, could adversely affect both mother and newborn health, including a rise in preterm births and maternal mortality.[5–12]

The adaptations made in antenatal and postnatal services, the modifications to provide maternity care can also influence intrapartum services. These modifications can involve changes to provide care for pregnant women during labor, including alterations in anesthesia practices and the approach to childbirth itself.[5,8,12–16] Regarding the mode of birth, most studies have focused on assessing COVID-19-infected pregnant women.[14,15] Furthermore, while the context of the COVID-19 pandemic may have led to an increase in pre-planned induced births and chosen c-sections compared to vaginal delivery, the evidence regarding the indirect impact of pandemic and lockdown measures on the mode of birth is inconsistent.[5,8,9,16–18]

Latin American countries were impacted harder by COVID-19 than observed in developed countries.[7,19] Brazil was one of the most affected countries worldwide.[7,20,21] After the first case of COVID-19 reported on February 26, 2020, in the city of São Paulo,[22] COVID-19 initially spread to Brazil's largest metropolitan areas in the Southeast. It quickly moved to other regions, starting in the North and Northeast, followed by the Midwest and South. In May 2020, the public healthcare system in Manaus, a city in the North with the least ICU beds, had already collapsed, foreshadowing the country's severe pandemic from late 2020 to the end of 2021. The disease's focal point shifted during the pandemic, resulting in three significant waves of infections and deaths from March 2020 to January 2022. By the end of 2022, Brazil had registered 36.3 million confirmed COVID-19 cases, constituting around 5% of global cases. It ranked second in deaths among countries, accounting for about 10% of worldwide COVID-related deaths.[20,21] Factors contributing to the severe impact of COVID-19 in Brazil involve inconsistent containment measures, delayed guidelines for COVID-19 care, restricted health access, disparities among vulnerable populations, and the strain of the pandemic on an already strained and underfunded Brazilian public health system.[22,23]

In this scenario, the primary objective of this study is to assess the impact of the COVID-19 pandemic on birth, vaginal delivery, and c-section rates in a Brazilian metropolitan area. The secondary objective is to compare the maternal mortality before and after the pandemic.

Materials and Methods

Study Design

A time-series cohort study including all women admitted for childbirth (vaginal delivery or c-section) at the maternities in the Public Health System of Federal District (FD), Brazil, between March 2018 and February 2022. Data were obtained from the Hospital Information System in the Department of Informatics of the Brazilian Unified Health System

(SIH/DATASUS), an audited nationwide database with information regarding every hospital admission performed in the healthcare services affiliated with the Brazilian public health system (SUS).[24,25] The dataset was extracted from SIH/DATASUS on September 30, 2022.

Setting and Participants

The FD is a metropolitan area with 2,469,489 inhabitants that includes the city of Brasilia, the capital of Brazil, and has the highest Human Development Index (HDI) in Brazil. The first case of COVID-19 was reported on February 26, 2020, in the city of São Paulo.[22] Soon after this case, COVID-19 spread to other Brazilian states, with the first COVID-19 case in the FD dated March 8, 2020. The state government established the first lockdown in the FD due to COVID-19 on March 18, 2020, when there were 36 confirmed cases and another 174 notifications to be evaluated. The lockdown measures included suspending non-essential activities and the closure of gyms, schools, and shopping centers, restricting people's movement, and curbing the transmission of the virus. Thus, in this study, the pre-COVID-19 onset period was defined as between March 2018 and February 2020, and the post-COVID-19 onset period was between March 2020 and February 2022.

The public healthcare system of FD comprises 12 maternities in hospitals and one birth house. All information regarding admissions and procedures on these healthcare services needs to be provided in SIH/DATASUS to reimburse hospital-related procedures. Thus, the study included all women admitted for childbirth (vaginal delivery or c-section) at the hospital maternities and the birth house of the FD Public Health System between March 2018 and February 2022, informed in the SIH/DATASUS until September 30, 2022. No exclusion criteria were applied.

Data Collection

The SIH/DATASUS plays a pivotal role in processing and monitoring hospital admissions in the SUS and is responsible for managing hospital admission authorization forms, payments for hospital-related procedures and streamlining hospital oversight and audit functions, concurrently monitoring disbursements related to hospital admissions in Brazilian public healthcare services. Its database contains relevant parameterized information, including procedure code, hospital identification, and patient information, such as the city of residence, age, sex, admission and discharge date, and discharge status. Therefore, the SIH/DATASUS is widely used in epidemiological studies in Brazil.[24,25]

The variables collected from the SIH/DATASUS were maternal age, mode of birth (vaginal delivery or c-section), city of residence, maternal admission and discharge date, maternal length-of-stay (LOS), and discharge status (survivor or non-survivor).

Statistical Analysis

The distribution and normality of variables were checked using the Shapiro–Wilk test. Quantitative data are expressed as mean ± standard deviation (SD), median, and interquartile range (IQR25%–75%), and categorical variables are expressed as numbers and percentages.

Birth, Vaginal Delivery, and c-Section Rate Analysis

First, the total births, vaginal deliveries, and c-sections were calculated for each epidemiological week between March 2018 and February 2022. The trend of births, vaginal deliveries, and c-sections over the epidemiological weeks during the study period was initially evaluated using univariate linear regression analysis. The Cochran-Armitage test for trend in proportions was also performed to preliminarily compare the number of vaginal deliveries and c-sections between March 2018 and February 2019, March 2019 and February 2020, March 2020 and February 2021, and March 2021 and February 2022.

Then, the causal effects of COVID-19 onset on birth, vaginal delivery, and c-section rates were evaluated using causal impact analysis with the CausalImpact R package that applies a Bayesian structural time series model with predictor data sets to determine the likely trajectory of a trend line had a particular event not occurred (the COVID-19 pandemic) and then calculated the difference between that projected counterfactual trend line (if COVID-19 pandemic had not occurred) and the real data line (after the COVID-19 onset).[19] As control variables in the model, the causal impact analysis of the

COVID-19 pandemic on births was adjusted for the estimated population of the FD on each epidemiological week, and the causal impact analysis of the COVID-19 pandemic on c-sections was adjusted for the total births each epidemiological week.

The causal impact analysis extends the traditional interrupted time series (ITS) analysis by incorporating Bayesian structural time series models to adjust for seasonality and other factors. Thus, when an intervention or event occurs, the method estimates the causal effect by comparing the observed data to what would have been expected based on the model's predictions. While the ITS analysis typically focuses on identifying the immediate impact of an intervention on a time series data set, causal impact analysis not only quantifies the intervention's immediate effect but also provides a post-intervention counterfactual prediction, allowing for a more robust assessment of the causal effect. In this aspect, causal impact analysis accounts for various factors, including seasonality, by modeling the pre-intervention period using a Bayesian structural time series model. Thus, seasonal components, trends, and other time-varying covariates and patterns are captured in the model.[26,27]

Maternal Mortality Analysis

As the number of maternal deaths was too low during the study period, which poses challenges for conducting meaningful causal inference analysis for maternal mortality in maternity, impacting the analysis feasibility, reliability, and interpretability of causal inference analysis, we opted to use propensity score matching to evaluate the effect of the COVID-19 pandemic on maternal mortality.[26,27]

First, to evaluate the covariates considered for the propensity score matching, a univariate analysis was performed using Student's *t*-test or Mann–Whitney test to evaluate quantitative variables associated with maternal mortality in maternity, as appropriate, and Pearson's chi-square test ($\chi 2$) was used as necessary for categorical variables.

Thus, an enter method binary logistic regression analysis was used to evaluate independent factors associated with maternal mortality in maternity, including non-collinear variables associated with the outcome with a p-value < 0.05 in the univariate analysis and the confounding factors according to previous knowledge with a p-value < 0.20 in the univariate analysis. Non-collinearity was accepted when the tolerance was higher than 0.10 and the variance inflation factor (VIF) was lower than 10.0. The odds ratio (OR) expressed the results with their respective 95% confidence interval (95% CI).

Finally, a propensity score matching for maternal mortality in maternity applying a logit regression model adjusted to factors independently associated in the logistic regression analysis with maternal mortality in maternity was performed to assess the effect of COVID-19 on maternal mortality in maternity using the Easy R (EZR) software version 1.54 (Saitama Medical Center, Jichi Medical University, Japan) with a 1:1 pair-matching ratio without replacement on the logit of the propensity score applying a caliper of 0.2 widths. The OR and 95% CI of the COVID-19 effect on maternal mortality in maternity are calculated in the sample after matching and are shown as a forest plot.

For sensitivity analysis of the effect of the post-COVID-19 onset period on maternal mortality in maternity after propensity score matching, the e-value was used to measure the robustness of the association between COVID-19 and maternal mortality for unmeasured or unadjusted confounding, ie, a tool to evaluate the strength of the effected of another variable required to potentially overturn an observed effect estimate due to unmeasured or residual confounding. E-value was computed with an online e-value calculator (https://www.evalue-calculator.com/).[28,29]

Statistical analyses were performed using the IBM Statistical Package for the Social Sciences version 20.0 for Mac (SPSS 20.0 Mac, SPSS Inc., Chicago, Illinois, USA), Jamovi 2.3.24 (https://www.jamovi.org), and statistical software R version 4.2.3 (https://www.r-project.org/). Statistical significance was set at a two-sided p-value ≤ 0.05.

The study adhered to the principles outlined in the Declaration of Helsinki. Since DATASUS has no personal data, our study was exempt from review by the Brazilian National Research Ethics Committee (CONEP).

Results

Between March 2018 and February 2022, there were 150,617 births in the FD public health system, with 61,167 c-sections (40.6%). The mean maternal age was 26.8 ± 6.8 years (median: 26.0 years, IQR 25%–75%: 21.0–32.0 years),

and the median maternity LOS was 3.0 days (IQR 25%–75%: 2.0–4.0). The maternal mortality rate was 0.0003% (40 out of 150,617 women). See Supplementary Table S1.

Supplementary Figure S1 shows the number of births, vaginal deliveries, and c-sections per epidemiological week from March 2018 to February 2022. During the study period, the number of vaginal and total births decreased (r = −0.552, 95% CI: −0.552–-0.361, $p < 0.001$; r = −0.718, 95% CI: −0.548–-0.419, $p = 0.271$, respectively), whereas the number of c-sections did not change significantly ($r = 0.077$, 95% CI: −0.021–0.075, $p = 0.271$).

Figure 1 shows a causal impact analysis of the COVID-19 pandemic on the total births in the FD public health system over the study period, adjusted for the FD population. After the onset of COVID-19 in Brazil in March 2020, there were 72,948 births, compared to 71,488 births expected if the COVID-19 pandemic had not occurred (95% CI: 68,818–74,531 births). After adjusting for the FD population over the study period, the effect of the COVID-19 pandemic on births was not statistically significant when considering the entire period after the COVID-19 onset as a whole, with an absolute effect per epidemiological week of 5.5 births (95% CI: −24.0–33.4 births) and a relative effect of 0.9% (95% CI: −3.3–5.5%).

Although the COVID-19 pandemic did not affect total births in the FD public health system, there was an increase in c-sections compared to vaginal deliveries after the COVID-19 outbreak in March 2020 ($p < 0.001$). See Figure 2.

Figure 3 shows a causal impact analysis of the COVID-19 pandemic on the total number of c-sections in the FD public health system over the study period, adjusted for the total births. After the onset of COVID-19 in Brazil in March 2020, there were 30,462 c-sections in the FD public health system, compared to 28,596 c-sections expected if the COVID-19 pandemic had not occurred (95% CI: 28,000–29,233 C-sections). The causal impact analysis of the COVID-19 pandemic on c-sections, adjusted for the total births over the study period, revealed a statistically significant effect when considering the entire period after the COVID-19 onset as a whole, with an absolute effect per epidemiological week of 18.1 c-sections (95% CI: 11.9–23.9 c-sections) and a relative effect of 6.6% (95% CI: 4.2–8.8%).

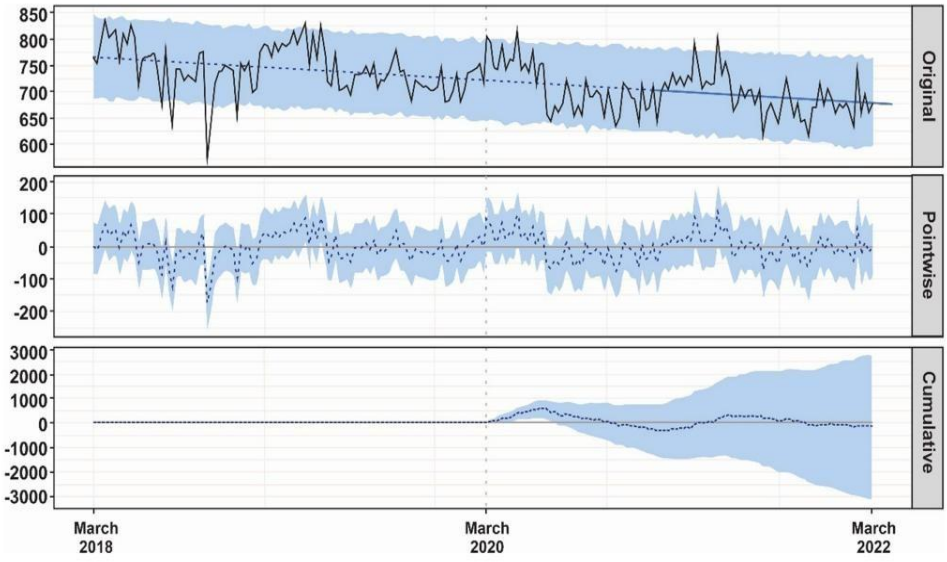

Figure 1 Causal impact analysis of the COVID-19 pandemic on total births in the Federal District public health system adjusted to the Federal District population over time using data from March 2018 to February 2022. The first panel shows the observed births (solid black line), the counterfactual prediction of births if COVID-19 had not occurred adjusted to the Federal District population over time (dotted blue line), and the 95% CI of births of the counterfactual prediction. The second panel shows the difference between observed births and the counterfactual prediction of births, the pointwise causal effect of COVID-19 on births adjusted to the Federal District population over time (dotted blue line). The third panel shows the pointwise contributions from the second panel, resulting in a plot of the cumulative effect of COVID-19 on births (dotted blue line). After the COVID-19 onset in Brazil in March 2020 (dotted gray vertical line), the 95% CI of the cumulative effect of COVID-19 on births includes the counterfactual prediction of cumulative deliveries (x-axis baseline) almost over time and at the end of the follow-up, meaning that it does not deviate significantly from the counterfactual prediction by the model.

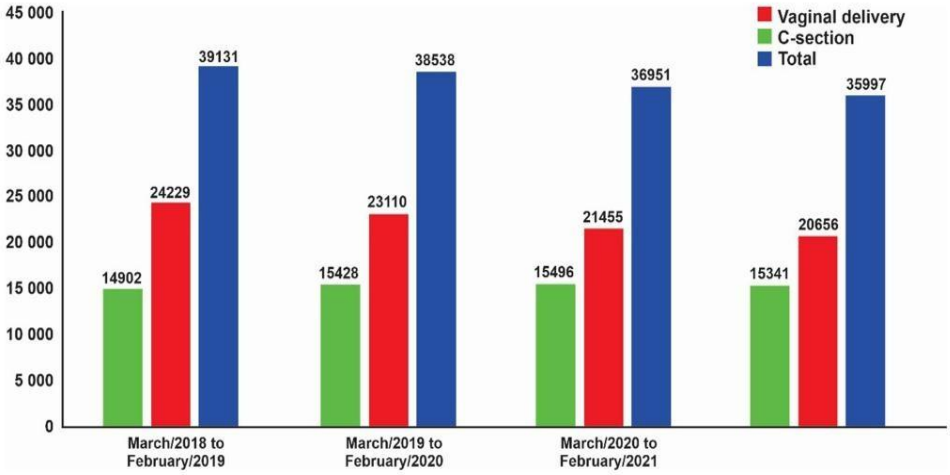

Figure 2 Vaginal deliveries, c-sections, and total births in the Federal District public health system annually from March 2018 to February 2022 (n = 150,617). Cochran-Armitage test for trend in proportions: *p*-value < 0.01.

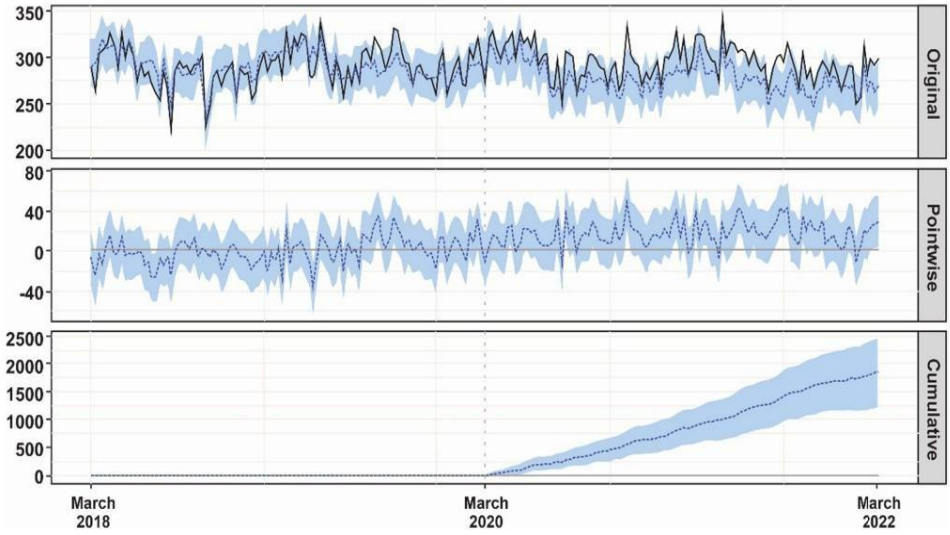

Figure 3 Causal impact analysis of the COVID-19 pandemic on c-sections performed in the Federal District public health system adjusted to the total births over time using data from March 2018 to February 2022. The first panel shows the observed c-sections (solid black line), the counterfactual prediction of c-sections if COVID-19 had not occurred adjusted to the total births over time (dotted blue line), and the 95% CI of the counterfactual prediction of c-sections. The second panel shows the difference between observed c-sections and the counterfactual prediction of c-sections, the pointwise causal effect of COVID-19 on c-sections adjusted to total births over time (dotted blue line). The third panel shows the pointwise contributions from the second panel, resulting in a plot of the cumulative effect of COVID-19 on c-sections (dotted blue line). After the COVID-19 onset in Brazil in March 2020 (dotted gray vertical line), the 95% CI of the cumulative effect of COVID-19 on c-sections (shaded region) moves above the counterfactual prediction of cumulative births (x-axis baseline) over time and deviates significantly at the end of the follow-up from the counterfactual prediction by the model.

Supplementary Table S2 shows the univariate analysis of maternal age and maternity LOS among births in the FD public health system before and after COVID-19 onset. Maternal age was higher ($p < 0001$), and maternity LOS was lower ($p < 0.001$) after the COVID-19 onset.

Table 1 Multivariate Analysis of Variables Associated with Maternal Mortality

	OR (95% CI)	*p*-value	Tolerance	VIF
March 2020 to February 2022	2.62 (1.37–5.03)	0.004	0.999	1.001
C-section, n (%)	3.10 (1.51–6.34)	0.002	0.999	1.001

Abbreviations: 95% CI, 95% Confidence interval; OR, Odds ratio; VIF, Variance inflation factor.

Supplementary Table S3 shows the univariate analysis of variables associated with maternal mortality in maternity. The c-section ($p < 0.002$) and post-COVID-19 onset period ($p < 0.001$) were associated with increased maternal mortality in maternity.

Table 1 shows the multivariate analysis of variables associated with maternal mortality in maternity. The c-section (OR: 3.10, 95% CI: 1.51–6.34, $p = 0.002$) and post-COVID-19 onset period (OR: 2.62, 95% CI: 1.37–5.03, $p = 0.04$) were independently associated with increased maternal mortality in maternity.

Figure 4 shows the effect of the post-COVID-19 onset period (March 2020 to February 2022) on maternal mortality in maternity after propensity score matching adjusted for c-section and age. COVID-19 was associated with increased maternal mortality in maternity (OR: 3.22, 95% CI: 1.53–6.81, $p = 0.02$).

For sensitive analysis of the effect of the post-COVID-19 onset period on maternal mortality in maternity after propensity score matching, the e-value of the adjusted OR for the association between the post-COVID-19 period and maternal mortality in maternity was 5.89, with a 95% CI of 2.43, suggesting that unmeasured confounders were unlikely to explain the entirety of the effect.

Discussion

Our study showed that the total births in the public maternities of FD was unaffected by the COVID-19 pandemic. However, there was an increase in c-sections compared to the counterfactual prediction if the COVID-19 pandemic had not occurred. Additionally, there was increased maternal mortality when comparing the pre-and post-COVID-19 periods. These findings may not only reflect the adaptations made in maternity units but also highlight the limitations in the provision and utilization of maternal healthcare services, which have had a detrimental impact on the continuity of maternal care.[4–6]

Although there was no alteration in the recommendations for the mode of birth during the pandemic, with vaginal delivery remaining the preferred approach and c-sections reserved for standard indications based on fetal and maternal factors, the observed increase in c-sections during this period can be attributed to various factors. The fear of contracting

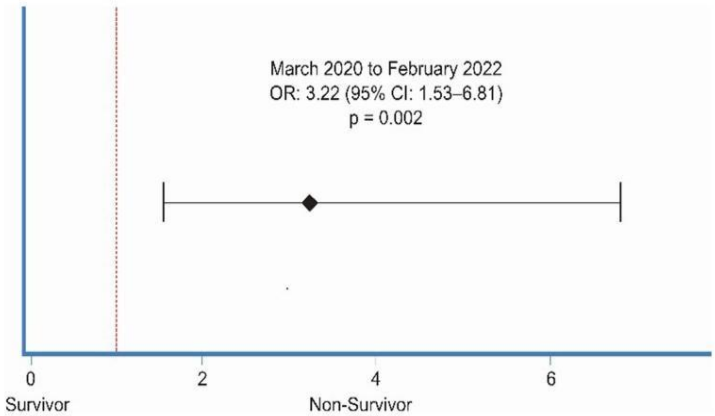

Figure 4 Effect of the post-COVID period (March 2020 to February 2020) on maternal mortality in maternity after propensity score-matching adjusted to c-section and age.

COVID-19 at healthcare facilities may have contributed to a hesitancy in timely referrals to emergency care units. These delayed referrals may have complicated the management of laboring women, particularly when facing obstetrical complications, thereby increasing the likelihood of resorting to a c-section. Moreover, some obstetricians may hesitate to expose themselves, their trainees, and midwives to pregnant patients whose PCR status is unknown. This cautionary approach may manifest as a preference for c-sections even when vaginal delivery would have been a more feasible choice. Furthermore, the threshold for opting for c-sections during the COVID-19 pandemic may have been lowered to minimize the duration of maternal hospitalization and mitigate the potential for cross-infection. Additionally, some pregnant women may have chosen to undergo a c-section out of fear of COVID-19 and due to restrictions on their partners' access to maternity.[16,30–32]

Similar to our findings, a study conducted in Iran reported a significant increase in the overall c-section rate during the initial wave of the COVID-19 pandemic.[33] Another Brazilian study showed increased c-sections in all gestational age groups and a higher risk of preterm babies during the COVID-19 pandemic.[7] A study during the COVID-19 lockdown period in India observed a significantly higher c-section rate than the pre-lockdown period.[34] Two studies in England, one study in Turkey, one study in Nepal, and one study in China also showed a rise in the overall c-section rate during the pandemic.[17,35–38] However, it is worth noting that other studies have presented conflicting results compared to our study regarding the mode of birth. Some studies have shown no significant change,[22,39–44] while others have even reported an increase in vaginal deliveries.[5] A systematic review with meta-analysis published in 2021, including 11 studies, did not find a significant difference in the c-section rate during the COVID-19 pandemic.[8]

Interestingly, a study performed at a Brazilian tertiary hospital in São Paulo, Brazil, during the initial surge of the COVID-19 pandemic in 2020, observed a significant increase in the number of pregnant patients admitted to the hospital in the advanced stages of labor. This trend was particularly evident among pregnant women who had initially been advised to undergo elective c-sections due to abnormal fetal presentation or previous c-sections.[45] It is plausible that this phenomenon was linked to the fear of exposure to COVID-19, prompting these women to commence labor at home.[45–47] In contrast to the increase in c-sections observed in our study, this finding raises an intriguing question and highlights the importance of considering the unique characteristics of the population evaluated in each study. It is important to note that the study in question was conducted on maternity at a specialized university hospital that serves a larger population of women with high-risk pregnancies. Additionally, the city where the study took place confronts formidable obstacles to urban transportation, thereby impeding the timely referral of pregnant individuals to maternity services compared to the FD. This is further compounded by reduced public transportation options during the pandemic. Consequently, many pregnant women were admitted to the hospital in a more advanced phase of labor, ultimately resulting in vaginal deliveries.[45] Indeed, a study in India observed a delay in seeking health care from pregnant women and a reduction in institutional births due to either inaccessibility, lack of transport, or fear of contracting infection.[46]

Our study identified an elevated incidence of maternal mortality in maternity during COVID-19. Notably, another Brazilian study analyzing national data on maternal mortality revealed a notable surplus of maternal deaths during the post-pandemic period following the emergence of COVID-19 in 2020, persisting even after considering the expected rise in mortality among women of reproductive age due to COVID-19,[48] which was also observed in a time-series study in the Brazilian state of Bahia.[49] These results align with two studies conducted in middle-income countries, India and Mexico, which also reported a significant surge in maternal deaths during the COVID-19 pandemic.[34,50] Another study in India showed increased non-COVID-19 maternal mortalities during the COVID pandemic.[51] Indeed, a systematic review with meta-analysis published in 2021 observed a significant increase in maternal death during the COVID-19 pandemic.[8]

Timely access to adequate maternity care is essential for women's safety and quality of care, as the delay in receiving care is associated with adverse maternal outcomes.[52] These findings indicate the presence of additional maternal deaths indirectly linked to COVID-19 can be attributed to the challenges encountered by healthcare systems in effectively managing the impact of the COVID-19 pandemic on the continuum of maternal care, including prenatal care, suitable childbirth, and postpartum care.[8] These challenges encompass a range of factors, such as reduced attendance for routine prenatal care and change in maternity care service provision, resulting in limited access to maternal care services.[39,42,46,53–56] Indeed, many pregnant women refrained from seeking healthcare services due to concerns about the risk of contracting COVID-19, government recommendations to stay at home, and limited availability of public

transportation during periods of lockdown.[46,57] Furthermore, a time-series study in Colombia showed increased maternal mortality, particularly pronounced in municipalities with the lowest wealth quintile. This finding shows the heightened vulnerability of women with lower income and disadvantaged living conditions, emphasizing the exacerbation of healthcare access inequities during the COVID-19 pandemic.[58]

Our study did not show difference in the number of births in the public maternities of FD comparing the pre- and post-COVID-19 pandemic period that was also observed in a study performed in Ethiopia.[55] However, it is important to analyze this finding within the context of how the pandemic has impacted healthcare services in different locations. Some studies have reported a decrease in hospital births, particularly during periods of strict lockdown and in regions where the healthcare system was under significant strain due to high numbers of COVID-19 cases.[32,34,35,41,42,46,51,56] In this aspect, the decline in births conducted in healthcare facilities may be attributed to a variety of factors, such as women may opt for home or at nearby healthcare facilities births due to factors such as limited accessibility, lack of transportation, and fear of infection in maternity.[32,46,51,59]

Our study has some limitations. Firstly, the lacked of information on the specific indications for c-sections, pregnancy complications, waiting time before being admitted and receiving care, and the complete demographic characteristics of the women, including their education and socio-economic status. Additionally, there was no data on the prevalence of COVID-19 among the study population, and our analysis was only limited to births in maternities. Furthermore, it is important to acknowledge that other factors not considered in our study could have influenced the group outcomes. While the absence of information on these variables is a limitation, the sensitivity analysis of the effect of the post-COVID-19 onset period on maternal mortality in maternity after propensity score matching using the e-value suggests that unmeasured confounders were unlikely to entirely explain the observed impact on maternal mortality to the point of modifying the observed results.[28,29] Regarding the causal impact analysis, the impact of COVID-19 on births, vaginal deliveries, and c-sections was evaluated from the combination of three elements: a regression component that relates the outcome of the COVID-19 period to the outcomes on counterfactual prevision, a time-series component capturing temporal patterns in the data, and an error element considering any unpredicted variation. Despite its strengths, there are limitations to the use of the causal impact analysis. Specifically, the underlying time-series model usually involves numerous unknown parameters, necessitating substantial data to estimate these parameters, including the counterfactual prediction accurately. In our study, 150,617 births were included. Further, the performance of the causal impact can be impacted if the outcome of interest is subject to measurement errors. However, this does not apply to the outcomes evaluated in our study.[26,27]

Conclusion

Our study revealed the detrimental impact of the COVID-19 pandemic on maternal care, specifically an increase in maternal mortality and c-section rates following the onset of the pandemic. These findings highlight the indirect consequences of COVID-19 on the continuum of maternal care. It is crucial to implement effective strategies to mitigate the long-term impact of COVID-19 on maternal health and enhance the overall health outcomes for both mothers and newborns.

Disclosure

The authors report no conflicts of interest in this work.

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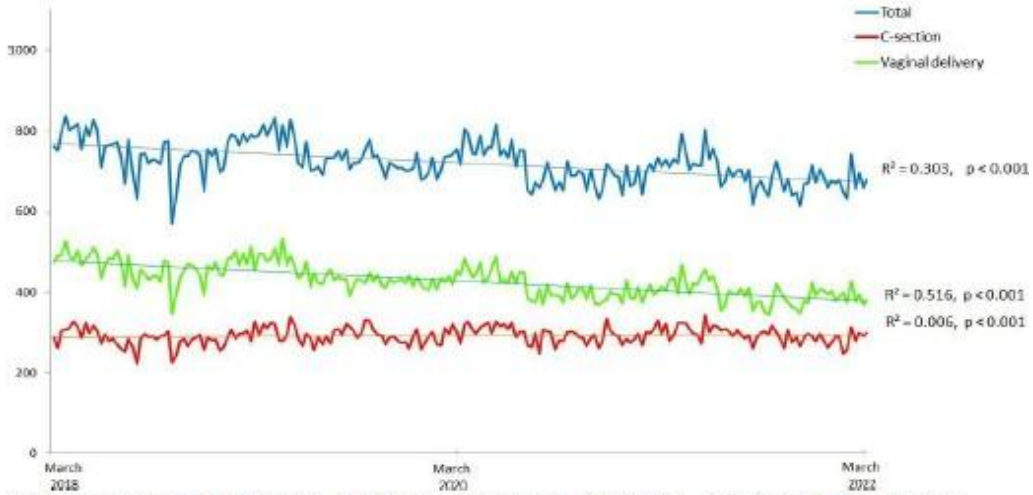
SUPPLEMENTARY FILE



Supplementary Figure S1. Vaginal deliveries, c-sections, and total births in the Federal District public health.

Supplementary Table S1. Deliveries in the Federal District public health system between March 2018 and February 2022 (n = 150,617).

Maternal age, years,	
mean (SD)	26.8 (6.8)
median (IQR 25%–75%)	26.0 (21.0–32.0)
C-section, n (%)	61,167 (40.6)
Maternity LOS, days,	
mean (SD)	3.3 (2.9)
median (IQR 25%–75%)	3.0 (2.0–4.0)
Maternal mortality in maternity, n (%)	40 (0.0003)

SD: Standard deviation; IQR 25%–75%: Interquartile range 25%–75%; LOS: Length of stay.

Supplementary Table S2. Maternal age and length of stay in maternity among biths in the Federal District public health system before and after the COVID-19 onset in Brazil in March 2020 (n = 150,617).

	March 2018 to February 2020 (n = 77,669)	**March 2020 to February 2022 (n = 72,948)**	***p*-value**
Maternal age, years			< 0.001
mean (SD)	26.6 (6.8)	26.9 (6.8)	
median (IQR 25%–75%)	26 (21.0–32.0)	26 (22.0–32.0)	
Maternity-LOS, days,			< 0.001
mean (SD)	3.5 (3.2)	3.1 (2.6)	
median (IQR 25%–75%)	3 (2–4)	3 (2–3)	

SD: Standard deviation; IQR 25%–75%: Interquartile range 25%–75%; LOS: Length of stay.

Supplementary Table S3. Univariate analysis of variables associated with maternal mortality in maternity among births in the Federal District public health system before and after the COVID-19 onset in Brazil in March 2020 (n = 150,617).

Variable	**Survivors (n = 150,577)**	**Non-survivors (n = 40)**	***p*-value**
Maternal age,years			0.774
mean (SD)	26.8 (6.8)	27.1 (7.0)	
median (IQR 25%–75%)	26.0 (21.0–32.3)	26.5 (21.0–32.0)	
March 2020 to February 2022	72,918 (48.3)	30 (75.0)	< 0.001
C-section, n (%)	61,141 (40.6)	26 (65.0)	0.002

IQR25%–75%: Interquartile range 25%–75%; SD: Standard deviation.

6.2 ARTIGO 2 – IMPACTO DA PANDEMIA DE COVID-19 EM CIRURGIAS ELETIVAS E DE URGÊNCIA EM UMA ÁREA METROPOLITANA BRASILEIRA: UM ESTUDO DE COORTE DE SÉRIE TEMPORAL

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ORIGINAL RESEARCH

Impact of the COVID-19 Pandemic on Elective and Emergency Surgeries, and Postoperative Mortality in a Brazilian Metropolitan Area: A Time-Series Cohort Study

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Purpose: The COVID-19 pandemic posed a worldwide challenge, leading to radical changes in surgical services. The primary objective of the study was to assess the impact of COVID-19 on elective and emergency surgeries in a Brazilian metropolitan area. The secondary objective was to compare the postoperative hospital mortality before and during the pandemic.

Patients and Methods: Time-series cohort study including data of all patients admitted for elective or emergency surgery at the hospitals in the Public Health System of Federal District, Brazil, between March 2018 and February 2022, using data extracted from the Hospital Information System of Brazilian Ministry of Health (SIH/DATASUS) on September 30, 2022. A causal impact analysis was used to evaluate the impact of COVID-19 on elective and emergency surgeries and hospital mortality.

Results: There were 174,473 surgeries during the study period. There was a reduction in overall (absolute effect per week: −227.5; 95% CI: −307.0 to −149.0), elective (absolute effect per week: −170.9; 95% CI: −232.8 to −112.0), and emergency (absolute effect per week: −57.7; 95% CI: −87.5 to −27.7) surgeries during the COVID-19 period. Comparing the surgeries performed before and after the COVID-19 onset, there was an increase in emergency surgeries (53.0% vs 68.8%, $P < 0.001$) and no significant hospital length of stay ($P = 0.112$). The effect of the COVID-19 pandemic on postoperative hospital mortality was not statistically significant (absolute effect per week: 2.1, 95% CI: −0.01 to 4.2).

Conclusion: Our study showed a reduction in elective and emergency surgeries during the COVID-19 pandemic, possibly due to disruptions in surgical services. These findings highlight that it is crucial to implement effective strategies to prevent the accumulation of surgical waiting lists in times of crisis and improve outcomes for surgical patients.

Keywords: COVID-19, surgical procedures, operative, elective surgical procedures, acute care surgery, hospital mortality

Introduction

Numerous hospitals and healthcare facilities had to suspend or limit surgeries to prioritize patient resources in response to the COVID-19 pandemic. This measure was implemented to secure the availability of hospital beds, staff, and personal protective equipment for individuals affected by COVID-19.[1] Besides, implementing lockdown measures and travel restrictions reduced access to healthcare services. The fear of exposure to the virus may have prompted patients to postpone

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seeking medical consultation, exacerbating delays in healthcare procedures, including surgeries.[1,2] Additionally, numerous surgeries were canceled due to positive pre-procedural COVID-19 test results, leading to delays and a backlog of cases.[3] Consequently, the COVID-19 pandemic has significantly impacted elective and emergency surgeries worldwide, leading to cancellations or delays, and procedures initially deemed elective may have transitioned into emergency matters.[1–7]

In addition to the resource constraints during the pandemic, surgeries typically involve close and personal contact between surgeons and their patients that differs from those encountered by non-surgical specialists.[6] In this way, the risk of COVID-19 transmission necessitated additional safety measures such as testing, preoperative quarantines, and cleaning protocols. These measures added complexity and cost to the surgical process.[4,6–9] The postponement or cancellation of elective surgeries can profoundly affect global health systems, as they may contend with an overwhelming backlog of patients awaiting surgery. Furthermore, the increased wait times for surgeries, especially for time-sensitive elective procedures such as cancer treatments, can have potentially devastating effects on patients. These delays elevate the risk of complications in the pre-and postoperative, worsen the quality of life, and may result in unnecessary deaths.[10] Notably, there was an increase in mortality in cardiac surgery in the United States,[11] and the United Kingdom during the COVID-19 pandemic.[12]

In the early months of the pandemic, various surgical societies worldwide recommended canceling elective surgeries.[6,13] However, the impact of the COVID-19 pandemic extended beyond elective procedures, significantly affecting emergency surgeries.[2,13–15] During the COVID-19 lockdown in Italy, an 86% reduction in emergency surgeries was reported.[16] Similar numbers were observed in Greece,[13] the United States,[14] Spain,[15] and Germany.[17] On the contrary, an increase in emergency surgeries in a teaching hospital in Saudi Arabia was observed.[2]

Latin American nations faced an intensified impact of the COVID-19 pandemic compared to more developed counterparts.[18] Brazil, in particular, was one of the most affected countries, with the initial reported case surfacing in São Paulo on February 26, 2020.[19–21] Starting as a localized outbreak in the Southeast, it rapidly spread across the country. The factors contributing to Brazil's severe COVID-19 predicament are multifaceted, including inconsistent containment measures, delayed directives for COVID-19 patient care, limited access to healthcare services, existing disparities in marginalized populations, and the overwhelming strain on an already beleaguered and underfinanced Brazilian public health system.[19]

During the COVID-19 pandemic, hospitals and healthcare systems faced resource constraints. Medical personnel, equipment, and supplies were diverted to COVID-19 response efforts. Operating rooms were repurposed for intensive care units (ICU) or COVID-19 treatment areas, limiting the availability of facilities for surgeries.[4,22] In this circumstance, the primary objective of this study is to assess the impact of COVID-19 on elective and emergency surgeries in a Brazilian metropolitan area. The secondary objective is to compare the postoperative hospital mortality before and after the pandemic.

Materials and Methods

Study Design

A time-series cohort study including all consecutive patients admitted for elective or emergency surgery at the hospitals in the Public Health System of Federal District (FD), Brazil, between March 2018 and February 2022. Data were extracted on September 30, 2022, from the Hospital Information System of Brazilian Ministry of Health (SIH/DATASUS), an audited nationwide database with administrative and epidemiologic information on every hospital admission performed in the healthcare services affiliated with the Brazilian public health system.[23,24]

Setting and Participants

The FD is a metropolitan area with 2,469,489 inhabitants, including the city of Brasilia, the capital of Brazil, and has the highest Human Development Index (HDI) in Brazil. The state government established the first lockdown on March 18, 2020, when there were 36 confirmed cases and another 174 notifications to be evaluated. The lockdown measures included suspending non-essential activities, closing gyms, schools, and shopping centers, restricting people's movement,

and curbing the virus transmission. Thus, in this study, the pre-COVID-19 onset period was defined as between March 2018 and February 2020, and the post-COVID-19 onset period was between March 2020 and February 2022.

The FD public healthcare system comprises 16 hospitals and 13 emergency units. All information regarding admissions and procedures on these healthcare services needs to be provided in SIH/DATASUS to reimburse hospital-related procedures. Thus, the study included all consecutive patients admitted for elective or emergency surgery at the public hospitals of the FD Public Health System between March 2018 and February 2022, informed in the SIH/DATASUS until September 30, 2022. No exclusion criteria were applied.

Data Collection

The SIH/DATASUS plays a pivotal role in the processing and surveillance of hospital admissions in Brazilian public healthcare services. Its database contains relevant parameterized information, including procedure code, hospital identification, and patient information, such as age, sex, city of residence, admission and discharge date, and discharge status. Therefore, the SIH/DATASUS is extensively utilized in epidemiological studies in Brazil.[23–25]

The variables collected from the SIH/DATASUS were age, sex, type of surgery (emergency or elective), site of surgery (digestive, orthopedic/trauma, gynecological/mammary, renal/urinary tract, skin/soft tissue, head/neck, neurological, thoracic, cardiovascular, transplant, and endocrine), admission and discharge date, hospital length-of-stay (LOS), and discharge status (survivor or non-survivor).

Statistical Analysis

The distribution and normality of variables were analyzed using the Shapiro–Wilk test. Quantitative data are expressed as mean ± standard deviation (SD), or median and interquartile range (IQR 25–75%), and categorical variables are expressed as numbers and percentages (%).

Cochran-Armitage test for trend in proportions was also performed to preliminarily compare the number of elective and emergency surgeries between March 2018 and February 2019, March 2019 and February 2020, March 2020 and February 2021, and March 2021 and February 2022.

Then, the number of elective, emergency, and overall surgeries, as well as mortality, were grouped into epidemiological weeks, and the trend of surgeries over the epidemiological weeks during the study period was initially evaluated using linear regression analysis.

Finally, a causal impact analysis was performed using the R package Causal Impact to estimate the causal effect of the COVID-19 onset on the time series of elective, emergency, and overall surgeries, as well as mortality. The causal impact analysis goes beyond traditional interrupted time series (ITS) analysis by integrating Bayesian structural time series models to account for seasonality and other variables. When an intervention or event occurs, the method calculates the causal effect by comparing observed data with what would have been expected based on the model's predictions. While ITS analysis typically focuses on identifying the immediate impact of an intervention, causal impact analysis not only quantifies the immediate effect but also provides a post-intervention counterfactual prediction. The causal impact analysis enables a more comprehensive assessment of the causal effect. Causal impact analysis considers various factors, including seasonality, by modeling the pre-intervention period with a Bayesian structural time series model, capturing seasonal components, trends, and other time-varying covariates and patterns in the model.[25–27] As a control variable in the model, the causal impact analysis of the COVID-19 pandemic on elective, emergency, and overall surgeries, as well as mortality, was adjusted for the estimated population of the FD on each epidemiological week.

To compare age and hospital-LOS between the pre-and post-COVID-19 period, the Student's *t*-test or Mann–Whitney test was performed to assess quantitative variables, as appropriate, and to compare the sex between the pre-and post-COVID-19 period, Pearson's chi-square test ($\chi 2$) was used for categorical variables.

Statistical analyses were performed using the IBM Statistical Package for the Social Sciences version 20.0 for Mac (SPSS 20.0 Mac, SPSS Inc., Chicago, Illinois, USA), Jamovi 2.3.24 (https://www.jamovi.org), and statistical software R version 4.2.3 (https://www.r-project.org/). Statistical significance was set at a two-sided P value ≤ 0.05.

Ethical Considerations

The study adhered to the principles outlined in the Declaration of Helsinki. Our study used data extracted from the SIH/DATASUS, a public database that does not identify research participants. According to Brazilian legislation and Resolution 466/2012 of the Brazilian National Research Ethics Council (CONEP), studies involving only publicly available data that do not identify research participants do not require approval from an Institutional Review Board (IRB) or local ethics review board.

Results

Between March 2018 and February 2022, there were 174,473 surgeries performed in the FD public health system; the majority were digestive surgeries (55,956/174,473; 32.1%), followed by orthopedic/trauma surgeries (48,143/174,473; 27.6%) and gynecological/mammary surgeries (21,280/174,473; 12.2%). Emergency surgeries were 105,655 (60.6%). The mean age was 40.3 ± 20.8 years, and 84,409 (48.4%) were female. The median hospital-LOS was 2.0 days (IQR 25%–75%: 1.0–6.0), and hospital mortality was 1.4% (2,520/174,473), Supplementary Table 1.

Figure 1 shows the causal impact analysis of the COVID-19 pandemic on surgeries performed in the FD public health system adjusted to the FD population over the study period. After COVID-19 onset in Brazil in March 2020, there were

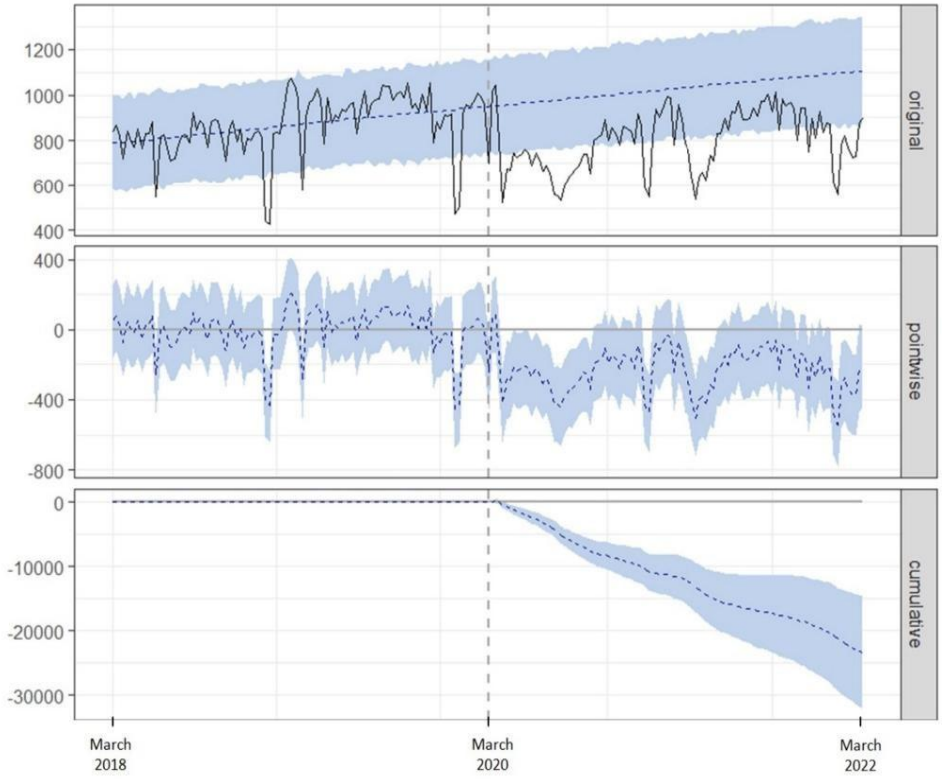

Figure 1 Causal impact analysis of the COVID-19 pandemic on overall surgeries performed in the Federal District public health system adjusted to the Federal District population using data from March 2018 to February 2022. The first panel shows the observed surgeries (solid black line), the counterfactual prediction if COVID-19 had not occurred adjusted to the Federal District population over time (dotted blue line), and the 95% confidence interval (95% CI) of the counterfactual prediction. The second panel shows the difference between observed surgeries and the counterfactual prediction, the pointwise causal effect of COVID-19 on surgeries adjusted to the Federal District population over time (dotted blue line). The third panel shows the pointwise contributions from the second panel, resulting in a plot of the cumulative effect of COVID-19 on surgeries (dotted blue line). After the COVID-19 onset in Brazil in March 2020 (dotted gray vertical line), the 95% CI of the cumulative effect of COVID-19 on surgeries (shaded region) moves below the counterfactual prediction of cumulative surgeries (x-axis baseline) over time, reducing significantly at the end of the follow-up from the counterfactual prediction of cumulative surgeries by the model.

82,568 surgeries, while 105,998 (95% CI: 97,204–114,789) surgeries would have been expected if the COVID-19 pandemic had not occurred. The effect of the COVID-19 pandemic reducing surgeries is statistically significant for the entire period after the COVID-19 onset, with an absolute effect of −227.5 (95% CI: −307.0 to −149.0) surgeries per epidemiological week and a relative effect of −22.0% (95% CI: −28.0 to −16.0%).

Despite an overall reduction in elective and emergency surgeries, there was a relative increase in emergency surgeries related to elective surgeries per year in the post-COVID-19 period compared to the pre-COVID-19 period ($P < 0.001$), Figure 2.

Figure 3 shows the causal impact analysis of the COVID-19 pandemic on elective surgeries performed in the FD public health system adjusted to the total number of surgeries over the study period. After COVID-19 onset in Brazil in March 2020, there were 25,783 elective surgeries, while 43,382 (95% CI: 37,314–49,763) elective surgeries would have been expected if the COVID-19 pandemic had not occurred. The effect of the COVID-19 pandemic in reducing elective surgeries is statistically significant when considering the entire period after the COVID-19 onset, with an absolute effect of −170.9 (95% CI: −232.8 to −112.0) elective surgeries per epidemiological week and a relative effect of −40.0% (95% CI: −48.0 to −31.0%).

Figure 4 shows the causal impact analysis of the COVID-19 pandemic on emergency surgeries performed in the FD public health system adjusted to the FD population over the study period. After COVID-19 onset in Brazil in March 2020, there were 56,839 emergency surgeries, while 62,783 (95% CI: 59,693–65,850) emergency surgeries would have been expected if the COVID-19 pandemic had not occurred. The effect of the COVID-19 pandemic in reducing emergency surgeries is statistically significant when considering the entire period after the COVID-19 onset, with an absolute effect of −57.7 (95% CI: −87.5 to −27.7) emergency surgeries per epidemiological week and a relative effect of −9.4% (95% CI: −14.0 to −4.8%).

Supplementary Table 2 shows the causal impact analysis of the COVID-19 pandemic on surgeries performed in the FD public health system according to surgery sites and adjusted to the total number of surgeries performed over the study period. Head/Neck (relative effect: −43.0, 95% CI: −53.0 to −28.0) was the surgery site with the highest reduction, followed by renal/urinary tract (relative effect: −30.0, 95% CI: −39.0 to −21.0) and skin/soft tissue (relative effect: −29.0, 95% CI: −39.0 to −18.0). Only transplant and endocrine surgeries did not show significant differences at the end of the follow-up from the counterfactual prediction of cumulative surgeries by the model when considering the entire period after the COVID-19 onset.

Figure 5 shows the causal impact analysis of the COVID-19 pandemic on in-hospital mortality after surgeries performed in the FD public health system adjusted to the total number of surgeries over the study period. After the onset of COVID-19 in Brazil in March 2020, there were 1279 in-hospital mortality after the onset of COVID-19 in Brazil on March 2020, compared

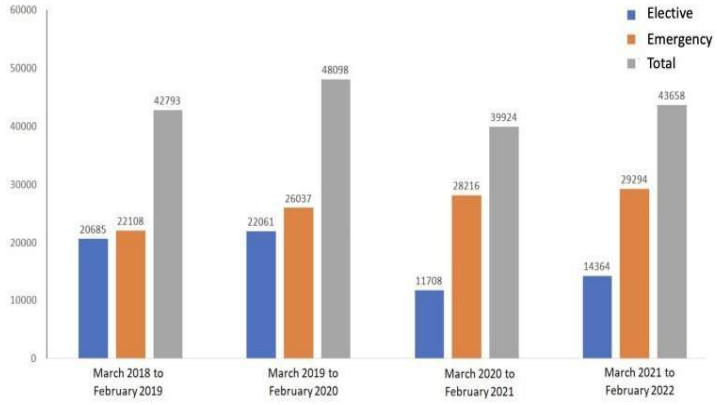

Figure 2 Elective, emergency, and overall surgeries performed in the Federal District public health system annually from March 2018 to February 2022 (n = 174,473). Cochran-Armitage test for trend in proportions: *P* value < 0.01.

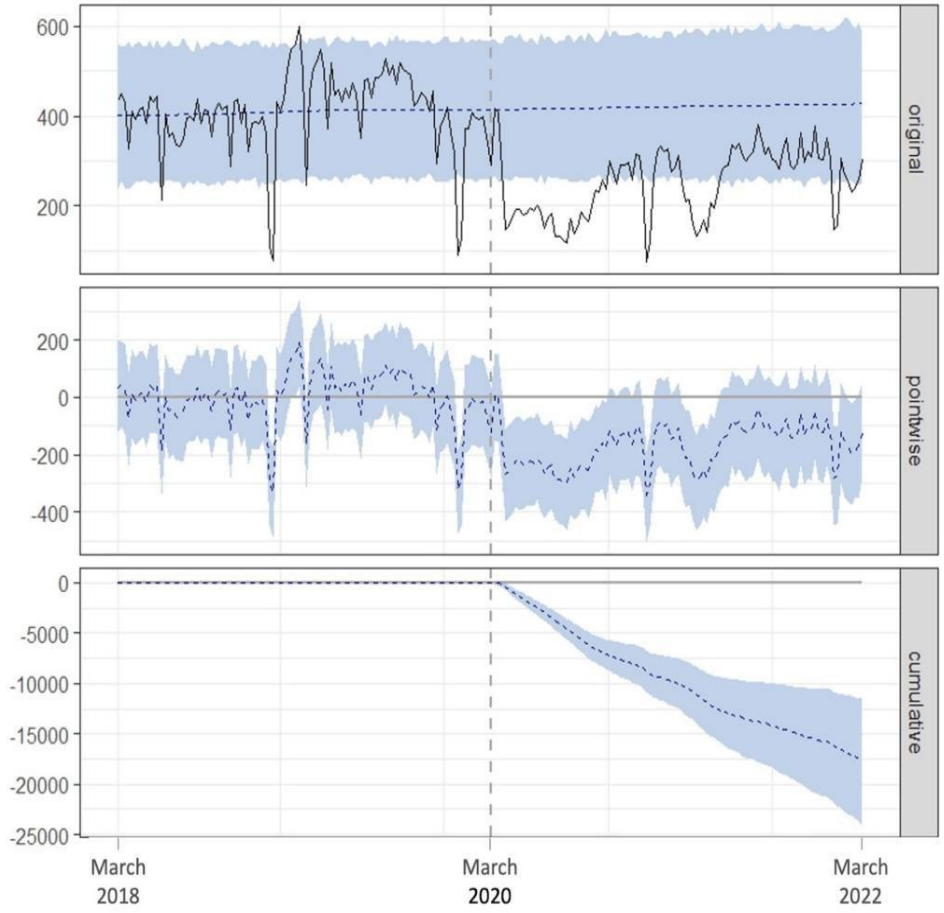

Figure 3 Causal impact analysis of the COVID-19 pandemic on elective surgeries performed in the Federal District public health system adjusted to the Federal District population using data from March 2018 to February 2022. The first panel shows the observed elective surgeries (solid black line), the counterfactual prediction if COVID-19 had not occurred adjusted to the Federal District population over time (dotted blue line), and the 95% confidence interval (95% CI) of the counterfactual prediction. The second panel shows the difference between observed elective surgeries and the counterfactual prediction, the pointwise causal effect of COVID-19 on elective surgeries adjusted to the overall surgeries (dotted blue line). The third panel shows the pointwise contributions from the second panel, resulting in a plot of the cumulative effect of COVID-19 on elective surgeries (dotted blue line). After the COVID-19 onset in Brazil in March 2020 (dotted gray vertical line), the 95% CI of the cumulative effect of COVID-19 on elective surgeries (shaded region) moves below the counterfactual prediction of cumulative elective surgeries (x-axis baseline) over time, reducing significantly at the end of the follow-up from the counterfactual prediction of cumulative elective surgeries by the model.

to 1067 in-hospital mortality that was expected if the COVID-19 pandemic had not occurred (95% CI: 850–1280). After adjusting for the FD population over the study period, the effect of the COVID-19 pandemic on hospital mortality was not statistically significant when considering the entire period after the COVID-19 onset, with an absolute effect per epidemiological week of 2.1 in-hospital mortality (95% CI: −0.01 to 4.2) and a relative effect of 21% (95% CI: −0.1% to 51.0%).

Comparing the surgeries before and after the COVID-19 onset in Brazil, there were no significant differences regarding age, sex, and hospital-LOS between the two periods, Supplementary Table 3.

Discussion

The COVID-19 pandemic disrupted the healthcare systems, postponing non-essential medical procedures due to various factors such as recommendations to allocate resources for COVID-19 patients and fear of infection.[1,5,28–30] In this

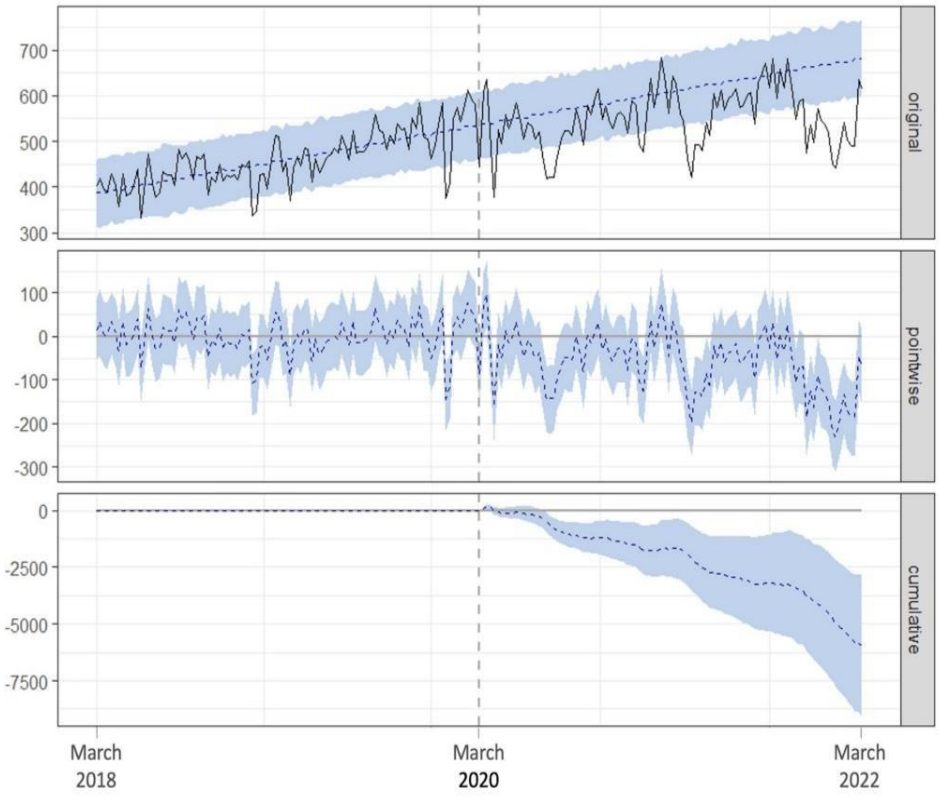

Figure 4 Causal impact analysis of the COVID-19 pandemic on emergency surgeries performed in the Federal District public health system adjusted to the Federal District population using data from March 2018 to February 2022. The first panel shows the observed emergency surgeries (solid black line), the counterfactual prediction if COVID-19 had not occurred adjusted to the overall surgeries over time (dotted blue line), and the 95% confidence interval (95% CI) of the counterfactual prediction. The second panel shows the difference between observed emergency surgeries and the counterfactual prediction, the pointwise causal effect of COVID-19 on emergency surgeries adjusted to the total surgeries (dotted blue line). The third panel shows the pointwise contributions from the second panel, resulting in a plot of the cumulative effect of COVID-19 on emergency surgeries (dotted blue line). After the COVID-19 onset in Brazil in March 2020 (dotted gray vertical line), the 95% CI of the cumulative effect of COVID-19 on emergency surgeries (shaded region) moves below the counterfactual prediction of cumulative emergency surgeries (x-axis baseline) over time, reducing significantly at the end of the follow-up from the counterfactual prediction of cumulative emergency surgeries by the model.

context, our study observed a reduction in elective and emergency surgeries during the COVID-19 pandemic compared to the counterfactual prediction in a Brazilian metropolitan area. In addition to the reallocation of resources to combat the pandemic, economic uncertainties and the imposition of lockdown measures during the pandemic might have compelled individuals to postpone surgeries, particularly those facing financial challenges, job loss, or future income apprehension.[31,32] Notably, this reduction in surgeries during periods of crisis like COVID-19 was also observed in other situations, such as the Ebola outbreak in West African countries between January 2014 and May 2015.[33]

Previous studies in different countries have also shown reductions in elective surgeries during the COVID-19 pandemic, such as Finland,[1] Saudi Arabia,[2] the United States,[34,35] Austria,[36] India,[37] Germany,[38] the United Kingdom,[39,40] France,[41] and Italy.[42,43] It was estimated that 28.4 million surgeries were canceled worldwide during the first wave of the pandemic.[44] A multicentric study in Finland noted a rapid reduction in elective surgeries soon after the COVID-19 pandemic onset in March 2020. However, in contrast to our findings, the number of elective surgeries rebounded in May–June 2020. Following this recovery, elective surgeries were 22% higher than in the reference years and maintained this level until the end of the year.[1] Another study utilizing a hospital administrative database in the United States, representing about 25% of inpatient discharges, noted a 71.3% reduction in elective surgeries in April 2020 compared to 2019 that did not recover to pre-pandemic levels until December 2020.[34] Besides, a review

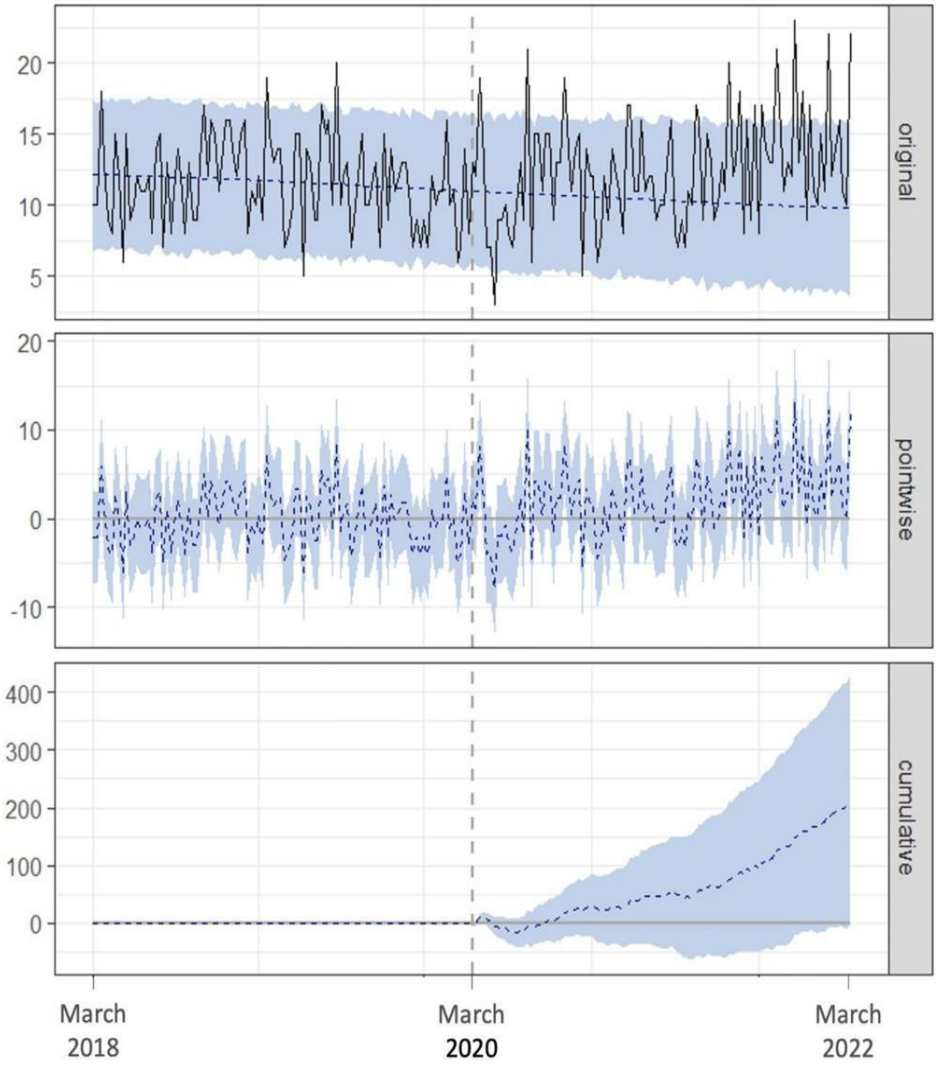

Figure 5 Causal impact analysis of the COVID-19 pandemic on in-hospital mortality in the Federal District public health system adjusted to the Federal District population over time using data from March 2018 to February 2022. The first panel shows the observed in-hospital mortality (solid black line), the counterfactual prediction if COVID-19 had not occurred adjusted to the Federal District population over time (dotted blue line), and the 95% confidence interval (95% CI) of in-hospital mortality of the counterfactual prediction. The second panel shows the difference between observed in-hospital mortality and the counterfactual prediction, the pointwise causal effect of COVID-19 on in-hospital mortality adjusted to the Federal District population population over time (dotted blue line). The third panel shows the pointwise contributions from the second panel, resulting in a plot of the cumulative effect of COVID-19 on in-hospital mortality (dotted blue line). After the COVID-19 onset in Brazil in March 2020 (dotted gray vertical line), the 95% CI of the cumulative effect of COVID-19 on in-hospital mortality includes the counterfactual prediction of cumulative in-hospital mortality (x-axis baseline) almost over time and at the end of the follow-up, meaning that it does not deviate significantly from the counterfactual prediction by the model.

analyzing data from studies in various countries observed a reduction in elective surgeries for colorectal cancer, ranging from 1% in New Zealand to 74% in the United States.[35]

The disparate impact of COVID-19 on elective surgeries across nations can be attributed to the extent of the pandemic's effect on each country, including the strain imposed on healthcare services, the characteristics of their populations, and the measures taken by their respective governments during the pandemic.[20,45,46] Regarding the diversities, Brazil offers a singular opportunity to evaluate the abovementioned issues as it stands among the countries

most severely affected by COVID-19 worldwide, ranking second in mortality.[20,21] Besides, the Brazilian government has recommended temporarily suspending elective procedures multiple times during the pandemic, and 75% of the Brazilian population relies solely on the public health system for healthcare.[47,48] A time series study that evaluated the first 9-month period of the COVID-19 pandemic in Brazil (March to December 2020) observed a 46% decrease in elective procedures in the public healthcare system, which corresponds closely to the 40% reduction in elective surgeries observed in our study.[48] In Italy, a country also severely affected by COVID-19, which exerted extraordinary pressures on the healthcare and long-term care systems, particularly during the first wave (March to May 2020), a survey of general surgery departments revealed a reduction in adequate beds dedicated to surgical procedures, affecting 59% of the surgical units, with 12.4% closed between March and May 2020, 2.6% between June and September 2020, and 7.7% between October and December 2020 (second wave in Italy).[43]

While the percentage of emergency surgeries related to elective surgeries relatively increased, the total number remained below the counterfactual prediction. Studies in Greece,[13] Spain,[16] Germany,[17] the United States,[8,14] Portugal,[49] and Italy[16,50] also observed a reduction in emergency surgeries. However, other studies showed different findings. In a study conducted at an emergency general surgery and trauma center in the United States, the number of emergency procedures during the COVID-19 pandemic remained similar to pre-pandemic levels. This study also observed higher rates of exploratory laparotomy and increased physiologic derangement upon presentation during the pandemic compared to the pre-pandemic period, which could be associated with patients presenting later for treatment.[51] Another study at a teaching hospital in Saudi Arabia reported an increase in emergency surgeries, but it did not compare the total number of emergency surgeries to a counterfactual prediction as performed in our study.[2]

Our study showed no effects of the COVID-19 period on hospital-LOS and mortality. Previous studies show conflicting results regarding these findings.[8,13,41,49,52–54] Similar to our findings, a study reported a decrease in elective and emergency cardiac surgeries in Sweden without a difference in mortality and postoperative complications.[55] In France, a national database study also showed that mortality following elective digestive resections remained stable during the COVID-19 pandemic.[41] Besides, a study performed in Spain showed no difference in mortality or reoperation rate during the COVID-19 pandemic.[53] On the contrary, a study in the United States noted a reduction in emergency surgeries and increased perioperative mortality and ICU admission rates after the COVID-19 onset.[8] In Portugal, a decrease of 30% in emergency surgery, accompanying the increase of newly COVID-19 diagnosed cases and containment measures, was observed. A higher mortality rate was also noted during the COVID-19 pandemic.[49] An international cohort study across 40 countries observed a shorter hospital-LOS and higher mortality in elective colorectal cancer surgery during the COVID-19 pandemic.[54] Other studies in Greece,[13] the United Kingdom,[39] Russia,[55] and Italy[56] also observed increased mortality during COVID-19. In a scoping review, it was observed that there was a delay in patients seeking care in emergency general surgeries, but it was impossible to conclude that there were more complications or increased mortality during the pandemic.[57]

Our study has some limitations. Firstly, there is a lack of information on the specific indications for elective and emergency surgeries, preoperative evaluations, surgery waiting time, and the complete demographic characteristics of the patients, including their socioeconomic status and schooling level. Additionally, there was no data regarding the frequency of COVID-19 among the study population. Moreover, it is crucial to recognize that additional factors not considered in our study could have impacted the outcomes. Finally, in the causal impact analysis, the assessment of COVID-19's impact on overall, elective and emergency surgeries and mortality involves three key components: a regression component linking the outcomes during the COVID-19 period to the outcomes on counterfactual prevision, a time-series component capturing temporal patterns in the data, and an error element accounting any unpredicted variation. Despite its strengths, there are limitations to using the causal impact analysis. Specifically, the underlying time-series model typically entails numerous unknown parameters, necessitating substantial data for accurate estimation, including counterfactual prediction. Regarding these facts, our study included 174,473 surgeries, providing a robust dataset. Further, the performance of causal impact may be affected if the outcome is susceptible to measurement errors. However, this fact does not apply to the outcomes evaluated in our study.[26,27]

Conclusion

Our study observed a significant detrimental impact of the COVID-19 pandemic on surgical services, reducing overall, elective, and emergency surgeries. These findings highlight the profound consequences of the pandemic on surgical healthcare, emphasizing the need for effective strategies to mitigate the enduring effects of postponed surgeries, especially elective ones. Healthcare systems must develop robust, adaptable approaches that ensure the continuity of surgical services to improve overall health outcomes and prevent the accumulation of surgical waiting lists, even in crises like the COVID-19 pandemic.

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Disclosure

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SUPPLEMENTARY FILE

Supplementary Table S1. Surgeries in the Federal District public health system between March 2018 and February 2022 (n = 174,473).

Age, years,	
mean (SD)	40.3 (20.8)
median (IQR 25%–75%)	40.0 (25.0–56.00)
Female, n (%)	84,409 (48.4)
Emergency surgery, n (%)	105,655 (60.6)
Site of surgery, n (%)	
Digestive	55,956 (32.1)
Orthopedic/Trauma	48,143 (27.6)
Gynecological/Mammary	21,280 (12.2)
Renal/Urinary tract	13,743 (7.9)
Skin/Soft tissue	11,053 (6.3)
Head/Neck	10,905 (6.3)
Neurological	5,400 (3.1)
Thoracic	2.472 (1.4)
Cardiovascular	3,750 (2.1)
Transplant	1,084 (0.6)
Endocrine	687 (0.4)
Hospital-LOS, days	
mean (SD)	5.3 (8.0)
median (IQR 25%–75%)	2.0 (1.0–6.0)
Hospital mortality, n (%)	2,520 (1.4)

IQR 25%–75%: Interquartile range 25%–75%; LOS: Length of stay; SD: Standard deviation.

Supplementary Table S2. Causal impact analysis of the COVID-19 pandemic on surgeries performed in the Federal District public health system according to the surgery site and adjusted to the Federal District population using data from March 2018 to February 2022 (n = 174,473).

Surgery site	Performed surgeries after the COVID-19 onset in Brazil in March 2020	Expected surgeries after the COVID-19 onset in Bazil in March 2020 (95% CI)	Absolute effect per epidemiological week (95% CI)	Relative effect, % (95% CI)
Digestive	27,020	32,775 (29,999 to 35,576)	-56.0 (-83.0 to -29.0)	-17.0 (-24.0 to -9.9)
Orthopedic/ Trauma	24,135	28,526 (26,589 to 30,371)	-43.0 (-61.0 to -24.0)	-15.0 (-21.0 to -9.2)
Gynecological / Mammary	10,109	13,920 (12,349 to 15,558)	-37.0 (-53.0 to -22.0)	-27.0 (-35.0 to -18.0)
Renal/Urinary tract	5,994	8,628 (7,562 to 9,772)	-26.0 (-37.0 to -15.0)	-30.0 (-39.0 to -21.0)
Skin/Soft tissue	5,207	7,415 (6,357 to 8,516)	-21.0 (-32.0 to -11.0)	-29.0 (-39.0 to -18.0)
Head/Neck	3,845	6,767 (5,356 to 8,240)	-29.0 (-43.0 to -15.0)	-43.0 (-53.0 to -28.0)
Neurological	2,528	3,445 (3,069 to 3,831)	-8.9 (-13.0 to -5.2)	-26.0 (-34.0 to -18.0)
Cardiovascular	1,845	2,357 (1,957 to 2,762)	-5.0 (-8.9 to -1.1)	-21.0 (-33.0 to -5.7)
Thoracic	1,099	1,403 (1,099 to 1,721)	-3.0 (-6.0 to -0.001)	-21.0 (-36.0 to -0.01)
Transplant	480	562 (407 to 718)	-0.8 (-2.3 to 0.7)	-13.0 (-33.0 to 18.0)
Endocrine	306	231 (97 to 364)	0,7 (-0.5 to 2.0)	49.0 (-16.0 to 214.0)

95% CI: 95% Confidence interval.

Supplementary Table S3. Age and hospital length of stay among the surgical patients in the Federal District public health system before and after the COVID-19 onset in Brazil in March 2022 (n = 174,473).

	March/2018 to February/2020 (n = 77,669)	**March/2020 to February/2022 (n = 72,948)**	***P* value**
Age, years			0.260
mean (SD)	40.2 (21.2)	40.4 (20.5)	
median (IQR 25%–75%)	40.0 (24.0–56.0)	26 (25.0–55.0)	
Female, n (%)	44,013 (48.4)	40,396 (48.3)	0.698
Hospital-LOS, days,			0.112
mean (SD)	5.5 (8.4)	5.2 (7.6)	
median (IQR 25%–75%)	2.0 (1.0–6.0)	2.0 (1.0–6.0)	

IQR 25%–75%: Interquartile range 25%–75%; LOS: Length of stay; SD: Standard deviation.

6.3 ARTIGO 3 – EFEITO DA COVID-19 NA MORTALIDADE PÓS-OPERATÓRIA: UMA ANÁLISE SECUNDÁRIA DE UM ESTUDO EM UMA REGIÃO METROPOLITANA BRASILEIRA UTILIZANDO PAREAMENTO POR ESCORE DE PROPENSÃO

RESEARCH LETTER

Effect of COVID-19 on postoperative hospital mortality: a secondary analysis from a Brazilian metropolitan area using propensity score matching

Ferreira DP, Bolognani CV, Santana LA, Amorim FF.

RESEARCH LETTER

Effect of COVID-19 on postoperative hospital mortality: a secondary analysis from a Brazilian metropolitan area using propensity score matching

ABSTRACT

The COVID-19 pandemic imposed extraordinary pressures on healthcare systems globally, forcing many hospitals to scale back or suspend surgical procedures. This study aimed to evaluate the effect of the COVID-19 period on postoperative hospital mortality, using propensity score matching (PSM) to balance confounding variables between the pre-pandemic and pandemic periods. We conducted a retrospective cohort study including all consecutive adult patients admitted for surgical procedures at hospitals within the Public Health System in the Federal District (FD), Brazil, from March 2018 to February 2022. A total of 174,473 surgeries were analyzed, with 90,290 performed before and 83,099 during the COVID-19 period. Univariate analysis revealed an increase in postoperative mortality during the pandemic ($p < 0.001$). However, multivariate analysis showed no significant difference in mortality between the pre-COVID-19 and COVID-19 periods ($p = 0.605$). Similarly, PSM analysis revealed no statistically significant effect of the pandemic period on postoperative mortality (OR: 0.944; 95% CI: 0.870–1.025; $p = 0.173$). In summary, our secondary analysis using PSM found that the COVID-19 pandemic did not significantly affect hospital mortality rates for patients undergoing surgery in the public health system of the FD despite the broad disruptions to surgical care delivery.

Keywords: COVID-19; Surgical Procedures, Operative; Elective surgical procedures; Hospital mortality

INTRODUCTION

The COVID-19 pandemic imposed extraordinary pressures on healthcare systems globally, forcing many hospitals to scale back or temporarily suspend surgical procedures. This reorganization aimed to redirect clinical and logistical resources toward responding to the surge of COVID-19 cases. In addition to these operational adjustments, several reports indicated a delay in patients seeking timely care for emergency surgical conditions, raising concerns about potential adverse outcomes associated with delayed treatment.[1]

Despite these concerns, the actual impact of the pandemic on postoperative mortality remains inconclusive. A previously published scoping review highlighted delays in emergency surgical care but did not establish a definitive association with increased postoperative death rates.[2] In an earlier study conducted in a Brazilian metropolitan region, we employed causal impact modeling to assess the impact of the pandemic on the volume of elective and emergency surgeries, as well as on postoperative mortality. Interestingly, no significant change in mortality rates was observed during the COVID-19 period, suggesting either a lack of effect or a confounding influence related to the reduced number of surgeries performed.[3]This observation on time series studies raises an important research question: Was the apparent stability in postoperative mortality during the pandemic merely a byproduct of the lower volume of surgical procedures performed, or did the COVID-19 pandemic genuinely not affect surgical outcomes for those who did undergo operations? Thus, to investigate this further, we carried out a secondary analysis of the same dataset, employing propensity score matching (PSM) to control for baseline differences and assess whether patients who underwent surgeries during the COVID-19 period in the Federal District of Brazil were at higher risk of postoperative death compared to those in the pre-pandemic period.

METHODS

We conducted a retrospective cohort study that included all consecutive adult patients admitted for elective or emergency surgical procedures at hospitals within the Public Health System in the Federal District (FD), Brazil, between March 2018 and February 2022. Data were obtained from the Hospital Information System (SIH/DATASUS), a national audited database maintained by the Brazilian Ministry of Health, which compiles administrative and epidemiological data for all hospital admissions carried out in public healthcare facilities across

the country. A comprehensive description of the study population, inclusion criteria, and data extraction procedures has been previously published.3

To assess the effect of COVID-19 on postoperative mortality, a propensity score matching (PSM) analysis was applied to balance confounding variables between the periods before and during the COVID-19 pandemic. For PSM analysis, a logit regression model adjusted to factors independently associated in the logistic regression analysis with the COVID-19 period and/or postoperative mortality was performed using Easy R (EZR) software version 1.54 (Saitama Medical Center, Jichi Medical University, Japan) with a 1:1 pair-matching ratio without replacement on the logit of the propensity score applying a caliper of 0.2 widths.

RESULTS

The study included 174,473 surgeries performed between March 2018 and February 2022, with 83,099 surgeries taking place during the COVID-19 period (March 2020 to February 2022) and 90,290 in the pre-COVID-19 period (March 2018 to February 2020). Comparing surgeries performed before and during COVID-19, there was an increase in the percentage of emergency surgeries ($p < 0.001$) during the COVID-19 period. Additionally, there was a significant difference in the distribution of surgical sites between the two periods ($p < 0.001$), Supplementary Table 1.

Supplementary Table S2 and Table 1 present the univariate and multivariate analyses of factors associated with postoperative mortality, respectively. Univariate analysis revealed an increase in postoperative mortality during the COVID-19 period ($p < 0.001$). However, in multivariate analysis, the difference in postoperative mortality between the pre-COVID-19 period and the COVID-19 period was not significant ($p = 0.605$). Increased age ($p <0.001$) and urgent surgery ($p <0.001$) were independently associated with increased postoperative mortality in the multivariate analysis, while female sex was independently associated with decreased postoperative mortality ($p = 0.028$). Additionally, there was a significant difference in mortality between the surgical sites.

Figure 1 shows the effect of the COVID-19 period (March 2020 to February 2022) on postoperative mortality after propensity score matching adjusted for age, sex, type of surgery (urgent/elective), and surgical site. PSM analysis showed no statistically significant effect of the COVID-19 period on postoperative mortality (OR: 0.944, 95% CI: 0.870–1.025, $p = 0.173$).

DISCUSSION

Our findings revealed no significant effect of the COVID-19 period (March 2020 to February 2022) on postoperative mortality. This result aligns with our initial causal impact analysis, indicating that the pandemic did not affect postoperative mortality among patients undergoing surgery in the FD public health system during the pandemic.[3] Similarly, a study using a national database in France found that mortality following elective digestive surgeries remained stable throughout the COVID-19 pandemic.[4] Additionally, a study conducted in Spain showed no difference in mortality or reoperation rate during the COVID-19 pandemic.[5] Conversely, an international cohort study across 40 countries observed higher mortality rates in elective colorectal cancer surgeries during the COVID-19 pandemic.[6] In Portugal, a higher postoperative mortality was also noted during the pandemic.[7] In the United States, a study noted increased perioperative mortality and ICU admission rates after COVID-19 onset.[8] These conflicting results highlight the importance of contextual factors, such as healthcare system capacity and the regional severity of COVID-19, in shaping the pandemic's impact on healthcare systems. The impact of the pandemic likely varied not only between countries but also across regions within each country. Specifically, in Brazil, the Federal District was the first area in the nation to implement social distancing measures, which may have shielded its healthcare system from worse outcomes.[9]

In summary, our secondary analysis, which employed a PSM analysis to compare postoperative mortality rates before and during the COVID-19 pandemic, found that the pandemic did not significantly affect mortality rates for patients undergoing surgery in the FD public health system. These findings highlight the importance of considering contextual factors in assessing the impact of COVID-19 on health outcomes. While some studies have reported an increase in postoperative mortality linked to pandemic-related challenges, our study highlights that specific conditions within the Federal District may have mitigated such effects. Ultimately, continuous evaluation remains crucial for shaping healthcare policies and improving surgical care in the face of future public health challenges.

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Table 1. Multivariate analysis of factors associated with hospital mortality among the surgical patients in the Federal District public health system before and after the COVID-19 onset in Brazil in March 2022 (n = 174,473)

Variable	OR (95% IC)	p-value	Tolerance	VIF
Age (per year)	1.039 (1.037-1.041)	< 0.001	1.01	0.988
Female (versus male)	0.905 (0.833–0.984)	0.019	1.02	0.984
mergency surgery (versus elective surgery)	5.767 (4.972-6.665)	< 0.001	1.01	0.987
Surgery site (versus digestive surgery)			1.00	0.987
Orthopedic/Trauma	0.301 (0.266-0.341)	< 0.001		
Gynecological/Mammary	0.072 (0.048-0.106)	< 0.001		
Renal/Urinary tract	0.246 (0.189-0.321)	< 0.001		
Skin/Soft tissue	0.440 (0.358-0.541)	< 0.001		
Head/Neck	0.067 (0.036-0.125)	< 0.001		
Neurological	3.618 (3.235-4.046)	< 0.001		
Cardiovascular	1.232 (1.042-1.456)	0.014		
Thoracic	2.642 (2.196-3.180)	< 0.001		
Endocrine	0.336 (0.125-0.902)	0.030		
Transplant	1.466 (1.050-2.047)	0.024		
March 2020 to February 2022 (March 2018 to February 2020)	0.979 (0.902-1.062)	0.605	1.00	0.996

95% CI: 95% Confidence interval; OR: Odds ratio; VIF: Variance inflation factor.

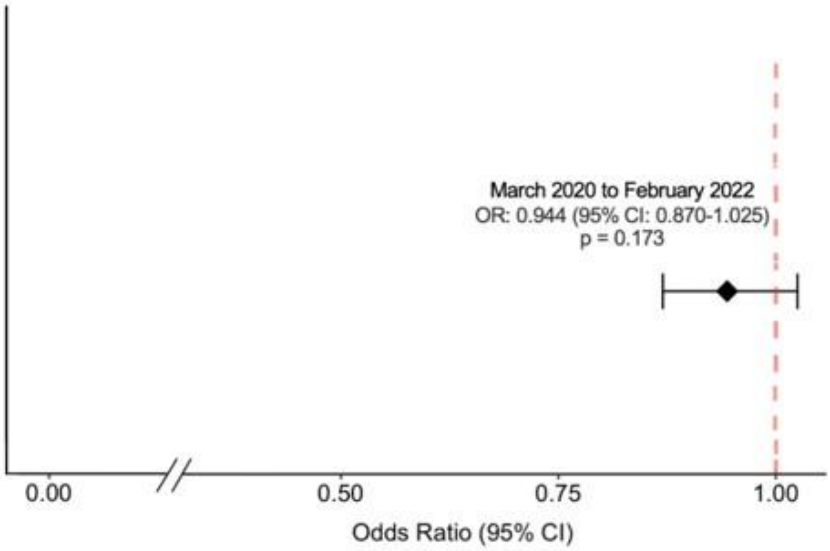

Figure 1. Effect of the post-COVID period (March 2020 to February 2020) on postoperative mortality after propensity score-matching adjusted to age, sex, emergency surgery, and surgical site

SUPPLEMENTARY FILE

Supplementary Table S1. Age, sex, type of surgery, surgery site, and postoperative mortality among the surgical patients in the Federal District public health system before and after the COVID-19 onset in Brazil in March 2022 (n = 174,473)

Variable	March 2018 to February 2020 (n = 90,891)	March 2020 to February 2022 (n = 83,582)	p-value
Age, years, mean (SD)	40.2 (21.2)	40.4 (20.5)	0.090
Female, n (%)	44,013 (48.4)	40,396 (48.3)	0.698
Emergency surgery, n (%)	48,145 (53.0)	57,510 (68.8)	< 0.001
Surgery site, n (%)			< 0.001
Digestive	28,590 (31.5)	27,366 (32.7)	
Orthopedic/Trauma	23,723 (26.1)	24,420 (29.2)	
Gynecological/Mammary	11,039 (12.3)	10,241 (12.3)	
Renal/Urinary tract	7,673 (8.4)	6,070 (7.3)	
Skin/Soft tissue	5,787 (6.4)	5,266 (6.3)	
Head/Neck	7,015 (7.7)	3,890 (4.7)	
Neurological	2,842 (3.1)	2,558 (3.1)	
Cardiovascular	1,881 (2.1)	1,869 (2.2)	
Thoracic	1,362 (1.5)	1,110 (1.3)	
Endocrine	378 (0.4)	309 (0.4)	
Hospital mortality, n (%)	1,220 (1.3)	1,300 (1.6)	< 0.001

SD: Standard deviation.

Supplementary Table S2. Univariate analysis of factors associated with hospital mortality among the surgical patients in the Federal District public health system before and after the COVID-19 onset in Brazil in March 2022 (n = 174,473)

Variable	Survival (n = 2,520)	Non-Survival (n = 171,953)	p-value
Period, n (%)			< 0.001
March 2018 to February 2020	1,220 (48.4)	89,671 (52.1)	
March 2020 to February 2022	1,300 (51.6)	82,282 (47.9)	
Age, years, mean (SD)	62.0 (21.2)	40.0 (20.7)	< 0.001
Female, n (%)	1,072 (42.7)	83,337 (48.5)	< 0.001
Emergency surgery, n (%)	2,317 (91.9)	103,338 (60.1)	< 0.001
Surgery site, n (%)			< 0.001
Digestive	1,100 (43.7)	54,856 (31.9)	
Orthopedic/Trauma	331 (13.1)	47,812 (27.8)	
Gynecological/Mammary	26 (1.0)	21,254 (12.4)	
Renal/Urinary tract	59 (2.3)	13,684 (8.0)	
Skin/Soft tissue	102 (4.0)	10,951 (6.4)	
Head/Neck	10 (0.4)	10,895 (6.3)	
Neurological	535 (21.2)	4,865 (2.8)	
Cardiovascular	174 (6.9)	3,576 (2.1)	
Thoracic	141 (5.6)	2,331 (1.4)	
Endocrine	4 (0.2)	683 (0.4)	
Transplant	38 (1.5)	1046 (0.6)	

SD: Standard deviation.

6.4 ARTIGO 4 – COVID-19 E CIRURGIAS ELETIVAS: CANCELAMENTOS NO DIA DA CIRURGIA, REINTERVENÇÕES CIRÚRGICAS E MORTALIDADE HOSPITALAR EM UM HOSPITAL PÚBLICO BRASILEIRO

ORIGINAL ARTICLE

COVID-19 pandemic and elective surgeries: day-of-surgery cancellations, surgical reinterventions and hospital mortality in a Brazilian public hospital

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ORIGINAL ARTICLE

COVID-19 pandemic and elective surgeries: day-of-surgery cancellations, surgical reinterventions and hospital mortality in a Brazilian public hospital

ABSTRACT

Background: The COVID-19 pandemic brought unprecedented challenges to healthcare systems worldwide, including significant disruptions in surgical services. The primary objective of this study was to investigate the association between the COVID-19 period and hospital mortality, day-of-surgery cancellations, and reintervention rates in a public tertiary hospital in Brazil. Methods: Retrospective cohort study including all individuals aged 18 or older with scheduled surgeries at a Brazilian tertiary public hospital between January 2018 and December 2022. The timeline was divided into three periods: pre-COVID-19 (March 2018–February 2020), the initial COVID-19 phase (March–August 2020, marked by strict social distancing), and the subsequent phase (September 2020–February 2022, following the easing of restrictions). Results: 8806 surgeries were scheduled at HRS: 5146 (58.4%) during the pre-pandemic period, 2528 (28.7%). There was a reduction in the percentage of elective surgeries during the COVID-19 pandemic period, especially during the initial phase of the pandemic ($p < 0.001$). Among the elective surgeries, no significant difference in hospital mortality was observed across the periods ($p = 0.847$). Day-of-surgery cancellations decreased during the initial phase of the COVID-19 pandemic (OR: 0.556; 95% CI: 0.448–0.691; $p < 0.001$) and remained comparable to pre-pandemic levels in the subsequent period (OR: 0.828; 95% CI: 0.650–1.055; $p = 0.126$). Surgical reinterventions did not change significantly during the first phase (OR: 0.888; 95% CI: 0.717–1.099; $p = 0.274$) but showed a decline in the later period after social distancing measures were lifted (OR: 0.534; 95% CI: 0.390–0.733; $p < 0.001$). Conclusion: Our study provides evidence that, despite the widespread disruption to surgical services caused by the COVID-19 pandemic, it was possible to maintain key standards of surgical safety within a tertiary public hospital in the Federal District of Brazil. Contrary to initial expectations, we observed a reduction in day-of-surgery cancellations during the initial phase of the pandemic and a decline in surgical reinterventions among elective procedures in the subsequent period, with no significant increase in postoperative mortality.

Keywords: COVID-19; Surgical Procedures, Operative; Elective surgical procedures; Hospital mortality; Reinterventions; Cancelations

INTRODUCTION

The COVID-19 pandemic has had a profound and lasting impact on healthcare systems worldwide, significantly affecting surgical services. The rapid spread of the virus necessitated a reevaluation of healthcare priorities, resulting in the urgent allocation of resources to care for patients infected with COVID-19. Consequently, this situation led to drastic alterations in hospital workflows and the availability of surgical procedures.[1] Both elective and emergency surgeries experienced substantial disruptions, culminating in widespread elective surgery cancellations, delays in treatment, and an alarming increase in postoperative complications, which often required reintervention.[2]

In numerous countries, including Brazil, public health measures such as lockdowns, movement restrictions, and the reconfiguration of healthcare facilities to accommodate COVID-19 patients resulted in the suspension of non-essential procedures.[3] Elective surgeries, those that necessitate prior scheduling and are generally associated with treatable conditions, were particularly hard-hit. During the first wave of the pandemic, it is estimated that around 28.4 million elective surgeries were canceled worldwide. This disruption led to significant treatment delays, worsening clinical conditions, and a rise in postoperative complications, which frequently necessitated additional surgical interventions. The repercussions were especially severe in nations with already frail healthcare systems, such as Brazil, where a large segment of the population relies on the public health system for their medical needs.[4]

Although emergency surgeries were prioritized and largely continued during the pandemic, they encountered significant challenges. Many patients hesitated to seek medical care due to concerns about the risk of COVID-19 transmission, as well as reduced access to healthcare services.[5] Even though these surgeries were deemed essential, the landscape of emergency surgery underwent a dramatic transformation throughout the pandemic. Patients often arrived with more advanced stages of illness because they had postponed seeking care. Additionally, the introduction of extra safety measures, such as preoperative testing, quarantine protocols, and stringent infection control practices, complicated the delivery of care and increased associated costs.[6-8]

Emergency surgeries are crucial for addressing conditions that may become life-threatening or cause irreversible harm if treatment is delayed, making them particularly vulnerable during this period. Research conducted in countries like Italy, Spain, Greece, the United States, and Germany revealed a startling decline in the number of emergency surgeries performed during lockdowns, with reductions of up to 86% reported in certain areas.[6,7,9-11] However, this decrease was accompanied by a proportional increase in the number of

emergency procedures relative to the total number of surgeries performed, indicating a shift in which numerous conditions initially categorized as elective were reclassified as urgent due to treatment delays.[5]

In a global context, research has demonstrated significant reductions in the volume of elective surgeries during the pandemic, with profound implications, including deterioration in patients' health conditions, elevated mortality rates, and the necessity for reinterventions in cases that were initially treated inadequately or incompletely.[9] In Brazil, the situation was exacerbated, marked by an overwhelming strain on the public health system, which serves approximately 75% of the population. The lack of standardized governmental responses, combined with pervasive social and economic inequalities, exacerbated the difficulties faced by hospitals and healthcare professionals.[3,12]

The increasing need for reinterventions emerged as a critical concern, further deteriorating the already limited capacity of hospitals. In light of these challenges, this study aims to investigate the association between the COVID-19 period and hospital mortality, day-of-surgery cancellation, and reintervention ratios in a public tertiary hospital in Brazil.

METHODS

Study design

A retrospective cohort study including all individuals aged 18 years or older who had surgeries scheduled, whether performed or not, at the surgical center of the Hospital Regional de Sobradinho (HRS), Brasilia, Federal District (FD), Brazil, between January 1, 2018, and December 31, 2022. Data were obtained from the electronic medical records of the Public Health System of the Federal District and the HRS surgical scheduling logbooks.

Setting and participants

The HRS is a tertiary hospital located in FD, a metropolitan area in the Midwest region of Brazil with 2,469,489 inhabitants, including the city of Brasilia, the capital of Brazil, which holds the highest Human Development Index (HDI) in the country. The HRS surgical center comprises eight operating rooms and performs a broad range of surgeries, including orthopedic, general, urological, vascular, reconstructive plastic, maxillofacial, minor, gynecological, obstetric, and otorhinolaryngological procedures. On average, the general surgery unit handles 1,100 consultations per month, the gynecology/obstetrics unit 1,600 consultations, and the orthopedics and traumatology unit 3,200 consultations. Approximately 350 surgeries are performed monthly, including around 60 elective and 290 emergency procedures.

In FD, the state government implemented the first lockdown on March 18, 2020, when there were 36 confirmed cases and another 174 under investigation. The lockdown measures included the suspension of non-essential activities, closure of gyms, schools, and shopping centers, restrictions on people's mobility, and efforts to contain the spread of the virus. These measures remained in place until September 2, 2020, when a gradual easing of the more restrictive measures began.

All individuals aged 18 years or older who were either scheduled for or underwent surgical procedures (elective or emergency) at the participating hospital between March 1, 2018, and February 28, 2022, were consecutively included in the study. Thus, the inclusion criteria were being over 18 years of age and having had a surgical procedure scheduled, regardless of whether it was performed, at the HRS surgical center during the study period. No exclusion criteria were applied.

Data collection

The variables collected from the electronic medical records and surgical procedure logbooks included age, sex, type of surgery (elective/emergency), surgery status (performed/canceled), surgical site, surgical specialty, location and type of procedure, need for surgical reintervention (yes/no), and discharge status (survivor or non-survivor).

In this study, the pre-COVID-19 period was defined as between March 2018 and February 2020. The COVID-19 period (March 2020 and February 2022) was divided into two phases: the initial phase, from March 2020 to August 2020, characterized by government-enforced social distancing measures, and the subsequent phase, from September 2020 to February 2022, which followed the gradual lifting of these restrictions.

STATISTICAL ANALYSIS

The distribution and normality of the variables were assessed using the Shapiro–Wilk test. Quantitative data were presented as mean ± standard deviation (SD), median, and interquartile range (IQR, 25%–75%). Categorical variables were expressed as absolute numbers and percentages.

The Cochran–Armitage trend test was used to compare the proportions of day-of-surgery cancellations, surgical reinterventions, and in-hospital mortality across the pre- and post-COVID-19 pandemic periods.

To assess the factors associated with day-of-surgery cancellation, the need for surgical reintervention, and in-hospital mortality, an initial univariate analysis was conducted using the Student's t-test or Mann–Whitney U test for quantitative variables and the Pearson's chi-square

test (χ^2) for categorical variables. Subsequently, binary logistic regression analysis was performed using the Enter method to evaluate independent factors associated with each outcome. The model included non-collinear variables that were associated with the outcome at a p-value < 0.05 in the univariate analysis, as well as potential confounding variables identified a priori with a p-value < 0.20 in the univariate analysis. Collinearity was considered acceptable when the tolerance was greater than 0.10, and the variance inflation factor (VIF) was less than 10.0. Results were presented as odds ratios (ORs) with their respective 95% confidence intervals (95% CI).

Statistical analyses were performed using IBM Statistical Package for the Social Sciences, version 20.0 for Mac (SPSS 20.0 Mac, SPSS Inc., Chicago, Illinois, USA) and Jamovi version 2.3.24 (https://www.jamovi.org). Statistical significance was defined as a two-tailed p-value ≤ 0.05.

RESULTS

During the study period, 8806 surgeries were scheduled at HRS, with 5146 (58.4%) during the pre-pandemic period (March 2018 to February 2020) and 3660 (41.6%) during the COVID-19 pandemic (March 2020 to February 2022): 2528 (28.7%) during the initial period of the pandemic (March 2020 to August 2020), marked by the government-enforced social distancing measures, and 1132 (12.9%) in the subsequent period following the gradual removal of the government-enforced restrictions (September 2020 to February 2022). The mean age was 44.7 ± 18.7 years, and 4703 (53.4%) were female. Elective surgeries accounted for 5,482 (62.3%) of the total surgeries. The majority were orthopedic/trauma surgeries (n = 2756, 31.5%), followed by digestive surgeries (n = 2603, 29.7%) and gynecological/mammary surgeries (n = 1590, 12.2%). A total of 1076 (12.2%) surgeries were canceled. Surgical reinterventions were required in 1036 (11.8%) cases. Hospital mortality rate was 5.2% (n = 462), Supplementary Table 1.

Table 1 compares the scheduled surgeries across the pre-pandemic, the initial COVID-19 pandemic, and the subsequent pandemic periods. The mean age was lower in the initial pandemic period (p = 0.44), and the proportion of female patients was significantly higher (p = 0.022). Considering the total number of surgeries, there was a reduction in the percentage of elective surgeries during the COVID-19 pandemic period, especially during the initial phase of the pandemic (p < 0.001). There was also a significant difference in the surgical sites, with orthopedic/trauma surgeries being the most frequent during the pandemic, while digestive surgeries were the most common before the pandemic (p < 0.001). No significant difference in

hospital mortality was observed across the periods ($p = 0.356$), even when the different surgical sites were evaluated individually.

Table 2 compares the scheduled elective surgeries across the pre-pandemic, the initial COVID-19 pandemic, and the subsequent pandemic periods. Consistent with the findings for total scheduled surgeries, the proportion of female patients was significantly higher during the pandemic periods ($p = 0.031$). However, no significant differences were observed in the mean age of patients across the study periods ($p = 0.191$). A statistically significant variation in the distribution of surgical sites was identified ($p < 0.001$), with an increase in the proportion of gynecological/mammary surgeries and a sustained decline in orthopedic/trauma surgeries during the pandemic periods. The overall day-of-surgery cancellation rate among elective surgeries was 16.4% ($n = 897$), with a significant decrease observed during the COVID-19 period ($p < 0.001$), from a peak of 18.2% in the pre-pandemic period to the lowest rate of 10.8% between March 2020 and August 2020. Similarly, the rate of surgical reintervention also showed a significant decline during the pandemic periods ($p < 0.001$). The overall hospital mortality rate for elective surgeries was 4.1% ($n = 227$), with no statistically significant differences observed across the analyzed periods ($p = 0.847$).

Table 3 presents the univariate analysis of factors associated with day-of-surgery cancellations and surgical reinterventions among elective surgeries. Patients whose surgeries were canceled had a higher mean age compared to those whose procedures were completed ($p = 0.006$) and a lower proportion of female patients (55.9% vs. 64.0%; $p < 0.001$). Day-of-surgery cancellations were more frequent during the pre-pandemic period (76.3%) and declined significantly during the pandemic periods ($p < 0.001$). The distribution of surgical sites also showed significant associations, with orthopedic/trauma and digestive surgeries having the highest cancellation rates ($p < 0.001$). Regarding surgical reinterventions, patients requiring a second procedure were also older ($p = 0.002$) and had a lower proportion of female patients ($p = 0.007$). Most reinterventions occurred before the pandemic (73.2%), with a significant decrease in the subsequent periods ($p < 0.001$). The surgical site was also significantly associated with reintervention rates, with higher frequencies observed in gynecological/mammary and orthopedic/trauma surgeries ($p < 0.001$).

Table 4 presents the multivariate analysis of factors associated with day-of-surgery cancellations among elective surgeries. The initial period of the COVID-19 pandemic (March 2020 to August 2020), characterized by government-enforced social distancing measures, was independently associated with a reduced risk of cancellation (OR: 0.556; 95% CI: 0.448–0.691; $p < 0.001$) compared to the pre-pandemic period (March 2018 to February 2020). During the

subsequent period following the removal of these restrictions (September 2020 to February 2022), no significant difference in cancellation rates (OR: 0.828; 95% CI: 0.650–1.055; p = 0.126) was observed when compared to the pre-pandemic period.

Table 5 shows the multivariate analysis of factors associated with reintervention among elective surgeries. During the initial period of the COVID-19 period (March 2020 to August 2020), no significant difference in reintervention rates (OR: 0.888; 95% CI: 0.717–1.099; p = 0.274) was observed when compared to the pre-pandemic period (March 2018 to February 2020). However, the subsequent phase (September 2020 to February 2022) was independently associated with a reduced likelihood of surgical reintervention (OR: 0.534; 95% CI: 0.390–0.733; p < 0.001) compared to the pre-pandemic period (March 2018 to February 2020).

DISCUSSION

In our study evaluating the impact of the COVID-19 pandemic on surgical procedures at a tertiary hospital in a Brazilian state, we observed a significant decline in the proportion of elective surgeries, particularly during the early months of the pandemic, when strict social distancing measures were in place, a finding that is consistent with previous studies.[1,9,13-24] However, interestingly, although a decline in elective procedures was anticipated, our findings revealed that day-of-surgery cancellations decreased during the initial phase of the COVID-19 pandemic, when social distancing measures were in place, and remained comparable to pre-pandemic levels in the subsequent period. In contrast, surgical reinterventions did not change significantly during the first phase but showed a decline in the later period after social distancing measures were lifted. Additionally, no significant difference in hospital mortality was observed when compared pandemic periods to the pre-COVID-19 pandemic period. These results contrast with initial concerns that delays in healthcare would worsen clinical conditions and increase the risk of postoperative complications.[1,2,4,25-28]

The reduction in elective surgeries during the pandemic global trends that are well documented in the literature.[1, 9,13-30] However, studies analyzing the effect of the pandemic on postoperative mortality have reported conflicting findings.[7,13,21,29,30-36] Our finding of no impact of COVID-19 on postoperative mortality, even though changes in the types of surgeries performed and in the demographic profile of patients, is consistent with a previous time-series study conducted by our research group, which also found no increase in postoperative deaths during the pandemic among patients admitted for elective or emergency surgeries in hospitals of the FD Public Health.[13] Similarly, studies conducted in Spain, Sweden, Romania, and France also reported no significant differences in postoperative mortality during the COVID-19 period

when compared to pre-pandemic levels.[21,30-32] Conversely, a cohort study conducted at a university hospital designated as a COVID-19 referral center in the Southern region of Brazil reported a significant increase in postoperative mortality, including among patients who were not infected with COVID-19, even after adjustment for the predicted preoperative risk of death.[29] Another study, conducted in a different state of the Brazilian Southern region, also demonstrated elevated postoperative mortality in abdominal wall hernia repair surgeries and cholecystectomy in a tertiary hospital.[33] Additionally, higher perioperative mortality rates during the COVID-19 period were reported in studies from the United States, Portugal, Greece, Italy, and Russia.[7,34-37] A study conducted in the United Kingdom observed an increase in 30-day inpatient mortality following emergency colorectal cancer resections. However, this difference was not statistically significant for elective procedures.[38] Meanwhile, an international multicenter study across 40 countries also reported increased mortality in patients undergoing elective colorectal cancer surgery during the pandemia.[4]

Although the interruption of elective surgeries was expected to result in adverse long-term outcomes, such as increased complications and the progression of untreated conditions,[29,31,33] our study identified a reduction or at least no significant change in day-of-surgery cancellations and surgical reinterventions among elective procedures across the pandemic periods. The discrepancies observed in postoperative mortality across studies, as well as the apparent paradox regarding our findings on day-of-surgery cancellations and reinterventions for elective surgeries, maybe more closely related to the varying capacity of surgical services to uphold key standards of surgical safety despite the operational constraints imposed by the COVID-19 pandemic. These differences may also be influenced by the severity of the pandemic's impact on each country or region, as well as the timeliness and effectiveness of government-imposed measures.[39-41] Notably, in this context, the FD, where our study was conducted, was the first state in Brazil to implement social restriction measures in response to COVID-19.[3]

Additional factors may account for the reduction in day-of-surgery cancellations among elective procedures during the first period of the COVID-19 pandemic. Similar to our findings, a study conducted in Germany reported a decline in day-of-surgery cancellations during the initial phase of the pandemic, followed by a return to pre-pandemic levels in the subsequent period.[42] The authors attributed this reduction to improved patient triage, optimized preoperative planning, and increased operating room availability resulting from the suspension of non-essential services. These structural and logistical adaptations may have also contributed to the decrease in day-of-surgery cancellations observed in our study during the early pandemic

period, particularly when elective cases were carefully selected and institutional resources were reallocated to ensure surgical efficiency and safety, including improved adherence to preoperative assessment protocols and the implementation of stricter patient selection criteria.[25,41] Moreover, the reduced flow of patients seeking medical care may have shortened wait times for accessing surgical services, especially in countries where prolonged surgical waiting periods are common.[33,43]

Especially regarding surgical reinterventions, while previous literature highlighted concerns about a potential increase due to delays and late presentations,[31,37] our study found no effect of the pandemic during the initial period, followed by a statistically significant decline in surgical reinterventions in the subsequent phase. Similar to our findings, a study conducted in the United Kingdom found no significant differences in reoperation rates before and during the pandemic,[38] and a study on metabolic and bariatric surgery in the United States reported a decrease in reinterventions in 2020 to the five years preceding the pandemic.[44] Another study in Romania did not find an association between the COVID-19 period and surgical reinterventions.[30]

Multiple factors may underlie the reduction of decline in surgical reinterventions observed in our study. First, the suspension of elective procedures that would have previously proceeded directly to surgery likely filtered outpatients with higher surgical risk or borderline indications, which may lead to a more selective surgical cohort, allowing for better clinical stabilization prior to surgery and ultimately reducing the risk of complications during the pandemic. [25,41] Second, the overall reduction in surgical volume enabled teams to provide more focused perioperative care, along with better logistical coordination and resource allocation, as surgical staff operated under less pressure and with fewer competing demands.[30] Third, improved adherence to preoperative assessment protocols and the implementation of stricter patient selection criteria during the pandemic may also have contributed to the decrease in postoperative complications.[25,45] Furthermore, the significant reduction in surgical reinterventions observed during the post-restriction period may reflect the progressive adaptation of health services over time through the incorporation of more rigorous criteria for resuming elective surgeries and improvements in perioperative planning.[46]

Nevertheless, our findings must be interpreted with caution. The retrospective nature of the study and reliance on administrative and clinical records may limit the accuracy of certain variables. Additionally, potential confounding factors, such as underlying health conditions, intraoperative complications, and postoperative healthcare quality, were not fully captured in the dataset. Furthermore, the specific institutional context of the HRS, located in the Federal

District, the Brazilian state with the highest HDI and the first to adopt social restriction measures against COVID-19, may limit the generalizability of our findings to less-equipped facilities or rural regions. Furthermore, due to the study design, it was not possible to assess deaths related to postponed, rescheduled, or canceled surgeries nor to examine postoperative mortality beyond the immediate hospitalization period. Future research should focus on multicenter analyses to evaluate the broader impact of the pandemic on surgical care across diverse healthcare settings. It is also essential to investigate the long-term outcomes of patients whose surgeries were canceled or delayed and explore the structural changes implemented during the pandemic that may be retained to optimize surgical care post-COVID-19.

In conclusion, our study provides evidence that, despite the widespread disruption to surgical services caused by the COVID-19 pandemic, it was possible to maintain key standards of surgical safety within a tertiary public hospital in the Federal District of Brazil. Contrary to initial expectations, we observed a reduction in day-of-surgery cancellations during the initial phase of the pandemic and a decline in surgical reinterventions among elective procedures in the subsequent period, with no significant increase in postoperative mortality. These findings may reflect the adaptive capacity of the local health system, including improved preoperative protocols, stricter patient selection, and reduced surgical volume, which allowed for more focused healthcare.

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Table 1. Comparison of the scheduled surgeries at Hospital Regional de Sobradinho, Federal District, Brazil, across the pre-pandemic period (March 2018 to February 2020), the initial COVID-19 pandemic period (March 2020 to August 2020), and the subsequent pandemic period (September 2020 to February 2022) (n = 8806).

Variable	March 2018 to February 2020 (n = 5146)	March 2020 to August 2020 (n = 2528)	September 2020 to February 2022 (n = 1132)	p-value
Age, years, mean (SD)	44.8 (18.9)	44.0 (18.3)	45.4 (18.7)	0.044
Female, n (%)	2820 (54.7)	1283 (50.8)	600 (53.0)	0.022
Elective surgery, n (%)	3764 (73.1)	1070 (42.3)	648 (62.3)	<0.001
Surgical site, n (%)[a]				<0.001
Orthopedic/Trauma	1468 (28.7)	901 (35.7)	387 (34.5)	
Digestive	1572 (30.8)	729 (28.9)	302 (26.9)	
Gynecological/Mammary	942 (18.4)	427 (16.9)	221 (19.7)	
Skin/Soft tissue	451 (8.8)	174 (6.9)	67 (6.0)	
Vascular	266 (5.2)	155 (6.1)	69 (6.1)	
Renal/Urinary tract	218 (4.3)	96 (3.8)	43 (3.8)	
Head/Neck	190 (3.7)	41 (1.6)	34 (3.0)	
Hospital Mortality, n (%)				
Total	245 (4.8)	127 (5.0)	61 (5.4)	0.356
Orthopedic/Trauma[a]	59 (4.0)	45 (5.0)	23 (5.9)	0.082
Digestive[a]	101 (6.4)	44 (6.0)	19 (6.3)	0.818
Gynecological/Mammary[a]	25 (2.7)	6 (1.4)	4 (1.8)	0.227
Skin/Soft tissue[a]	18 (4.0)	7 (4.0)	6 (9.0)	0.148
Vascular[a]	15 (5.6)	14 (90)	6 (8.7)	0.218
Renal/Urinary tract[a]	19 (8.7)	11 (11.5)	1 (2.3)	0.452
Head/Neck[a]	4 (2.1)	0 (0.0)	1 (2.9)	0.150

SD: Standard deviation. [a]The surgical site was missing in 53 cases surgical site.

Table 2. Comparison of the scheduled elective surgeries at Hospital Regional de Sobradinho, Federal District, Brazil, across the pre-pandemic period (March 2018 to February 2020), the initial COVID-19 pandemic period (March 2020 to August 2020), and the subsequent pandemic period (September 2020 to February 2022) (n = 5482).

Variable	Total (n = 5482)	March 2018 to February 2020 (n = 3764)	March 2020 to August 2020 (n = 1070)	September 2020 to February 2022 (n = 648)	p-value
Age, years, mean (SD)	46.8 (17.9)	46.9 (18.2)	46.0 (16.9)	47.3 (17.7)	0.191
Female, n (%)	3437 (62.7)	2323 (61.7)	691 (64.6)	423 (65.3)	0.031
Surgical site, n (%)[a]					<0.001
Gynecological/Mammary	1456 (26.8)	917 (24.6)	325 (30.5)	214 (33.2)	
Orthopedic/Trauma	1186 (21.8)	849 (22.7)	245 (23.0)	92 (14.4)	
Digestive	1372 (25.2)	968 (25.9)	239 (22.4)	165 (25.7)	
Skin/Soft tissue	482 (8.9)	372 (10.0)	71 (6.7)	39 (6.1)	
Vascular	417 (7.7)	248 (6.6)	106 (9.9)	63 (9.8)	
Renal/Urinary tract	277 (5.1)	193 (5.2)	48 (4.5)	36 (5.6)	
Head/Neck	249 (4.6)	185 (5.0)	32 (3.0)	32 (5.0)	
Cancelled surgery, n (%)	897 (16.4)	684 (18.2)	116 (10.8)	97 (15.0)	<0.001
Surgical reintervention, n (%)	638 (11.6)	467 (12.4)	124 (11.6)	47 (7.3)	<0.001
Hospital Mortality, n (%)					
Total	227 (4.1)	157 (4.2)	44 (4.1)	26 (4.0)	0.847
Orthopedic/Trauma[a]	45 (3.8)	29 (3.4)	10 (4.1)	6 (6.5)	0.162
Digestive[a]	68 (5.0)	49 (5.1)	15 (6.3)	4 (2.4)	0.352
Gynecological/Mammary[a]	33 (2.3)	24 (2.6)	5 (1.5)	4 (1.9)	0.331
Skin/Soft tissue[a]	24 (5.0)	17 (4.6)	3 (4.2)	4 (10.3)	0.221
Vascular[a]	26 (6.2)	13 (5.2)	7 (6.6)	6 (9.5)	0.215
Renal/Urinary tract[a]	21 (7.6)	17 (8.8)	4 (8.3)	0 (0.0)	0.104
Head/Neck[a]	5 (2.0)	4 (2.2)	0 (0.0)	1 (3.1)	0.963

SD: Standard deviation. [a] 43 surgical site - missing

Table 3. Univariate analysis of factors associated with surgery cancellation and surgical reintervention among elective surgeries scheduled at Hospital Regional de Sobradinho, Federal District, Brazil, from March 2018 to February 2022 (n = 5,482).

Variable	Cancelled surgery			Surgical reintervention		
	Yes (n = 855)	No (n = 4584)	p-value	Yes (n = 855)	No (n = 4584)	p-value
Age, years, mean (SD)	47.0 (18.8)	46.5 (17.7)	0.006	47.5 (16.8)	46.0 (18.0)	0.002
Female, n (%)	501 (55.9)	2936 (64.0)	<0.001	369 (57.8)	3068 (62.3)	0.007
COVID-19 period			<0.001			<0.001
March 2018 to February 2020	684 (76.3)	3080 (67.2)		467 (73.2)	3297 (68.1)	
March 2020 to August 2020	116 (12.9)	954 (20.8)		124 (19.4)	946 (19.5)	
September 2020 to February 2022	97 (10.8)	581 (12.0)		47 (7.4)	601 (12.4)	
Surgical site, n (%)[a]			<0.001			< 0.001
Orthopedic/Trauma	287 (33.6)	899 (19.6)		161 (25.2)	1025 (21.3)	
Digestive	244 (28.5)	1128 (24.6)		115 (18.0)	1257 (26.2)	
Gynecological/Mammary	139 (16.3)	1317 (28.7)		148 (23.2)	1308 (27.2)	
Skin/Soft tissue	47 (5.5)	435 (9.5)		52 (8.2)	430 (9.0)	
Vascular	65 (7.6)	353 (7.7)		92 (14.4)	325 (6.8)	
Renal/Urinary tract	37 (4.3)	240 (5.2)		50 (7.8)	227 (4.7)	
Head/Neck	36 (4.2)	213 (4.6)		20 (23.3)	229 (4.8)	

SD: Standard deviation. [a] 43 surgery site - missing.

Table 4. Multivariate analysis of factors associated with surgery cancellation among elective surgeries scheduled at Hospital Regional de Sobradinho, Federal District, Brazil, from March 2018 to February 2022.

Variable	OR (95% IC)	p-value	Tolerance	VIF
Age (per year)	1.007 (1.002–1.011)	0.002	1.04	0.962
Female (versus male)	0.916 (0.774–1.084)	0.306	1.12	0.889
Surgical site (versus digestive surgery)	1.492 (1.228–1.813)	<0.001	1.03	0.974
Orthopedic/Trauma	0.530 (0.417–0.672)	<0.001		
Gynecological/Mammary	0.468 (0.335–0.654)	<0.001		
Skin/Soft tissue	0.902 (0.666–1.220)	0.503		
Vascular	0.656 (0.448–0.959)	0.030		
Renal/Urinary tract	0.468 (0.335–0.654)	<0.001		
Head/Neck				
COVID-19 period (versus March 2018 to February 2020)	0.556 (0.448–0.691)	< 0.001	1.00	0.996
March 2020 to August 2020	0.828 (0.650–1.055)	0.126		
September 2020 to February 2022				

95% CI: 95% Confidence interval; OR: Odds ratio; VIF: Variance inflation factor.

Table 5. Multivariate analysis of factors associated with surgical reintervention among elective surgeries scheduled at Hospital Regional de Sobradinho, Federal District, Brazil, from March 2018 to February 2022.

Variable	OR (95% IC)	p-value	Tolerance	VIF
Age (per year)	1.006 (1.001–1.011)	0.018	1.04	0.960
Female (versus male)	0.803 (0.658–0.980)	0.031	1.12	0.851
Surgical site (versus digestive surgery)			1.03	0.966
	1.662 (1.287–2.145)	<0.001		
Orthopedic/Trauma	1.429 (1.085–1.883)	0.011		
Gynecological/Mammary	1.253 (0.885–1.774)	0.204		
Skin/Soft tissue	3.326 (2.449–4.517)	<0.001		
Vascular	2.164 (1.496–3.131)	<0.001		
Renal/Urinary tract	1.084 (0.654–	0.755		
Head/Neck	0.1796)			
COVID-19 period (versus March 2018 to February 2020)			1.00	0.996
	0.888 (0.717–1.099)	0.274		
March 2020 to August 2020	0.534 (0.390–0.733)	< 0.001		
September 2020 to February 2022				

95% CI: 95% Confidence interval; OR: Odds ratio; VIF: Variance inflation factor.

SUPPLEMENTARY FILE

Supplementary Table S1. Scheduled surgeries at Hospital Regional de Sobradinho, Federal District, Brazil, between March 2018 and February 2022 (n = 8806).

Variable	Value
Age, years, mean (SD)	44.7 (18.7)
Female, n (%)	4703 (53.4)
COVID-19 period, n (%)	
March 2018 to February 2020	5146 (58.4)
March 2020 to August 2022	2528 (28.7)
September 2020 to February 2022	1132 (12.9)
Elective surgery, n (%)	5482 (62.3)
Surgical site, n (%)[a]	
Orthopedic/Trauma	2756 (31.5)
Digestive	2603 (29.7)
Gynecological/Mammary	1590 (18.2)
Skin/Soft tissue	692 (7.9)
Vascular	490 (5.6)
Renal/Urinary tract	357 (4.1)
Head/Neck	265 (3.0)
Cancelled surgery, n (%)	1076 (12.2)
Surgical reintervention, n (%)	1036 (11.8)
Hospital mortality, n (%)	461 (5.2)

SD: Standard deviation. [a]The surgical site was missing in 53 cases surgical site.

6.5 CONSIDERAÇÕES FINAIS

A presente tese demonstrou, a partir de análise abrangente de dados extraídos de bases institucionais e registros hospitalares do Sistema Único de Saúde do Distrito Federal (SUS/DF), os múltiplos impactos da pandemia de COVID-19 sobre a oferta e os desfechos de cirurgias eletivas e de urgência, partos e mortalidade materna em uma metrópole brasileira. Ao longo deste trabalho, evidenciou-se que, embora a pandemia tenha gerado uma drástica reorganização dos sistemas de saúde, seus efeitos sobre os desfechos cirúrgicos e obstétricos variaram de acordo com a natureza dos procedimentos, a fase da pandemia e a capacidade de resposta institucional.

Em relação às cirurgias eletivas, observou-se uma redução significativa na quantidade de procedimentos realizados, com um efeito claro sobre o acúmulo de demandas reprimidas. Apesar da expectativa de aumento nos cancelamentos no dia da cirurgia e na necessidade de reintervenções, os dados analisados no Hospital Regional de Sobradinho (HRS) mostraram um resultado paradoxal: tanto os cancelamentos quanto as reoperações reduziram-se durante o período pandêmico. Tais achados sugerem que a suspensão seletiva de procedimentos, aliada a estratégias de triagem pré-operatória mais rigorosas e à reconfiguração logística do bloco cirúrgico, pode ter resultado em um perfil mais selecionado de pacientes, com melhor preparo pré-operatório e, consequentemente, melhores desfechos.

As cirurgias de urgência, embora prioritárias, também sofreram redução inicial no volume, refletindo uma hesitação da população em procurar atendimento durante os períodos de maior circulação viral. Ainda assim, com o avanço da pandemia e a adaptação dos serviços, identificou-se um aumento proporcional das cirurgias de urgência em relação ao total de procedimentos realizados, possivelmente devido à reclassificação de casos inicialmente eletivos. É importante destacar que não foi evidenciada uma elevação, estatisticamente significativa, na mortalidade hospitalar pós-operatória, ou nas cirurgias eletivas, tão pouco nas de urgência, o que corrobora a resiliência do sistema hospitalar local, mesmo sob estresse.

Quanto à saúde materna, embora o número total de nascimentos não tenha se alterado significativamente, a pandemia se associou a um aumento expressivo nas taxas de cesarianas e, de forma alarmante, à elevação da mortalidade materna — efeito que persistiu mesmo após ajuste por escore de propensão. Este achado denuncia uma vulnerabilidade específica no cuidado obstétrico durante a crise sanitária e reforça a necessidade de estratégias específicas de proteção à gestante e à parturiente em contextos pandêmicos.

Este trabalho também evidencia a importância da adoção precoce e coordenada de medidas de saúde pública. O Distrito Federal, pioneiro nas ações de distanciamento social no Brasil, demonstrou indicadores de mortalidade pós-operatória mais favoráveis que outras regiões do país, o que sugere que respostas rápidas e organizadas podem mitigar os impactos adversos sobre a saúde cirúrgica e materna.

Contudo, limitações inerentes ao delineamento retrospectivo e à natureza dos bancos de dados administrativos devem ser consideradas, particularmente no que se refere à ausência de informações clínicas detalhadas, como comorbidades e complicações pós-alta. A ausência de dados de mortalidade tardia, especialmente entre pacientes cujas cirurgias foram adiadas ou canceladas, representa um viés importante a ser considerado em interpretações futuras.

Diante disso, é imperativo que os sistemas de saúde aprendam com a experiência da COVID-19 para fortalecer sua capacidade de resposta a futuras crises. A institucionalização de critérios objetivos para priorização cirúrgica, a integração de ferramentas de planejamento preditivo e o investimento contínuo na formação e proteção dos profissionais de saúde são componentes essenciais para garantir a continuidade do cuidado e a segurança do paciente em situações de calamidade pública.

Por fim, espera-se que os achados aqui apresentados contribuam para a formulação de políticas públicas mais resilientes e equitativas, que contemplem não apenas a manutenção da capacidade assistencial durante pandemias, mas também a preservação de direitos fundamentais como o acesso universal e tempestivo à saúde.

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ANEXO

ANEXO A – Parecer consubstanciado do Comitê de Ética em Pesquisa da Fundação de Ensino e Pesquisa em Ciências da Saúde

Secretaria de Estado de Saúde do Distrito Federal

FUNDAÇÃO DE ENSINO E PESQUISA EM CIÊNCIAS DA SAÚDE - FEPECS/SES/DF

Plataforma Brasil

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Efeito da pandemia pela COVID-19 na realização de procedimentos cirúrgicos em um hospital público do Distrito Federal

Pesquisador: DILSON PALHARES FERREIRA

Área Temática:

Versão: 2

CAAE: 66815323.4.0000.5553

Instituição Proponente: Escola Superior de Ciências da Saúde

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 6.092.322

Apresentação do Projeto:

Projeto em 2ª versão.

1. Tipo de Projeto:

Projeto de pesquisa não relacionad a TCC.

2. Instituição Proponente:

Escola Superior de Ciências da Saúde

3.Trata-se de um Estudo Multicêntrico?

( ) Sim (x) Não

4.Se Multicêntrico, qual a origem? NSA

( ) Nacional ( ) Internacional

5.Se Internacional, qual o país de origem da Pesquisa? NSA

6.A pesquisa é patrocinada ou de financiamento próprio? NSA

( ) Patrocinada (x) Financiamento Próprio

7.Se for pesquisa patrocinada, citar o(s) patrocinador (es):NSA

8.Qual o tamanho da amostra a ser estudada na SES-DF?

500 participantes

9.Citar TODOS os locais da SES-DF onde a pesquisa será realizada:

Hospital Regional de Sobradinho do DF
10. Qual a População que será estudada:
( ) RNs
( ) Lactentes
( ) Crianças
( ) Adolescentes
(x) Adultos
( ) Idosos
11. Envolve População em situação de vulnerabilidade?
Não

12. Hipótese(s):
Supõe se que as medidas adotadas para o enfrentamento a pandemia de COVID 19, especialmente aquelas que restringiram a realização de procedimentos de cirurgia geral, eletivos e de urgência, em um hospital público do Distrito Federal, tenham reduzido o número de cirurgias eletivas e de urgência e, supostamente, aumentado tempo de internação hospitalar, necessidade de internação em unidade de terapia intensiva e infecção hospitalar

13. Critério de Inclusão:
- Pacientes acima de 18 anos,
- Ter sido submetido a procedimentos cirúrgicos de cirurgia geral no período
do estudo.

14. Critério de Exclusão:
Pacientes que tenham dados incompletos no prontuário e que impeçam a análise dos dados

15. Breve consideração sobre a metodologia (metodologia utilizada e descrição das etapas):
Estudo misto do tipo antes e depois e de coorte histórico a ser conduzido no Hospital Regionais de Sobradinho, um hospital público da Secretaria de Estado de Saúde do Distrito Federal, Brasil, que incluirá de forma consecutiva todos os pacientes submetidos a procedimentos de cirurgia geral no período de 01 de janeiro de 2018 a 31 de maio de 2022

Objetivo da Pesquisa:

Objetivo Primário:

Avaliar os efeitos da pandemia pela COVID-19, especialmente das medidas adotadas para o enfrentamento a pandemia, na realização de procedimentos de cirurgia geral, eletivos e de urgência, de um hospital público do Distrito Federal, assim como avaliar o efeito do início da vacinação e do término das medidas de isolamento na quantidade e características dos procedimentos cirúrgicos realizados.

Avaliação dos Riscos e Benefícios:

Riscos:

Os riscos são a perda dos dados dos prontuários dos pacientes bem como a exposição das informações dos pacientes com a identificação dos
mesmos.

Destacamos que todos os esforços serão feitos para reduzir estes riscos.

Não haverá identificação dos pacientes no banco de dados da pesquisa. Os registros na base de dados da pesquisa serão feitos por códigos(e não por nomes ou números de prontuários ou dados de identificação) que não permitirão qualquer identificação dos pacientes. Ademais as planilhas de pesquisa estarão restritas ao pesquisador que usará banco de dados protegido por senha, em computador único destinado somente à pesquisa.

Benefícios:

Após determinar o impacto nos desfechos dos pacientes que necessitaram de cirurgia eletiva e de urgência no período definido, após as medidas
para o enfrentamento da pandemia da COVID 19, tais como: se permaneceram mais tempo internados no hospital, se necessitaram de internação
em UTI, se tiveram infecção hospitalar, sugerir aos gestores medidas de minimizar os potenciais danos sofridos. Assim os potenciais benefícios para
os envolvidos na pesquisa serão propostas de ajustes aos gestores, na priorização cirúrgicas dos

pacientes que tiveram suas cirurgias realizadas no
período em questão, em eventuais necessidades cirúrgicas posteriores, mitigando o impacto daquele momento.

Comentários e Considerações sobre a Pesquisa:

1.Ponderação entre os riscos e benefícios da pesquisa: apresentada
2.Relevância social: apresentada
3.Processo de recrutamento: apresentado
4.Critérios para inclusão e exclusão de participantes na pesquisa: Apresentada
5.Processo de obtenção do TCLE: Não apresentado
6.Justificativa de Dispensa do TCLE: Apresentado
7.Procedimentos efetivos para garantia do sigilo e confidencialidade: Apresenatdo
8.Proteção de participantes de pesquisa em situação de vulnerabilidade: Não se aplica
9.Orçamento para realização da pesquisa: Apresentado
10.Cronograma de Execução da pesquisa: Apresentado

Considerações sobre os Termos de apresentação obrigatória:

1.Carta de encaminhamento do Projeto: Apresentada
2.Declaração de Compromisso do Pesquisador responsável: Apresentada
3.Folha de Rosto: Apresentada
4.Termo de Anuência ou Coparticipação: Apresentada
5.Projeto Brochura: Apresentado não adequado
6.Curriculum Lattes de todos os envolvidos na pesquisa: Apresentados
7.TCLE (ou Termo de Assentimento) ou Dispensa dos mesmos: Apresentado

O projeto apresentou as pendências abaixo informadas e todas foram solucionadas na atual versão do projeto.

1. PENDÊNCIA - PB - INFORMAÇÃO BÁSICA DO PROJETO

No campo que refere se haverá uso de fonte secundária, foi marcado "não", porém em outro momento foi dito que uma das fontes de informação será os prontuários dos pacientes e caderno de registro do centro cirúrgico.

Serão utilizadas ou não fontes secundárias?

Ajustado o campo, conforme carta de resposta.

2. PENDÊNCIA - BENEFÍCIOS
Os benefícios foram descritos em forma de objetivo.
Quais os potenciais benefícios ao participante da pesquisa envolvidos no estudo?
Adequar.
A Resolução CNS Nº 466 de 2012, no item III.1.b, define que "A eticidade da pesquisa implica em (...) ponderação entre riscos e benefícios, tanto conhecidos como potenciais, individuais ou coletivos, comprometendo-se com o máximo de benefícios e o mínimo de danos e riscos".

Ajustado conforme carta de resposta

3. PENDÊNCIA - HIPÓTESE
a) Inserir a hipótese no projeto detalhado;
b) Retirar da hipótese a frase "Estudos tem demostrado a redução de diversos procedimentos como atendimentos oftalmológicos, atendimentos em setores de emergência e transplante de órgãos."
Hipótese: "Definida como uma resposta suposta, provável e provisória ao problema, pode ser testada verdadeira ou falsa pelo experimento delineado, independentemente de valores de opinião:
Suposta - a hipótese é uma suposição, pois o experimento ainda não produziu evidências para sua confirmação ou negação;
Provável - toda hipótese deve ser passível de teste experimental para sua comprovação;
Provisória - a hipótese será aceita até sua confirmação ou negação pelos resultados do experimento.

Devidamente ajustada na atual versão

4. PENDÊNCIA - PROJETO DETALHADO
Revisar o projeto detalhado:
1. Retirar as partes destacadas em amarelo;
2. Número da amostra está 400 parcipantes divergindo dos demais documentos apresentados;
3. Inserir a hipótese;

Ajustes realizados na atual versão

5. PENDÊNCIA - CRONOGRAMA
a) Adequar o cronograma em todos os documentos, considerando prazos deste CEP e tempo de correção adotado pela pesquisadora. A coleta de dados só poderá ter início após a aprovação do projeto pelo CEP.
b) Adequar o período de coleta de dados em todos os documentos.

Devidamente ajustado

6. PENDÊCIA - RELEVÂNCIA SOCIAL: apresentar.

Apresentada na atual versão do projeto

Recomendações:

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Conclusões ou Pendências e Lista de Inadequações:
Aprovado

*** A responsabilidade do pesquisador é indelegável e indeclinável e compreende os aspectos éticos e legais.
O pesquisador assume o compromisso de garantir o sigilo que assegure o anonimato e a privacidade dos participantes da pesquisa e de que os dados obtidos na mesma deverão ser utilizados exclusivamente para a finalidade prevista no seu protocolo.
Cabe, ainda, ao pesquisador:

a) desenvolver o projeto conforme delineado;
b) elaborar e apresentar os relatórios parciais e final;
c) apresentar dados solicitados pelo CEP ou pela CONEP a qualquer momento;
d) manter os dados da pesquisa em arquivo, físico ou digital, sob sua guarda e responsabilidade, por um período de 5 anos após o término da pesquisa;
e) encaminhar os resultados da pesquisa para publicação, com os devidos créditos aos pesquisadores associados e ao pessoal técnico integrante do projeto; e
f) justificar fundamentadamente, perante o CEP ou a CONEP, interrupção do projeto ou a não publicação dos resultados.

*** Reiteramos os cuidados referentes a Pandemia (COVID-19), para que sejam obedecidas as orientações legais vigentes quanto a proteção do pesquisador e dos participantes de pesquisas).

Considerações Finais a critério do CEP:

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_2026744.pdf	18/04/2023 16:01:50		Aceito
Recurso Anexado pelo Pesquisador	Recurso_anexado_pesquisador.docx	18/04/2023 15:57:39	DILSON PALHARES FERREIRA	Aceito
Projeto Detalhado / Brochura Investigador	Projeto_Detalhado.docx	18/04/2023 15:53:57	DILSON PALHARES FERREIRA	Aceito
Outros	Termo_Compromisso_Pesquisador_Assinado.pdf	19/01/2023 13:42:02	DILSON PALHARES FERREIRA	Aceito
Outros	CURRICULO_Fabio_Amorim_23.doc	19/01/2023 13:40:56	DILSON PALHARES FERREIRA	Aceito
Outros	CURRICULO_Dilson_23.doc	19/01/2023 13:40:27	DILSON PALHARES FERREIRA	Aceito
Outros	Carta_Encaminhamento_Assinada.pdf	19/01/2023 13:39:44	DILSON PALHARES FERREIRA	Aceito
Declaração de concordância	termo_concordancia.pdf	23/12/2022 12:42:08	DILSON PALHARES FERREIRA	Aceito
Folha de Rosto	FOLHA_ROSTO_ASSINADA.pdf	23/12/2022 12:29:45	DILSON PALHARES FERREIRA	Aceito
TCLE / Termos de Assentimento /	DISPENSA_TCLE.docx	20/12/2022 11:26:14	DILSON PALHARES FERREIRA	Aceito

Justificativa de Ausência	DISPENSA_TCLE.docx	20/12/2022 11:26:14	DILSON PALHARES FERREIRA	Aceito

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

BRASILIA, 31 de Maio de 2023

Assinado por:
Marcondes Siqueira Carneiro
(Coordenador(a))