The impact of the COVID-19 pandemic on emergency department presentations, hospitalisations, all-cause mortality and cancer notifications in Western Australia

Health Economics and Data Analytics

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Executive Summary

Background

The COVID-19 pandemic had a significant effect on the delivery of healthcare across the public and private sectors in Western Australia. Changes included an increased availability of telehealth for many outpatient services so as to avoid the need for face-to-face visits, and the cancellation of elective surgical procedures for part of 2020. Alongside this, public health measures were introduced with the aim of reducing the potential for spread of COVID-19. The specific measures have varied in response to changing circumstances throughout the pandemic but have generally included social distancing, isolation measures, border controls and efforts to shift community behaviour in terms of hand hygiene and mask wearing. The restrictions and changes imposed by Federal and State Governments were successful in ending early waves of COVID-19 and allowing time for the uptake of vaccines in WA before widespread transmission of the virus. There is, however, evidence that these public health measures may have also affected access to services for non-COVID conditions, which may have implications for the management of some patients over the longer term.

The aims of this study were to assess the impact of the 2020 COVID-19 pandemic-related restrictions in Western Australia on use of health services for non-COVID conditions to identify potential patient cohorts that may need to be monitored over the longer term.

The project objectives were to:

1) Assess the impact of COVID-19 on emergency department (ED) presentations;
2) Assess the impact of COVID-19 on hospital admissions, length of stay and cost;
3) Assess the impact of COVID-19 on all-cause mortality;
4) Assess the impact of COVID-19 on the incidence of cancer;
5) Assess the impact of COVID-19 on use of Medicare rebateable services;
6) Assess the impact of COVID-19 on dispensed medications funded under the Pharmaceutical Benefits Scheme (PBS) and Repatriation PBS (RPBS).

Methods

A retrospective observational study was carried out using administrative data supplied by the WA Health Data Linkage Branch (DLB) for this work, and publicly available data on Medicare-funded services and medications dispensed under the PBS and RPBS. Administrative data were available for a period from October 2014 to September 2019, while Medicare data were available to August 2022, and PBS/RPBS data to June 2022. Trends were assessed using Interrupted Time Series Analysis (ITSA). ITSA allows for the daily, weekly, or monthly counts of events (e.g. ED presentations, hospitalisations, etc.) following an intervention (the COVID-19 pandemic) to be compared against a counterfactual, i.e. an estimate of the event counts that would be expected in the absence of the intervention.

Data were organised as weekly or monthly counts of health services, with each year starting on the first Monday in October, so that the introduction of COVID-19 public health measures in March 2020 would fall at roughly the mid-point. Therefore, the data comprises an intervention group consisting of data from October 2019 to September 2020, and a counterfactual group consisting of data from October 2014 to September 2019. Separate analyses using a longer follow up were also undertaken for Medicare and PBS/RPBS data. Data on ED presentations and hospitalisations were analysed as weekly counts, with other data sources analysed as monthly counts. The analysis provides estimates of the effect of the COVID-19 pandemic on the use of these health services, in terms of the difference between the observed weekly/monthly service counts, and the expected counts based on the previous five years of data. Analyses were conducted for each objective both overall and by demographic and clinical subgroups where possible.

Findings

Following the introduction of COVID-19 public health measures in WA, there was a large decrease in ED presentations, though these returned to pre-pandemic levels within six months. A similar, but slightly smaller, decrease was observed for hospital admissions. Monthly cancer diagnoses did not change for the population overall, nor did counts of deaths. The monthly numbers of outpatient Medicare-funded services and the counts of medications subsidised via the PBS/RPBS remained the same through the six months following the introduction of public health measures.

These patterns were similar regardless of age, sex, remoteness and socioeconomic status, except for a slight difference in those aged 19-44 in how ED presentations and hospitalisations were affected in comparison to other age groups, a significant decrease in cancer diagnoses in women, and one-month increase in deaths in women, which quickly returned to expected levels. The decrease in cancer diagnoses in women was partly driven by a reduction in breast cancer diagnoses, likely caused by the cessation of breast screening programs during the pandemic. There was also a reduction in lung cancer diagnoses. These findings may point to patient cohorts who require further investigation to determine whether apparent delays in diagnosis have led to differences in patient management and outcomes since the pandemic.

There were differences between diagnostic categories in the way health service use changed during the pandemic. Conditions with long lead times between onset and the need for health services, such as neoplasms and conditions originating in the perinatal period, along with dialysis and chemotherapy admissions, did not record changes in hospitalisation or ED use. Respiratory conditions and infectious/parasitic conditions had substantially larger reductions in ED and hospital use, which may have resulted from reductions in the transmission of infectious diseases resulting from pandemic control measures. For respiratory conditions, there was also a substantial increase in medication dispensations, while other common medication classes did not change. No change was recorded in any category of outpatient service through the 6-month follow-up period.

Contents

Background

The COVID-19 pandemic had a significant effect on health service delivery across the public and private sectors in Western Australia. This included a transition to telehealth for many outpatient services[1] and the cancellation of elective surgical procedures for part of 2020.[2] In addition to the transformation of services to digital platforms, there were also shifts in community behaviour and the need to enact social distancing and isolation measures; the specific measures varied in response to changing circumstances throughout the pandemic. The restrictions and changes imposed by Federal and State Governments were successful in turning the curve in relation to early waves of COVID-19 and allowing time for the uptake of vaccines before widespread transmission of the virus.[3] However, there is evidence that the public health measures and changes in community behaviour in response to COVID-19 may have affected access to services for non-COVID conditions.[4]

Emergency department data suggests a 40% decrease in presentations for heart attack and stroke symptoms during the pandemic, which could create major impacts on health outcomes for those impacted and major cost implications for health systems over the medium and longer term.[5] Published data from abroad have emerged describing these trends. Rasau et al.[6] has documented decreased emergency department presentations in Italy, prompting concerns of downstream consequences from unmanaged acute health conditions. An analysis by Mafham et al.[7] reported a substantial reduction in presentations for acute coronary syndromes in early 2020 in the United Kingdom, with these authors concluding the pandemic contributed to lower presentation and higher out-of-hospital deaths and long-term, suboptimally managed sequelae. There is also a 'third wave' which relates to care interruptions for those with chronic disease and behavioural shifts of individuals at risk of or living with a disease not accessing services; this could be due to fear of contracting COVID or due to changes in the way services are provided. This could have a flow-on effect of higher hospital admissions for ambulatory care sensitive conditions, which are considered potentially preventable hospitalisations.[8]

There are also concerns around falling rates of new cancer diagnoses, which have been identified internationally.[9] Anecdotal evidence and early analysis of data suggest a number of reasons for the decline in cancer incidence during the pandemic, including 1) Patient reluctance to attend GP appointments; 2) Lower cancer screening activity, either due to programs being suspended or individuals not attending routine screens for skin or cervical cancer; 3) The switch to telehealth which may have impacted patient assessment, with a lack of physical assessment being available; 4) Reductions in pathology and radiology tests; and 5) Reluctance of clinicians to refer patients for some tests due to an attempt to safeguard the health system. [10] Post COVID-19 there are concerns that the capacity to return to normal routine care will be delayed. Delays in cancer diagnosis can detrimentally affect the outcomes for patients and place major burdens on the health system if cancer detection is delayed and patients present with late stage cancers.[10]

The impact of COVID-19 on health system and community behaviour could have a negative impact on individual and population health outcomes, through the delay in diagnosis and early prevention initiatives, alongside poorly managed chronic conditions. Furthermore, this could place a considerable burden on the health system in terms of both future demand and costs. This report explores the impact of COVID-19 on population health over the short and medium term. It also models the associated impacts of identified changes on future demand and cost. The study uses individual-level Western Australian health data to explore trends in emergency department and hospital presentations, cancer diagnoses and death registrations; and aggregated monthly counts of Medicare Benefits Schedule (MBS) funded services and medications dispensed via the Pharmaceutical Benefits Scheme (PBS) and Repatriation PBS (RPBS). The evidence generated by this study will support health service planning. The study also identifies at risk cohorts that can be targeted for future service provision and be appropriate to include in additional longitudinal studies.

Aims and objectives

The aims of this study were to assess the impact of the 2020 COVID-19 pandemic-related restrictions in Western Australia on use of health services to identify potential patient cohorts that may need to be monitored over the longer term.

Specifically, the project objectives are to:

7) Assess the impact of COVID-19 on emergency department presentations;
8) Assess the impact of COVID-19 on hospital admissions, length of stay and cost;
9) Assess the impact of COVID-19 on all cause mortality;
10) Assess the impact of COVID-19 on the incidence of cancer;
11) Assess the impact of COVID-19 on use of Medicare rebateable services;
12) Assess the impact of COVID-19 on dispensed medications funded under the PBS and RPBS.

Methods

Data

This is a retrospective observational study using (i) administrative data supplied by the WA Health Data Linkage Branch (DLB) for this work, and (ii) publicly available data downloaded from Medicare Australia.[11, 12] Specific datasets and key variables are as follows:

1) Hospital Morbidity Data Collection records from Jan 2010 – Dec 2020. Key variables include admission and separation dates, diagnosis codes (recorded using the International Classification of Diseases, 10th Edition, Australian Modification (ICD-10-AM)[13], patient age and sex. Remoteness and Socioeconomic status were supplied by the DLB based on patient address using the Accessibility/Remoteness Index for Areas[14] and Socioeconomic Indexes For Areas – Index of Relative Socioeconomic Disadvantage[15], respectively.
2) Emergency Department Data Collection records from Jan 2015 – Dec 2020. Key variables include presentation date, triage category, arrival type, patient demographics, and discharge diagnosis recorded as either an ICD-10-AM code or Major Diagnostic Category.
3) WA Cancer Registry records from Oct 2014 – Dec 2020, including diagnosis date, cancer type (coded based on ICD-10-AM codes) and patient demographics.
4) WA Death Registry records from Oct 2014 – Apr 2021, including date of death and patient demographics.
5) Medicare Benefit Schedule (MBS) item claims as monthly counts for each state for the period Oct 2014 – Aug 2022. These were also downloaded separately for WA by each Broad Type of Service:
    a. Allied health
    b. Dental
    c. Diagnostic imaging
    d. Diagnostic procedures
    e. Chronic disease management items
    f. General practitioner attendances
    g. Obstetric items
    h. Oral and maxillofacial services
    i. Pathology items
    j. Practice nurse items
    k. Specialist attendances

    l. Therapeutic procedures
6) Pharmaceutical Benefits Scheme (PBS) and Repatriation PBS (RPBS) item claims as monthly counts for all states for the period Oct 2014 – June 2022. These were downloaded separately for WA items relating to different body systems using the Anatomical Therapeutic Classification (ATC). To prevent reporting an excessive number of results, we report dispensations of the top five ATC categories by volume as reported by the Australian Institute of Health and Welfare (AIHW).[16] Categories included
    a. Alimentary tract and metabolic system
    b. Anti-infectives
    c. Cardiovascular system medications
    d. Nervous system medications
    e. Respiratory system medications

Sources 1-4 were provided at the level of individual service records, i.e. each record related to one hospitalisation, ED attendance, cancer diagnosis or death. Sources 5-6 were available as aggregated monthly data only. There were no linkages across or within data collections meaning we could not observe where two records related to the same individual or event (e.g., an ED attendance followed by hospital admission).

Analysis

Trends were assessed using Interrupted Time Series Analysis (ITSA). ITSA allows for the daily, weekly, or monthly counts of events (e.g. ED presentations, hospitalisations, etc.) following an intervention (the COVID-19 pandemic) to be compared against a counterfactual, i.e. an estimate of the event counts that would be expected in the absence of the intervention.

Typically, in ITSA, a counterfactual might be made up of data from an area or a group of people thought to be unaffected by the intervention. As no area or group unaffected by the COVID-19 pandemic could provide a suitable counterfactual, data on the use of health services through the preceding five years was used. A period of five years was used rather than a single year as this longer period would minimise the potential impact of short-term periods of uncharacteristically high or low health service use on the counterfactual and provide a more robust basis for comparison. This counterfactual would also capture normal annual trends in the use of health services.

Data were organised into years running from the first day of October to the last day of September in the following calendar year. This period was chosen so that the introduction of the pandemic-related restrictions in Western Australia (WA) throughout March 2020 would occur at roughly the mid-point. Data were organised as daily counts of health services, with each year starting on the first Monday in October. Therefore, the data comprises an intervention group consisting of data from October 2019 to September 2020, and a counterfactual group consisting of data from October 2014 to September 2019.

Different timelines were selected for the MBS and PBS data due to the availability of more up-to-date data from these sources. For these data sources, two analyses were conducted: (i) a 'short-run analysis' which used the same timelines as for the other health service data, and (ii) a 'long-run analysis' that took advantage of the more up-to-date data. For the long-run analyses, the control period ran from October 2014 to August 2018 for MBS and to June 2018 for PBS data, while the intervention period ran from October 2018 to August 2022 for MBS data and to June 2022 for PBS data, providing additional ~ 1.5 to 2 years of follow-up post intervention date. This long-run allowed an assessment of longer-term changes in service use following the pandemic.

Data were analysed as event counts on a weekly basis for the hospitalisation and emergency department data. For cancer registry and death data, monthly counts were used as the count of weekly events was

insufficient for analysis. For MBS and PBS services, data were only available on a monthly basis hence all analyses present monthly counts of services/dispensations.

Intervention dates

In WA non-essential businesses were closed and non-essential activities banned to slow the spread of COVID-19 from 23 March 2020, with some restrictions having been applied in the preceding weeks including bans on large gatherings and restrictions on travel into the State.[17] Restrictions on gatherings were eased from 27 April 2020 and restrictions continued to ease through the subsequent months. Through the remainder of 2020 and into 2022 there were minimal restrictions in place in WA, with the exception of brief lockdowns when cases were detected in the community. Border control policies remained in place for almost all of 2021, limiting movement into the State.[17]

The restrictions in place differed to some extent across the states and territories. In general, the introduction of public health measures occurred across a similar timeframe in each jurisdiction though the relaxation of restrictions, and in some cases re-introduction of public health measures, differed in response to local circumstances. In terms of the introduction of restrictions, New South Wales was the first state to ban large gatherings (of >500 people) on 16 March 2020, though all states and territories banned gatherings of >100 people on 18 March 2020.[17] Those states and territories which introduced border restrictions (all but NSW, Victoria and the ACT) did so between 19 and 24 March 2020.[18] Non-essential businesses were closed in all states and territories from 25 March 2020.[17]

Public health emergencies were declared in QLD on 29 January 2020, in the ACT and Tasmania on 16 March 2020, and in the NT on 19 March 2020, while the Federal Government declared a human biosecurity emergency on 18 March 2020.[17] States of emergency were declared on 15 March 2020 in WA,[17] 16 March 2020 in Victoria,[17] 19 March 2020 in Tasmania,[18] and 22 March 2020 in South Australia,[17] while NSW introduced an emergency measures bill (without declaring a state of emergency) on 24 March 2020.[18] "Lockdowns", with people required to stay home, except for a small number of permitted reasons, were introduced, from 23 March 2020 in the ACT,[17] from 31 March 2020 in Tasmania, NSW, Victoria[17, 18] and WA,[19] and from 02 April 2020 in QLD,[17] along with the release on 30 March 2020 of national advice from the Federal Government to remain at home except for essential travel.[20]

The relaxation of restrictions was more variable as a result of different COVID-19 case numbers in each state and territory. In WA, the first easing of restrictions occurred on 26 April 2020, while some elective surgeries resumed on 28 April 2020.[18] From late June 2020 the main restrictions in place within WA were some social distancing measures while border controls remained in place.[19] In the ACT and the NT the first easing of restrictions occurred from 01 May 2020, while in NSW the first restrictions eased from 28 April 2020, as in WA, while restrictions began to ease in QLD from 26 April 2020. SA and Victoria eased some restrictions from 11 May 2020, Tasmania from 20 May 2020.[18] These changes generally began with the permission of slightly larger gathering sizes and continued over the subsequent months. In most states, short lockdowns continued to occur when cases were detected in the community or when case numbers showed a rapid increase,[17] these snap lockdowns occurred at different times and different durations in each jurisdiction. In some cases the return of public health measures extended for longer periods. In Victoria, tougher restrictions were reintroduced on 30 June 2020 in response to rapidly increasing case numbers,[18] followed by a full lockdown from 9 July 2020, and the declaration of a state of disaster on August 2 2020. This lockdown began to lift from 28 October 2020.[17] Similarly, restrictions were reintroduced in NSW in July 2020 due to high case numbers, and these were not relaxed again until October 2020.

In these analyses an intervention date of 23 March 2020 was used, reflecting the introduction of strict public health measures in WA. The period from the start of October 2019 until 22 March 2020 is referred to as the pre-intervention period, and the period from 23 March 2020 until the end of September 2020 is referred to

as the intervention period. Although short lockdowns did occur at times in Western Australia through 2020 and 2021, these were too brief to be considered as additional "interventions" in the analysis. This intervention date was kept consistent across states and territories where MBS and PBS/RPBS data were analysed, given the similar timelines for the introduction of restrictions. Although some states recorded more extended lockdowns during late 2020 and in 2021 (which would be captured in the "long run" analyses), the analysis of other states is performed primarily to provide a comparison of Western Australia against jurisdictions with higher case numbers throughout the pandemic, as patient behaviours may have differed.

The CausalImpact[21] package in R was used. This package provides an estimate of the effect of the intervention on event counts through the intervention period. The effect estimate represents the difference between the counts of events observed through the intervention period, and the expected count based on the counterfactual. The effect estimate is presented both as an absolute and relative difference and can be positive (i.e. the observed count of events exceeded the expectation based on the counterfactual) or negative (the reverse). This is provided on both an average (i.e., per week/month) and cumulative (i.e., across the entire intervention period) basis. Each effect estimate includes a 95% confidence interval (95%CI). The 95%CI for a given analysis represents the range of values within which we can be confident the true effect falls. If the 95%CI excludes zero, the effect estimate is interpreted as being statistically significant; if the 95%CI includes zero (i.e. no effect) we assume that there was no statistically significant effect. For the main analysis, models included adjustment for seasonality on a weekly or monthly basis. A sensitivity analysis was conducted which repeated all analyses, without seasonality adjustment. This report includes the results from the main analysis, which are the more conservative of the two analyses (i.e. have wider confidence intervals) with interpretation of tables and figures. The appendix includes all tables and figures from the sensitivity analyses, without interpretation.

The CausalImpact package outputs include a table and figures. The table provides the observed and expected event counts, and the difference between these on both an absolute and percentage basis, per week/month and summed across the follow-up period. The table does not report to a consistent number of decimal places, in this report numbers below one are reported to one decimal place and larger numbers without decimal places. Figures produced by the package include the weekly/monthly observed and expected event counts, the difference between these each week/month, and the cumulative difference across the follow-up period. The y-axis scale and values are selected automatically by the program and cannot be amended, meaning that in some cases demographic subgroups being compared (e.g. females and males) are presented with different y-axes. For large numbers, the program reports in scientific notation.

Subgroups

Analyses were repeated by subgroups based on demographic and health service factors.

Demographics

All outcomes for which demographic data were available (ED presentations, hospital admissions, cancer diagnoses and deaths) were analysed separately for each of the following demographic subgroups:

1) Sex
2) Age groups (0-18, 19-44, 45-64, 65+)
3) Socioeconomic status (SES). Socioeconomic status was based on deciles of the Socioeconomic Indexes for Areas – Index of Relative Socioeconomic Disadvantage,[22] with deciles 7-10 combined into a high SES group (i.e. containing those people living in areas of least disadvantage), 4-6 making up the medium SES group and 1-3 making up the low SES group.
4) Remoteness of residence based on the Accessibility Remoteness Index of Australia collapsed into metropolitan, and non-metropolitan groups.[23] Note that remoteness is based on the postcode of residence. For ED data, postcode information was missing for a six-week period at the end of the intervention period, hence analysis of ED data by remoteness ends earlier than other analyses.

ED presentations

ED presentations were additionally analysed for subgroups based on the following factors:

1) Discharge destination (admitted, not admitted)
2) Mode of arrival - ambulance (including helicopter/Royal Flying Doctor Service) and non-ambulance (including private transport, public transport, hospital transport, police or correctional services, and taxi)
3) Day of presentation (weekday vs weekend)
4) Time of presentation (working hours (8am – 4pm), evening (4pm – midnight), and night-time (midnight – 8am))
5) Triage category, from 1 (resuscitation) to 5 (non-urgent)
6) The diagnosis code assigned at discharge, coded based on ICD-10-AM.[13] Categorised based on the chapter of the diagnosis code assigned using the discharge diagnosis. For records with a major diagnosis category captured rather than an ICD-10-AM code, the major diagnostic category (MDC) was assigned to the best matching ICD-10-AM chapter. Categories were therefore blood and blood forming organs, circulatory system, digestive system, ear and mastoid processes, endocrine system, eye and adnexa, genitourinary system, infectious and parasitic diseases, injury and poisoning, mental disorders, musculoskeletal disorders, neoplasms, nervous system, perinatal conditions, pregnancy, respiratory system, and skin disorders. Presentations due to injury were further categorised based on the type of injury (head (ICD-10-AM codes S00-S09), mechanical injuries (ICD-10-AM codes S10-S99, T00-T09), complications of surgical and medical care (T80-T88), and other injuries (T15-T19, T20-T79, T89)).
7) External causes of injury (transport and pedestrian, falls, force, others and unknown)

Hospitalisations

Hospitalisations were analysed according to all demographic subgroups listed above, plus classified according to the below:

1) Emergency vs planned admissions
2) By the chapter of the ICD-10-AM code assigned as the principal diagnosis, as for ED presentations
3) Separated into those with and without any procedure performed
4) Separately for admissions for dialysis and chemotherapy

Hospitalisations were further assessed in terms of the average length of stay (ALOS) of hospitalisations admitted per week, as this may be impacted by both changes in the case mix of those admissions occurring and changes in discharge practices. Hospitalisations were additionally assessed in terms of the average cost per hospitalisation admitted per week, based on the diagnostic-related group assigned to the hospitalisation, to reflect changes in the severity of admitted episodes.

Cancer

Diagnosis of new cancers were characterised based on demographics described above, plus according to the type of cancer for the five most common cancers in Australia,[24] including breast (ICD-10-AM code C50), prostate (C61), melanoma (C44), colorectal (C18-C20) and lung (C33-C34) cancers.

Medicare claims

Medicare service claims were evaluated by state/territory for all Medicare items, and separately within WA only by Broad Type of Service, as outlined under the “Data” subheading.

Medications

PBS and RPBS dispensations were evaluated both by state/territory for all medications, and separately within WA only for the top five Anatomical Therapeutic Chemical (ATC) groups according to the number of

dispensations between 2018-19 to 2020-21 as reported by the Australian Institute of Health and Welfare (AIHW).[16]

Results

ED presentations

Overall

Following the introduction of strict COVID-19 public health measures on 23 March 2020, all-cause ED presentations in WA showed an immediate and substantial decline of approximately 7,500 presentations per week (**Error! Reference source not found.**). Soon after, weekly presentations began increasing again. By the end of September 2020, the observed weekly count of ED presentations had reached expected pre-pandemic levels, although the difference between observed and expected ceased to be statistically significant from approximately July 2020. Throughout the 6-month intervention period, there was a 12% (95%CI -14%, -9%) reduction in all-cause ED presentations, translating to a weekly reduction of 2,462 presentations (-2,972, -1,925) and a cumulative reduction of 68,939 (-83,219, -53,912) across the entire follow-up period (Table 1). This difference was highly statistically significant.

Table 1: Changes in counts of all-cause emergency department presentations in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020.

Posterior inference	**Average number of presentations per week**				**Cumulative number of presentations over follow up**			
	Count	SD	95% CI		Count	SD	95%CI	
Actual	18,903				529,278			
Prediction	21,365	266	20,828	21,875	598,217	7,447	583,190	612,497
Absolute effect	-2,462	266	-2,972	-1,925	-68,939	7,447	-83,219	-53,912
Relative effect (%)	-12%	1%	-14%	-9%	-12%	1%	-14%	-9%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

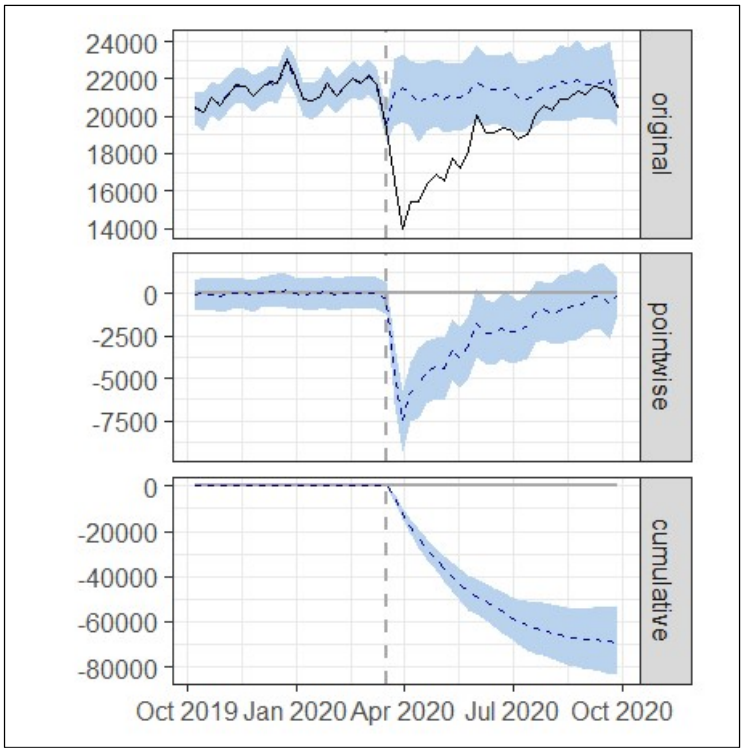

Figure 1: Weekly all-cause emergency department presentations in Western Australia.

Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Sex

Amongst both female and male patients there was an immediate and substantial decline in all-cause ED presentations in WA following the introduction of COVID-19 public health measures (Figure 22:). As observed for overall ED presentations, weekly counts immediately began increasing after this initial drop in both females and males. For both sexes, weekly counts reached expected levels by the end of the follow-up period, though they ceased being statistically significant, different from expected levels several months earlier. The relative change in counts across the follow-up period was similar for females (-11%; 95%CI -14%, -9%) and males (-12%; -14%, -10%) (Table 2). For both sexes, the difference between observed and expected was statistically significant.

Table 2: Changes in counts of all-cause emergency department presentations in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020, by sex.

Posterior inference	**Average number of presentations per week**				**Cumulative number of presentations over follow up**			
	Count	SD	95% CI		Count	SD	95%CI	
Females								
Actual	9,510				266,276			
Prediction	10,722	147	10,407	11,005	300,217	4,129	291,398	308,144
Absolute effect	-1,212	147	-1,495	-897	-33,941	4,129	-41,868	-25,122
Relative effect (%)	-11%	1%	-14%	-9%	-11%	1%	-14%	-9%
Males								
Actual	9,390				262,913			
Prediction	10,636	122	10,378	10,867	297,807	3,419	290,578	304,277
Absolute effect	-1,246	122	-1,477	-988	-34,894	3,419	-41,364	-27,665
Relative effect (%)	-12%	0.6%	-14%	-10%	-12%	0.6%	-14%	-10%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

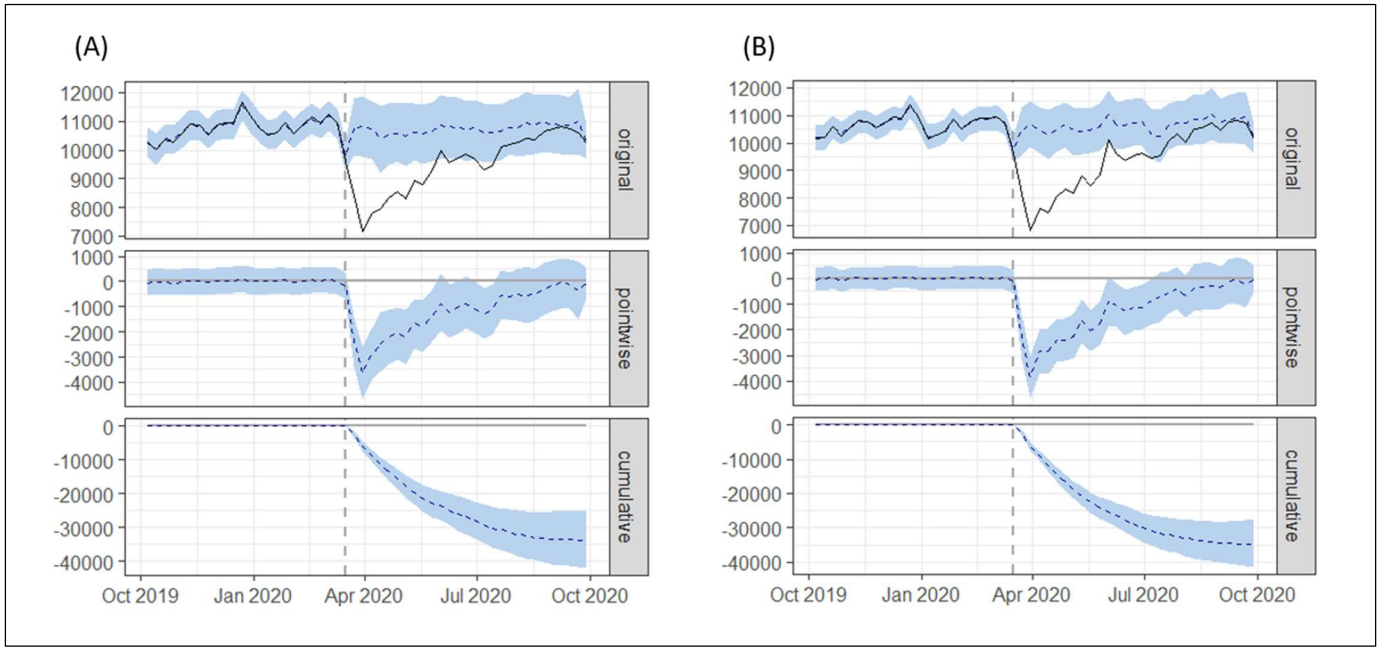

Figure 2: Weekly all-cause emergency department presentations in Western Australia among (A) Females and (B) Males.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Socioeconomic status

For all SES groups (low, medium and high), changes in ED presentation counts through the COVID-19 pandemic resembled patterns for overall ED presentations: a substantial immediate decline after which counts began increasing, reaching pre-pandemic levels near the end of the six-month follow-up period (Figure 3). For all levels of SES, the difference between observed and expected levels was statistically significant, and the scale of the reduction in ED presentations was similar between groups in relative terms. For the high SES groups, there was a 15% reduction through the intervention period (95%CI -17%, -12%), for the medium group a reduction of 12% (-14%, -9%) and for the low SES group a reduction of 12% (-15%, -10%) (Table 22). Note that reductions in each of these groups exceed the relative reduction of 12% recorded for overall ED presentations (Table 1); this is because information on socioeconomic status was missing for the final 6 weeks of the intervention period, and during this period there was generally little difference between observed and expected counts.

Table 3: Changes in counts of all-cause emergency department presentations in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020 by socioeconomic status.

Posterior inference	**Average number of presentations per week**				**Cumulative number of presentations over follow up**			
	Count	SD	95% CI		Count	SD	95%CI	
High SES								
Actual	5,712				114,238			
Prediction	6,693	113	6,481	6,921	133,859	2,256	129,621	138,421
Absolute effect	-981	113	-1,209	-769	-19,621	2,256	-24,183	-15,383
Relative effect (%)	-15%	1%	-17%	-12%	-15%	1%	-17%	-12%
Medium SES								
Actual	6,102				170,854			
Prediction	6,918	89	6,738	7,090	193,696	2,497	188,672	198,523
Absolute effect	-816	89	-988	-636	-22,842	2,497	-27,669	-17,818
Relative effect (%)	-12%	1%	-14%	-9%	-12%	1%	-14%	-9%
Low SES								
Actual	6,253				175,073			
Prediction	7,151	125	6,913	7,363	200,239	3,491	193,566	206,156
Absolute effect	-899	125	-1,110	-660	-25,166	3,491	-31,083	-18493
Relative effect (%)	-13%	2%	-15%	-10%	-13%	2%	-15%	-10%

Footnote: Follow-up period ends in August 2020; this differs from other analyses due to there being a six-week period with missing postcode information in the data used, which is necessary for categorising socioeconomic status. SD: standard deviation; CI: confidence interval.

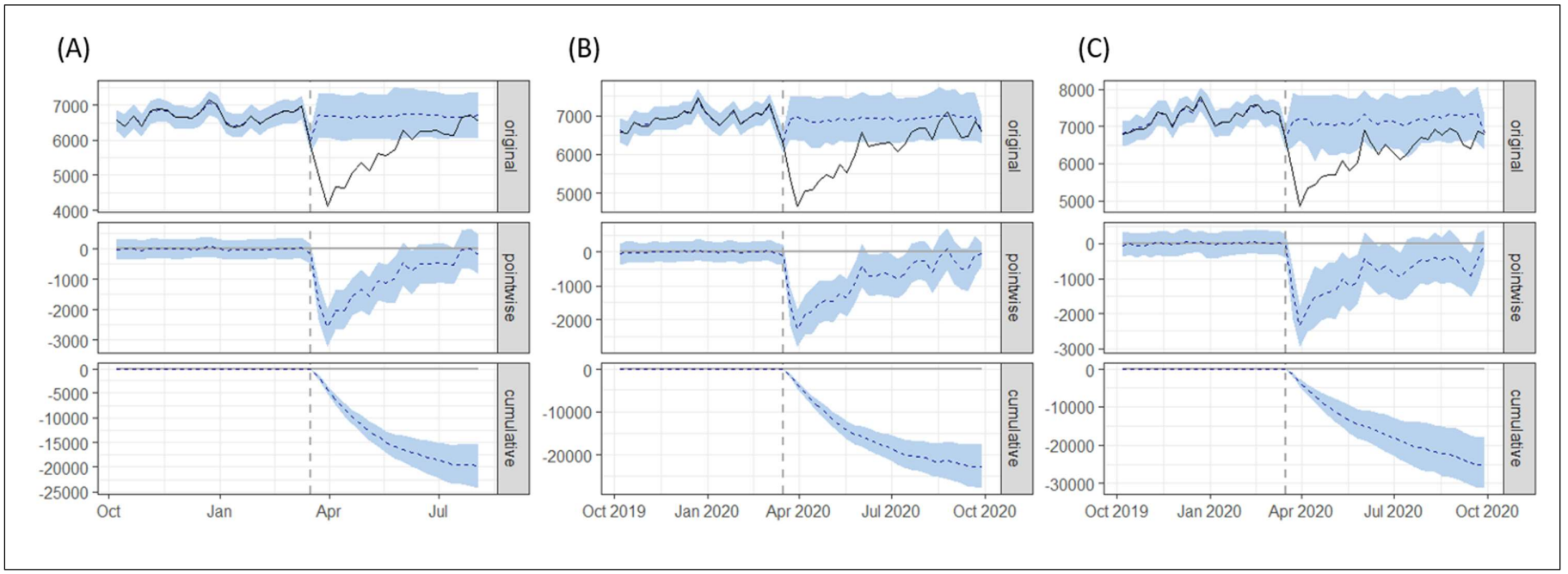

Figure 3: Weekly all-cause emergency department presentations in Western Australia among people living in areas of (A) High, (B) Medium and (C) Low socioeconomic status.

Footnote: Top panel displays weekly counts observed from October 2019 to mid-August 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts, over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Remoteness

Residents of metropolitan and non-metropolitan areas recorded similar reductions in ED presentation counts during the pandemic. For metropolitan residents, weekly presentation counts returned to pre-pandemic levels by August 2020. For non-metropolitan residents, weekly counts did not quite return to pre-pandemic levels however, differences between observed and expected counts were non-significant by this stage (Figure 4). Throughout follow-up, an overall reduction of 15% (95%CI -17%, -12%) was recorded for residents of the metropolitan area compared to a reduction of 14% (-17%, -10%) for residents of non-metropolitan areas (Table 4). Note that reductions in both groups exceed the relative reduction of 12% recorded for overall ED presentations (Table 1). This is because information on remoteness was missing for the final six weeks of the intervention period. During this period, there was generally little difference between observed and expected counts.

Table 4: Changes in counts of all-cause emergency department presentations in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020, by remoteness of patient residence.

Posterior inference	Average number of presentations per week				Cumulative number of presentations over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
Metropolitan								
Actual	10,595				211,891			
Prediction	12,394	189	12,036	12,767	247,870	3,782	240,712	255,344
Absolute effect	-1,799	189	-2,173	-1441	-35,979	3,782	-43,453	-28,821
Relative effect (%)	-15%	1%	-17%	-12%	-15%	1%	-17%	-12%
Non-Metropolitan								
Actual	6,810				136,203			
Prediction	7,940	169	7,597	8,234	158,794	3,390	151,949	164,685
Absolute effect	-1,130	169	-1,424	-787	-22,591	3,390	-28,482	-15,746
Relative effect (%)	-14%	2%	-17%	-10%	-14%	2%	-17%	-10%

Footnote: Follow-up period ends in August 2020; this differs from other analyses due to there being a six-week period with missing postcode information in the data used, which is necessary for categorising remoteness. SD: standard deviation; CI: confidence interval.

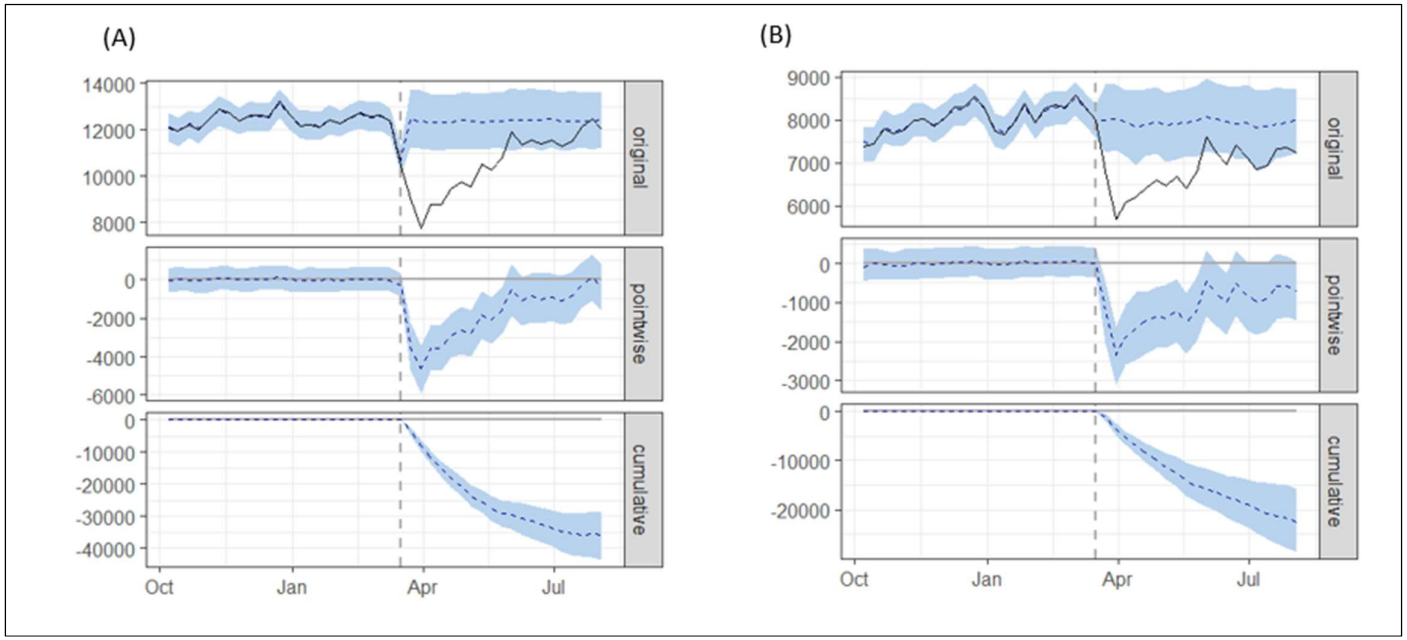

Figure 4: Weekly all-cause emergency department presentations in Western Australia among patients residing in (A) Metropolitan and (B) Non-Metropolitan areas.

Footnote: Top panel displays weekly counts observed from October 2019 to mid-August 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts, over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Admission status

Changes in ED presentation numbers were similar for those attendances which did and did not result in admission. For both categories, a drop in admission numbers was followed by a quick recovery, with the return to pre-pandemic levels occurring slightly earlier for the admitted group (Figure 5). Similarly, the drop in presentations across the follow-up period was slightly smaller in the admitted (8% reduction; 95%CI -13%, -3%) than in the non-admitted group (11% reduction; -14%, -8%), though this difference was not statistically significant (Table 5).

Table 5: Changes in counts of emergency department presentations in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020 by admission status.

Posterior inference	**Average number of presentations per week**				**Cumulative number of presentations over follow up**			
	Count	SD	95% CI		Count	SD	95%CI	
Admitted								
Actual	4,100				114,802			
Prediction	4,479	128	4,216	4,689	125,423	3,579	118,048	131,278
Absolute effect	-379	128	-588	-116	-10,621	3,579	-16,476	-3,246
Relative effect (%)	-8%	3%	-13%	-3%	-8%	3%	-13%	-3%
Non-admitted								
Actual	8,073				226,037			
Prediction	9,088	139	8,807	9,364	254,459	3,904	246,609	262,193
Absolute effect	-1,015	139	-1,291	-735	-28,422	3,904	-36,156	-20,572
Relative effect (%)	-11%	1%	-14%	-8%	-11%	1%	-14%	-8%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

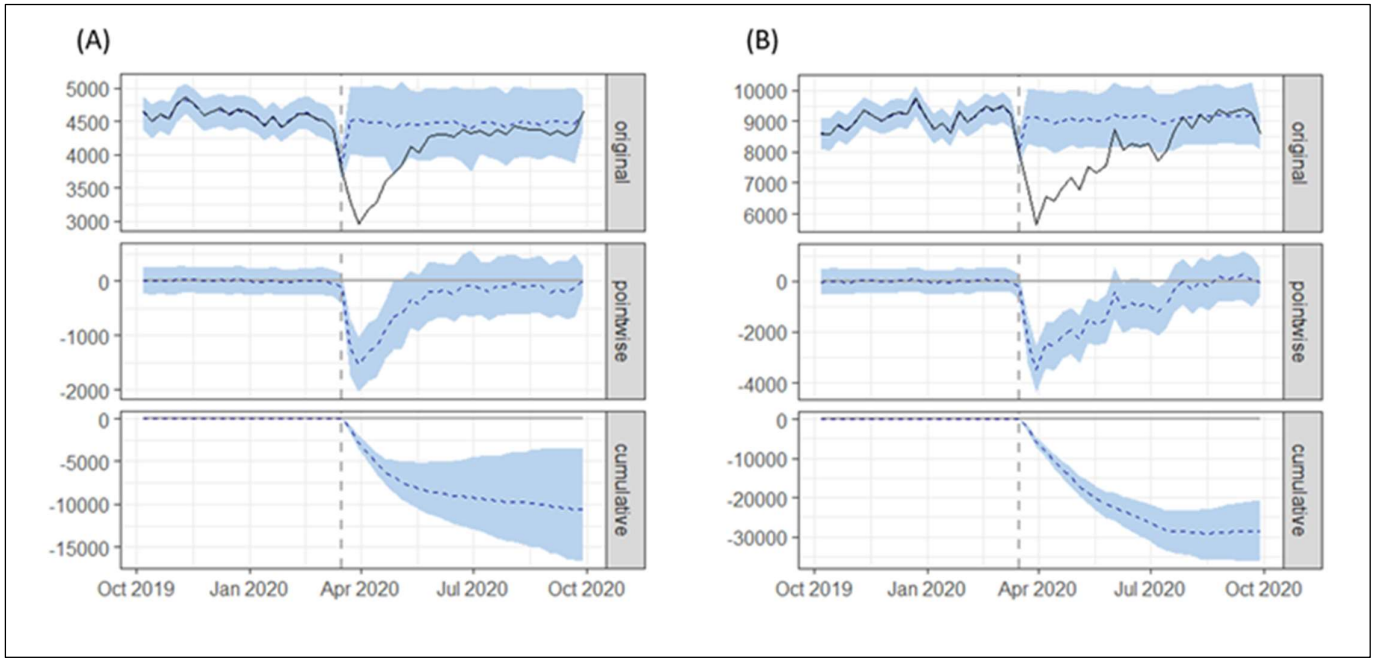

Figure 5: Weekly emergency department presentations in Western Australia, for episodes (A) Admitted to hospital and (B) Non-Admitted.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts, over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Age

Some differences in the pattern of ED presentation counts were observed between age groups. The decline in ED presentations was greatest in the group aged 0-18, with a reduction of 22% (95%CI -27%, -15%) which was a significantly greater decline than recorded for the 19-44 group (6% drop; -11%, -0.6%) and 45-64 group (6% decline; -10%, -2%); with the 65+years group in between (11% drop; -16%, -6%) (Table 6). Similarly, for the 0-18 group, there were significant differences between the observed counts of ED presentations and the counterfactual beyond July 2020, whereas, for all other age groups, the differences between observed and counterfactual counts ceased being statistically significant from April/May 2020 (Figure 6).

Table 6: Changes in counts of all-cause emergency department presentations in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020 by age group.

Posterior inference	**Average number of presentations per week**				**Cumulative number of presentations over follow up**			
	Count	SD	95% CI		Count	SD	95%CI	
Ages 0-18								
Actual	4,554				127,504			
Prediction	5,850	223	5,357	6241	163,804	6,256	150,008	174,756
Absolute effect	-1,296	223	-1,688	-804	-36,300	6,256	-47,252	-22,504
Relative effect (%)	-22%	3%	-27%	-15%	-22%	3%	-27%	-15%
Ages 19-44								
Actual	6,664				186,605			
Prediction	7,096	199	6,703	7448	198,685	5,582	187,694	208,534
Absolute effect	-431	199	-783	-39	-12,080	5,582	-21,929	-1,089
Relative effect (%)	-6%	3%	-11%	-0.6%	-6%	3%	-11%	-0.6%
Ages 45-64								
Actual	3,969				111,128			
Prediction	4,216	91	4,042	4394	118,036	2,538	113,186	123,024
Absolute effect	-247	91	-425	-73	-6,908	2,538	-11,896	-2,058
Relative effect (%)	-6%	2%	-10%	-2%	-6%	2%	-10%	-2%
Ages 65+								
Actual	3,716				104,041			
Prediction	4,200	112	3,966	4413	117,588	3,144	111,051	123,563
Absolute effect	-484	112	-697	-250	-13,547	3,144	-19,522	-7,010
Relative effect (%)	-11%	2%	-16%	-6%	-11%	2%	-16%	-6%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

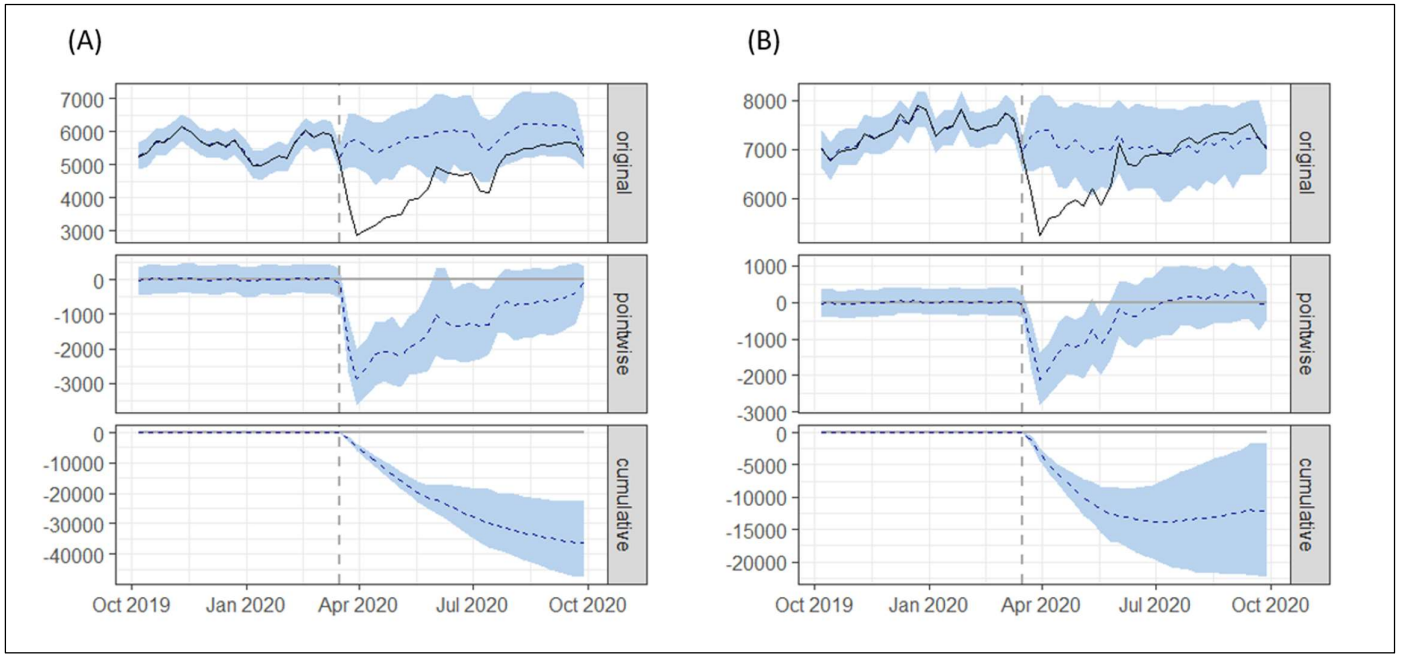

Figure 6: Weekly all-cause emergency department presentations in Western Australia among patients aged (A) 0-18, (B) 19-44, (C) 45-64, and (D) 65+.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts, over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

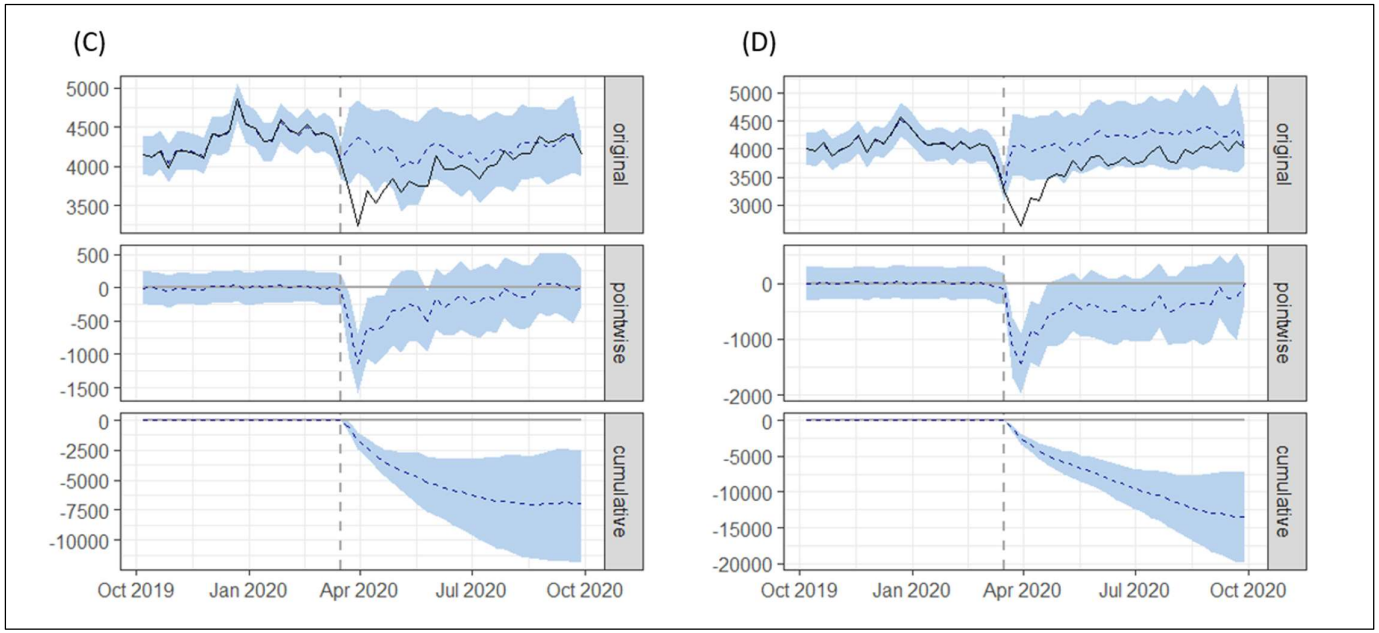

Figure 6 cont: Weekly all-cause emergency department presentations in Western Australia among patients aged (A) 0-18, (B) 19-44, (C) 45-64, and (D) 65+.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts, over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Arrival mode

Overall patterns were similar for patients arriving at the ED by ambulance and non-ambulance transport. For both groups, there was a recovery to pre-COVID presentation levels close to the end of the follow-up period (Figure 7). The drop in presentation numbers was slightly larger for non-ambulance arrivals (12% drop; 95%CI -14%, -9%) compared to ambulance arrivals (-9% drop; 95%CI 11%, -6%), though this difference was not significant (Table 7).

Table 7: Changes in counts of emergency department presentations in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020 by arrival mode.

Posterior inference	Average number of presentations per week				Cumulative number of presentations over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
Ambulance								
Actual	3,459				96,858			
Prediction	3,790	58	3,676	3,907	106,130	1,626	102,933	109,387
Absolute effect	-331	58	-447	-217	-9,272	1,626	-12,529	-6,075
Relative effect (%)	-9%	1%	-11%	-6%	-9%	1%	-11%	-6%
Non-ambulance								
Actual	18,903				529,278			
Prediction	21,365	266	20,828	21,875	598,217	7,447	583,190	612,497
Absolute effect	-2462	266	-2,972	-1,925	-68,939	7,447	-83,219	-53,912
Relative effect (%)	-12%	0.6%	-14%	-9%	-12%	0.6%	-14%	-9%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval. Arrival mode of "Ambulance" includes helicopter and Royal Flying Doctor Service arrivals. Non-ambulance includes private transport, public transport, hospital transport, police/correctional services and taxi.

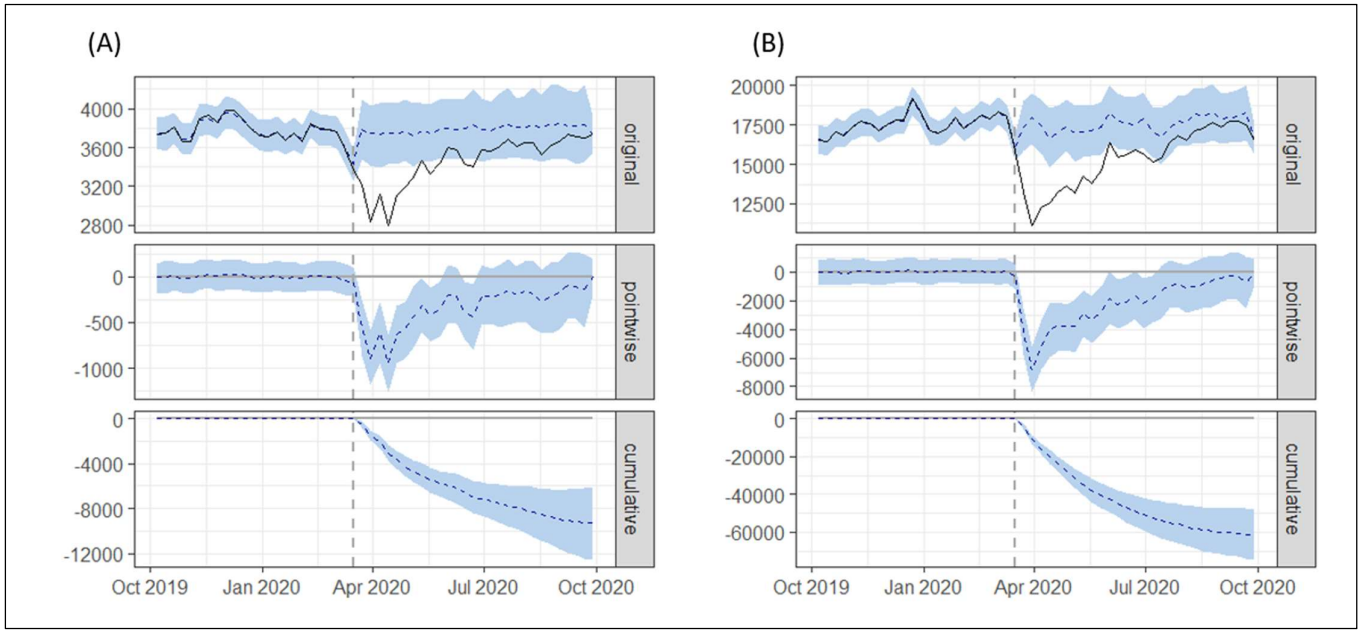

Figure 7: Weekly emergency department presentations in Western Australia among patients arriving by (A) Ambulance and (B) Non-ambulance.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Day of week

Changes in presentation counts were similar for weekdays and weekends. There was a reduction of 11% (95%CI -14%, -9%) on weekdays and 13% (-15%, -11%) on weekends (Table 8) and in both cases, presentation counts returned to pre-pandemic levels at the end of the follow-up period (Figure 8).

Table 8: Changes in counts of all-cause emergency department presentations in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020 by day of week.

Posterior inference	Average number of presentations per week				Cumulative number of presentations over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
Weekdays								
Actual	13,510				378,266			
Prediction	15,250	194	14,861	15,627	427,000	5,441	416,114	437,556
Absolute effect	-1,741	194	-2,118	-1,352	-48,734	5,441	-59,290	-37,848
Relative effect (%)	-11%	1%	-14%	-9%	-11%	1%	-14%	-9%
Weekends								
Actual	5,373				150,447			
Prediction	6,148	77	6,009	6,305	172,147	2,160	168,258	176,548
Absolute effect	-775	77	-932	-636	-21,700	2,160	-26,101	-17,811
Relative effect (%)	-13%	1%	-15%	-11%	-13%	1%	-15%	-11%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

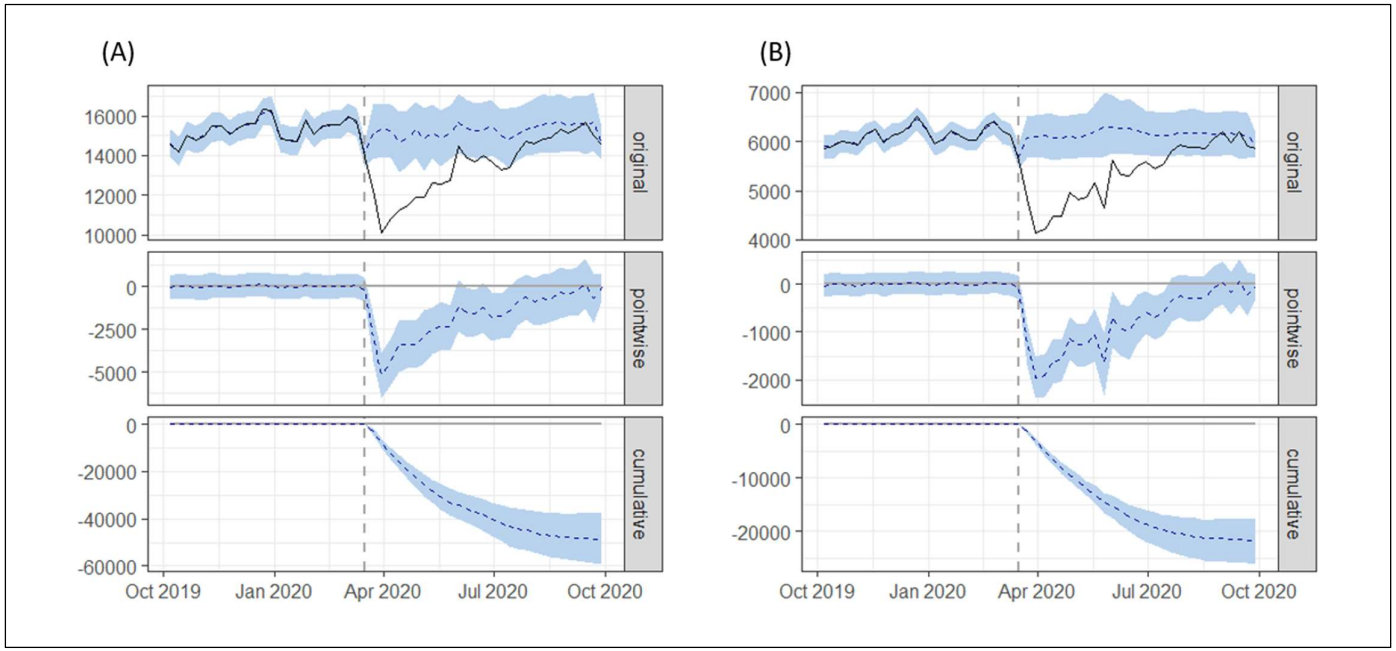

Figure 8: Weekly all-cause emergency department presentations in Western Australia on (A) Weekdays and (B) Weekends.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts, over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Time of day

The change in ED presentation counts recorded through the pandemic differed substantially according to the time of day. There was a relatively small reduction in presentations of 8% during working hours (95%CI -10%, -4%) compared to a 19% reduction during the night-time (-24%, -13%) and this difference was statistically significant (Table 9). Similarly, night-time presentations only returned to pre-pandemic levels at the very end of the follow-up period (though ceased to be statistically significantly lower earlier). Presentations during working hours returned to pre-pandemic levels from approximately August 2020 (Figure 9).

Table 9: Changes in counts of all-cause emergency department presentations in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020 according to time of day.

Posterior inference	**Average number of presentations per week**				**Cumulative number of presentations over follow up**			
	Count	SD	95% CI		Count	SD	95%CI	
Working hours (8am – 4pm)								
Actual	9,682				271,090			
Prediction	10,479	160	10,129	10,789	293,418	4,474	283,606	302,084
Absolute effect	-797	160	-1,107	-447	-22,328	4,474	-30,994	-12,516
Relative effect (%)	-8%	1%	-10%	-4%	-8%	1%	-10%	-4%
Evening (4pm – midnight)								
Actual	6,951				194,639			
Prediction	8,067	111	7,836	8,271	225,887	3,113	219,395	231,592
Absolute effect	-1,116	111	-1,320	-884	-31,248	3,113	-36,953	-24,756
Relative effect (%)	-14%	1%	-16%	-11%	-14%	1%	-16%	-11%
Night-time (midnight – 8am)								
Actual	2,270				63,547			
Prediction	2,792	96	2,615	2,984	78,169	2,688	73,224	83,559
Absolute effect	-522	96	-715	-346	-14,622	2,688	-20,012	-9,677
Relative effect (%)	-19%	3%	-24%	-13%	-19%	3%	-24%	-13%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

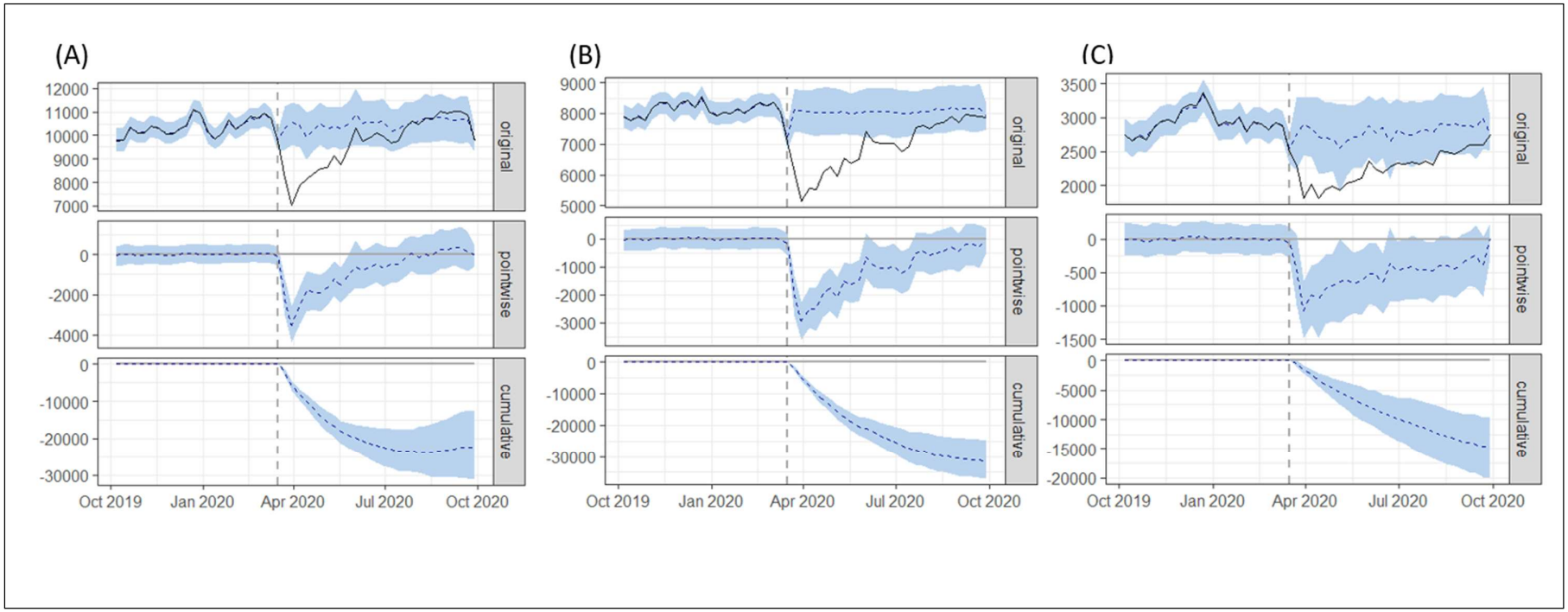

Figure 9: Weekly all-cause emergency department presentations in Western Australia during (A) Working hours, (B) Evening, and (C) Night-time.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts, over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Triage categories

The impact of the pandemic on ED presentation counts differed to some extent between triage levels. There was no clear gradient of an increasing or decreasing impact with decreasing urgency. For all categories, there was an immediate drop in weekly presentations and in all cases presentation counts returned to pre-pandemic levels (Figure 10). The non-urgent category differed from the others in that presentation numbers at the end of the follow-up period exceeded the expected pre-pandemic level, resulting in no net statistically significant reduction in presentations across the entire follow-up period. Among the other four categories, the greatest reduction was observed in the semi-urgent group, recording a 13% reduction through follow-up (95%CI -16%, -10%), followed by the urgent group. The emergency and resuscitation groups recorded the smallest change (9% reduction in the resuscitation group; -14%, -3%) (Table 10).

Table 10: Changes in counts of emergency department presentations in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020 by triage category.

Posterior inference	Average number of presentations per week				Cumulative number of presentations over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
Resuscitation								
Actual	146				4,087			
Prediction	161	5	150	170	4,499	142	4,202	4,768
Absolute effect	-15	5	-24	-4	-412	142	-681	-115
Relative effect (%)	-9%	3%	-14%	-3%	-9%	3%	-14%	-3%
Emergency								
Actual	2,548				71,350			
Prediction	2,771	47	2,671	2,861	77,585	1,321	74,798	80,116
Absolute effect	-223	47	-313	-123	-6,235	1,321	-8,766	-3,448
Relative effect (%)	-8%	2%	-11%	-5%	-8%	2%	-11%	-5%
Urgent								
Actual	6,260				175,279			
Prediction	7,000	147	6,793	7,352	200,000	4,121	190,213	205,865
Absolute effect	-777	147	-1,092	-533	-21,769	4,121	-30,586	-14,934
Relative effect (%)	-11%	2%	-15%	-8%	-11%	2%	-15%	-8%
Semi-urgent								
Actual	8,185				229,167			
Prediction	9,405	150	9,129	9,705	263,354	4,201	255,618	271,752
Absolute effect	-1,221	150	-1,521	-945	-34,187	4,201	-42,585	-26,451
Relative effect (%)	-13%	1%	-16%	-10%	-13%	1%	-16%	-10%
Non-urgent								
Actual	1,758				49,224			
Prediction	1,853	88	1,683	2,041	51,893	2,468	47,112	57,160
Absolute effect	-95	88	-283	75	-2,669	2,468	-7,936	2,112
Relative effect (%)	-5%	5%	-14%	5%	-5%	5%	-14%	5%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

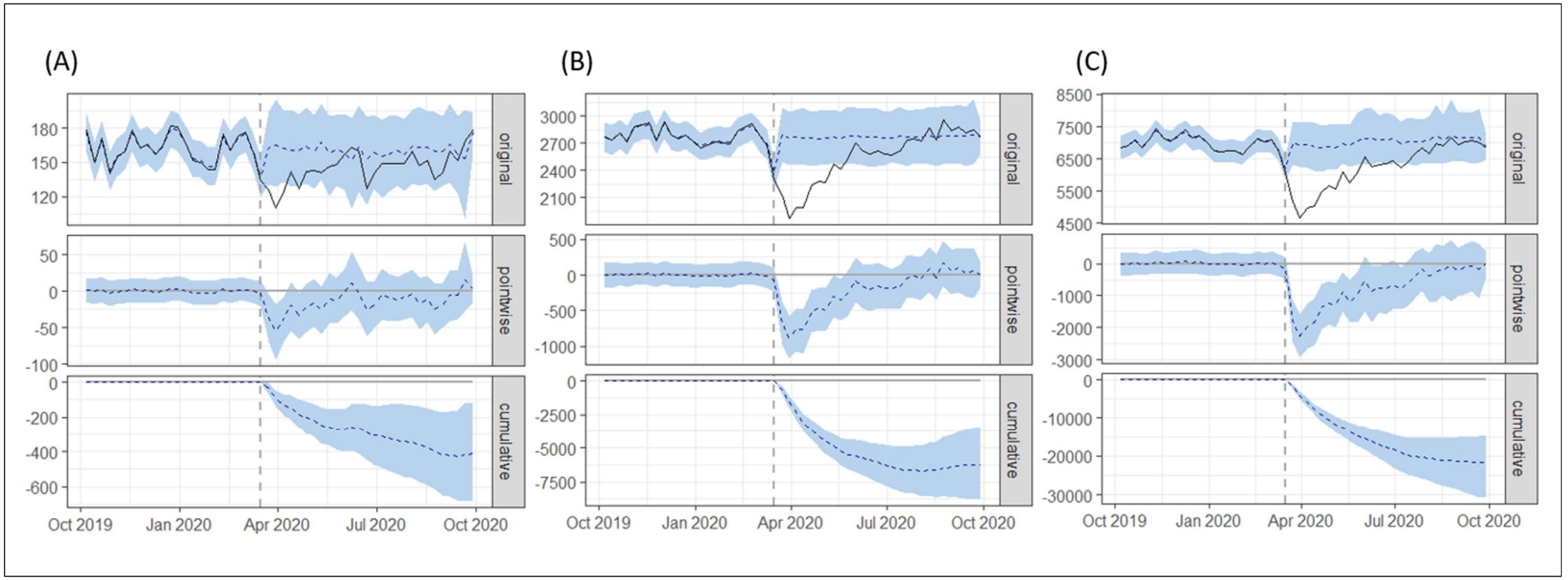

Figure 10: Weekly emergency department presentations in Western Australia for triage levels of (A) Resuscitation, (B) Emergency, (C) Urgent, (D) Semi-urgent, and (E) Non-urgent.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

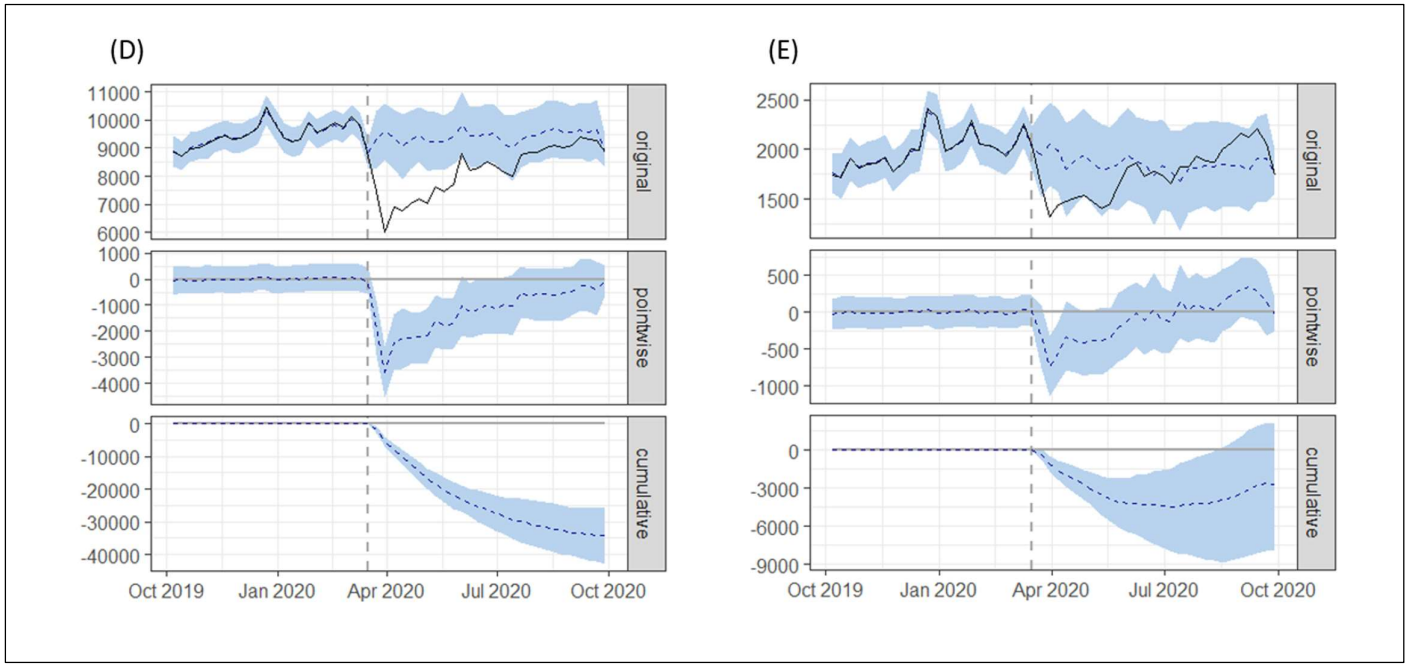

Figure 10 cont: Weekly emergency department presentations in Western Australia for triage levels of (A) Resuscitation, (B) Emergency, (C) Urgent, (D) Semi-urgent, and (E) Non-urgent.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Major diagnostic categories (ICD chapters)

The impact of the pandemic on ED presentations differed dramatically depending on the diagnostic category of the condition assessed during the presentation. For several diagnostic groups, there was no significant difference in ED presentation counts across the follow-up period (diseases of the circulatory system; diseases of the digestive system; neoplasms; diseases of the nervous system; conditions originating in the perinatal period; pregnancy, childbirth and the puerperium; diseases of the respiratory system; diseases of the skin and subcutaneous tissue) (Table 11). In some of these cases, there appeared to be no or minor change in presentations following the pandemic (e.g. neoplasms, Figure 11 panel L). In contrast, in other cases, there were declines followed by recovery or increases above pre-pandemic levels resulting in no net change through follow-up (e.g. diseases of the circulatory system, Figure 11 panel B). The largest declines were observed for infectious or parasitic diseases, recording a decline of 43% (95%CI -51%, -37%), and diseases of the ear and mastoid process, recording a decline of 32% (-42%, -13%). Some conditions showed declines which did not recover to pre-pandemic levels or appeared to recover relatively slowly (e.g. diseases of the ear and mastoid process Figure 11, panel D; endocrine, nutritional and metabolic system disorders (panel E); diseases of the eye and adnexa (panel F); and infectious/parasitic diseases (panel H)). Other conditions more closely resembled the pattern of ED presentations overall, i.e. a sudden decline followed by a return to pre-pandemic levels towards the end of the follow-up period, resulting in a significant reduction across the entire follow-up period (e.g. diseases of the genitourinary system (Figure 11, panel G); mental and behavioural disorders (panel J) and diseases of the musculoskeletal system (panel K)).

Table 11: Changes in counts of emergency department presentations in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020 by ICD chapter.

Posterior inference	Average number of presentations per week				Cumulative number of presentations over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
Diseases of the blood and blood-forming organs								
Actual	77				2,168			
Prediction	85	4	78	92	2,381	99	2,183	2,573
Absolute effect	-8	4	-14	-0.5	-213	99	-405	-15
Relative effect (%)	-9%	4%	-16%	-0.7%	-9%	4%	-16%	-0.7%
Diseases of the circulatory system								
Actual	717				20,074			
Prediction	713	17	684	753	19,958	481	19,158	21,086
Absolute effect	4	17	-36	33	116	481	-1,012	916
Relative effect (%)	0.7%	2%	-5%	5%	0.7%	2%	-5%	5%
Diseases of the digestive system								
Actual	1,145				32,052			
Prediction	1,159	36	1093	1235	32,464	1,007	30,606	34,573
Absolute effect	-15	36	-90	52	-412	1,007	-2,521	1,446
Relative effect (%)	-1%	3%	-7%	5%	-1%	3%	-7%	5%
Diseases of the ear and mastoid process								
Actual	230				6,427			
Prediction	338	31	264	395	9,477	871	7,390	11,051
Absolute effect	-109	31	-165	-34	-3,050	871	-4,624	-963
Relative effect (%)	-32%	7%	-42%	-13%	-32%	7%	-42%	-13%
Endocrine, nutritional and metabolic diseases								
Actual	160				4,476			
Prediction	198	8	180	213	5,549	229	5,050	5,964
Absolute effect	-38	8	-53	-21	-1,073	229	-1,488	-574
Relative effect (%)	-19%	3%	-25%	-11%	-19%	3%	-25%	-11%
Diseases of the eye and adnexa								
Actual	208				5,819			
Prediction	272	13	241	292	7,622	367	6,742	8,180
Absolute effect	-64	13	-84	-33	-1,803	367	-2,361	-923
Relative effect (%)	-23%	4%	-29%	-14%	-23%	4%	-29%	-14%
Diseases of the genitourinary system								
Actual	782				21,901			
Prediction	860	30	800	911	24,078	838	22,410	25,500
Absolute effect	-78	30	-129	-18	-2,177	838	-3,599	-509
Relative effect (%)	-9%	3%	-14%	-2%	-9%	3%	-14%	-2%
Certain infectious and parasitic diseases								
Actual	717				20,070			
Prediction	1,265	80	1,135	1462	35,420	2,243	31,786	40,939
Absolute effect	-548	80	-745	-418	-15,350	2,243	-20,869	-11,716
Relative effect (%)	-43%	4%	-51%	-37%	-43%	4%	-51%	-37%
Injury, poisoning and certain other consequences of external causes								
Actual	5,346				149,698			
Prediction	5,639	89	5,461	5807	157,880	2,486	152,919	162,593

Posterior inference	Average number of presentations per week				Cumulative number of presentations over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
Absolute effect	-292	89	-461	-115	-8,182	2,486	-12,895	-3221
Relative effect (%)	-5%	2%	-8%	-2%	-5%	2%	-8%	-2%
Mental and behavioural disorders								
Actual	804				22,524			
Prediction	894	21	857	944	25,043	591	23,991	26,419
Absolute effect	-90	21	-139	-52	-2,519	591	-3,895	-1467
Relative effect (%)	-10%	2%	-15%	-6%	-10%	2%	-15%	-6%
Diseases of the musculoskeletal system and connective tissue								
Actual	776				21,731			
Prediction	876	24	832	931	24,527	681	23,299	26065
Absolute effect	-100	24	-155	-56	-2,796	681	-4,334	-1,568
Relative effect (%)	-11%	2%	-17%	-7%	-11%	2%	-17%	-7%
Neoplasms								
Actual	52				1,464			
Prediction	54	3	48	60	1,501	82	1,336	1,666
Absolute effect	-1	3	-7	5	-37	82	-202	128
Relative effect (%)	-2%	5%	-12%	10%	-2%	5%	-12%	10%
Diseases of the nervous system								
Actual	288				8,066			
Prediction	296	7	282	310	8,300	199	7,897	8,690
Absolute effect	-8	7	-22	6	-234	199	-624	169
Relative effect (%)	-3%	2%	-7%	2%	-3%	2%	-7%	2%
Certain conditions originating in the perinatal period								
Actual	26				723			
Prediction	27	2	24	30	752	44	664	840
Absolute effect	-1	2	-4	2	-29	44	-117	59
Relative effect (%)	-4%	6%	-14%	9%	-4%	6%	-14%	9%
Pregnancy, childbirth and the puerperium								
Actual	229				6,402			
Prediction	242	8	224	255	6,766	210	6275	7,131
Absolute effect	-13	8	-26	5	-364	210	-729	127
Relative effect (%)	-5%	3%	-10%	2%	-5%	3%	-10%	2%
Diseases of the respiratory system								
Actual	1,219				34,138			
Prediction	1,713	365	1,017	2392	47,966	10,219	28,481	66,982
Absolute effect	-494	365	-1,173	202	-13,828	10,219	-32,844	5,657
Relative effect (%)	-25%	24%	-49%	20%	-25%	24%	-49%	20%
Diseases of the skin and subcutaneous tissue								
Actual	710				19,882			
Prediction	799	52	700	904	22,359	1,450	19,607	25,308
Absolute effect	-88	52	-194	10	-2,477	1,450	-5426	275
Relative effect (%)	-11%	6%	-21%	1%	-11%	6%	-21%	1%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

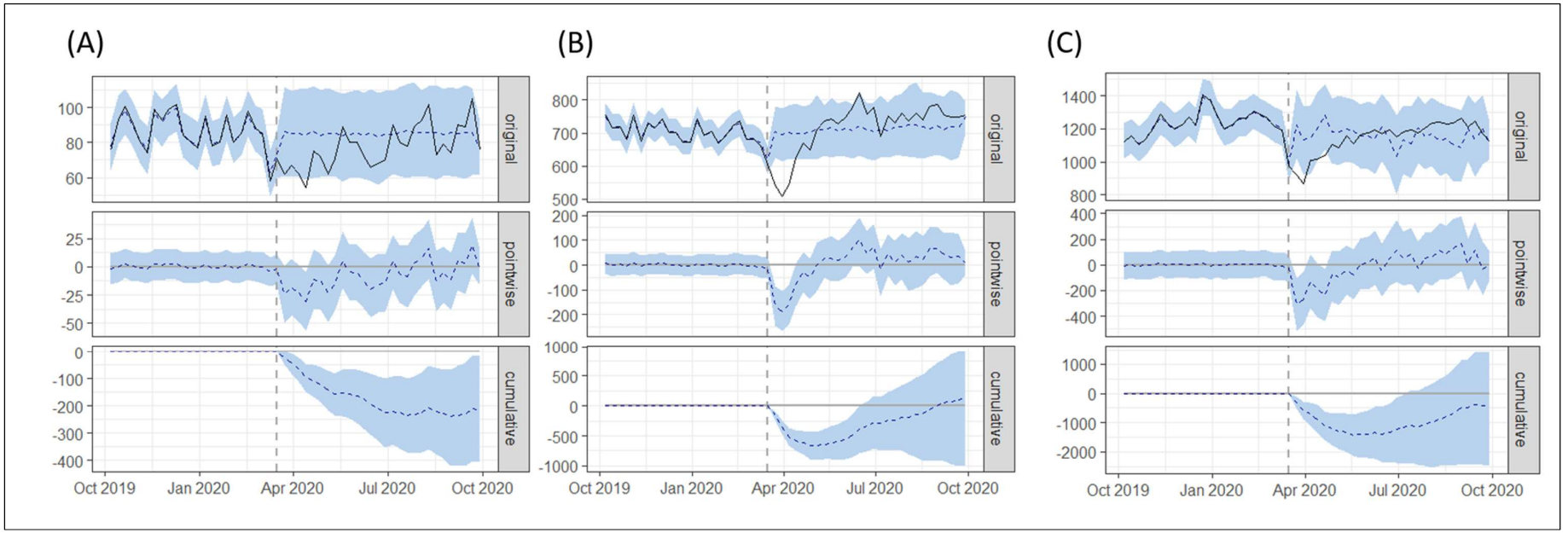

Figure 11: Weekly emergency department presentations in Western Australia for (A) Diseases of the blood and blood-forming organs, (B) Diseases of the circulatory system, (C) Diseases of the digestive system, (D) Diseases of the ear and mastoid process, (E) Endocrine, nutritional and metabolic diseases, (F) Diseases of the eye and adnexa, (G) Diseases of the genitourinary system, (H) Infectious and parasitic disorders, (I) Injury, poisoning and certain other consequences of external causes, (J) Mental and behavioural disorders, (K) Diseases of the musculoskeletal system and connective tissue, (L) Neoplasms, (M) Diseases of the nervous system, (N) Certain conditions originating in the perinatal period, (O) Pregnancy, childbirth and the puerperium, (P) Diseases of the respiratory system, and (Q) Diseases of the skin and subcutaneous tissue.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

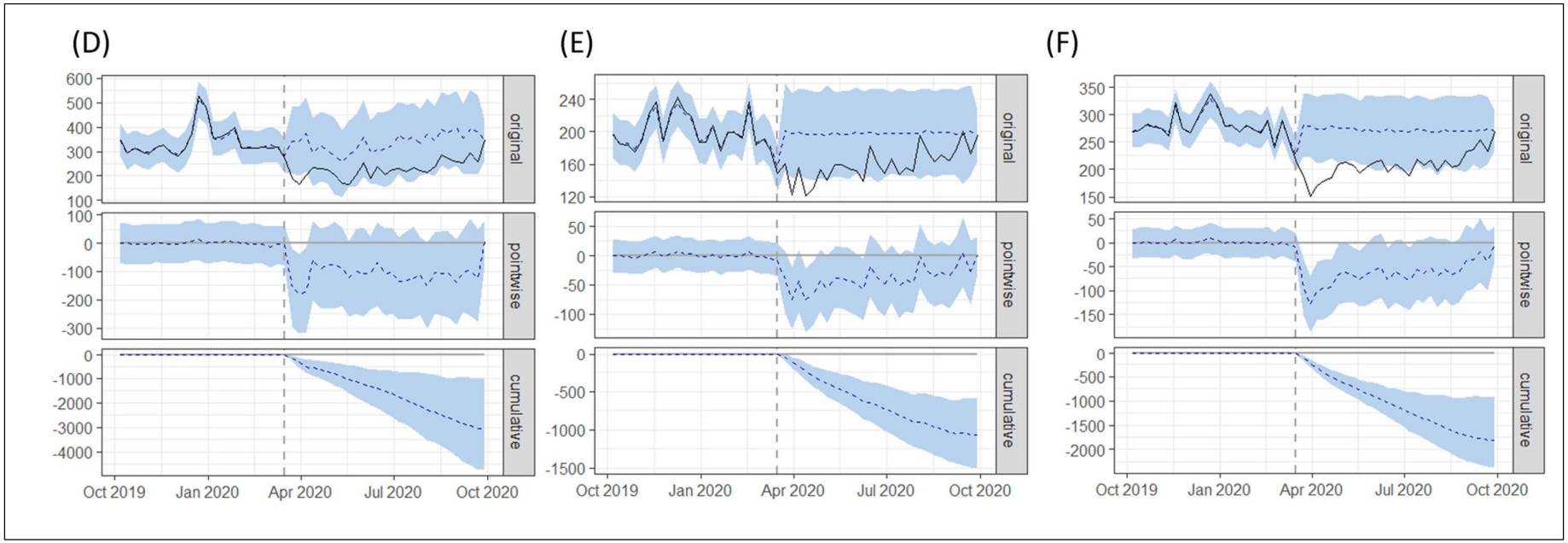

Figure 11 cont: Weekly emergency department presentations in Western Australia for (A) Diseases of the blood and blood-forming organs, (B) Diseases of the circulatory system, (C) Diseases of the digestive system, (D) Diseases of the ear and mastoid process, (E) Endocrine, nutritional and metabolic diseases, (F) Diseases of the eye and adnexa, (G) Diseases of the genitourinary system, (H) Infectious and parasitic disorders, (I) Injury, poisoning and certain other consequences of external causes, (J) Mental and behavioural disorders, (K) Diseases of the musculoskeletal system and connective tissue, (L) Neoplasms, (M) Diseases of the nervous system, (N) Certain conditions originating in the perinatal period, (O) Pregnancy, childbirth and the puerperium, (P) Diseases of the respiratory system, and (Q) Diseases of the skin and subcutaneous tissue.

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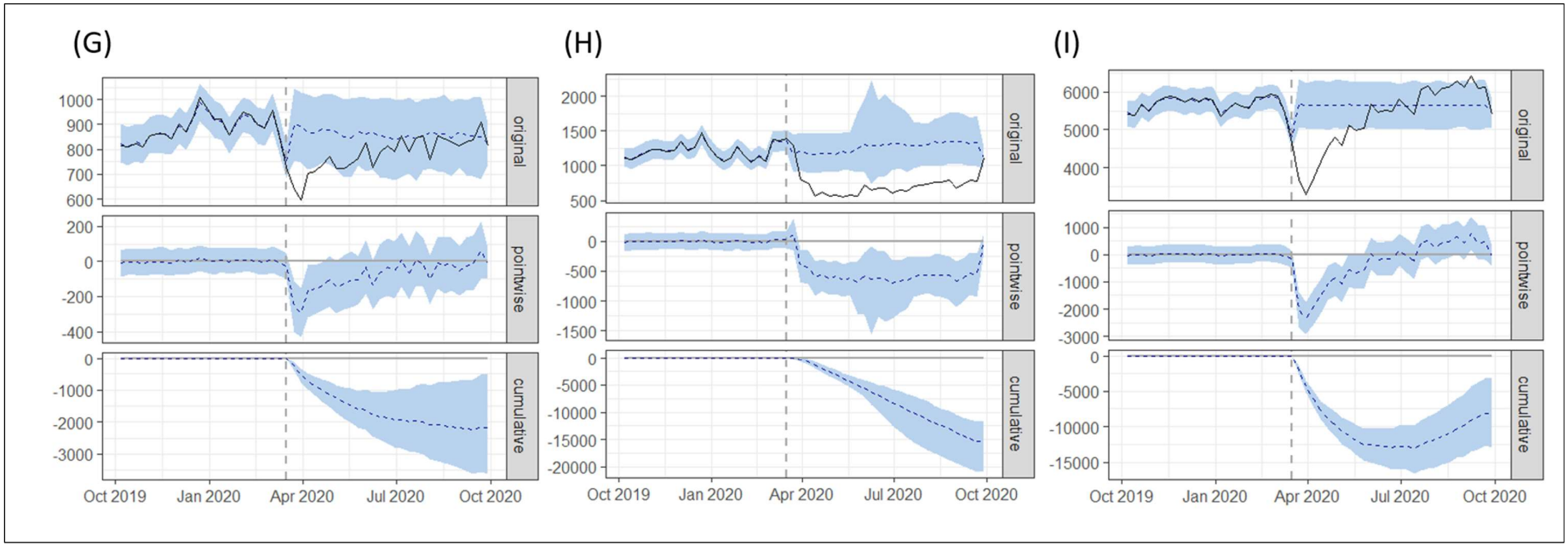

Figure 11 cont: Weekly emergency department presentations in Western Australia for (A) Diseases of the blood and blood-forming organs, (B) Diseases of the circulatory system, (C) Diseases of the digestive system, (D) Diseases of the ear and mastoid process, (E) Endocrine, nutritional and metabolic diseases, (F) Diseases of the eye and adnexa, (G) Diseases of the genitourinary system, (H) Infectious and parasitic disorders, (I) Injury, poisoning and certain other consequences of external causes, (J) Mental and behavioural disorders, (K) Diseases of the musculoskeletal system and connective tissue, (L) Neoplasms, (M) Diseases of the nervous system, (N) Certain conditions originating in the perinatal period, (O) Pregnancy, childbirth and the puerperium, (P) Diseases of the respiratory system, and (Q) Diseases of the skin and subcutaneous tissue.

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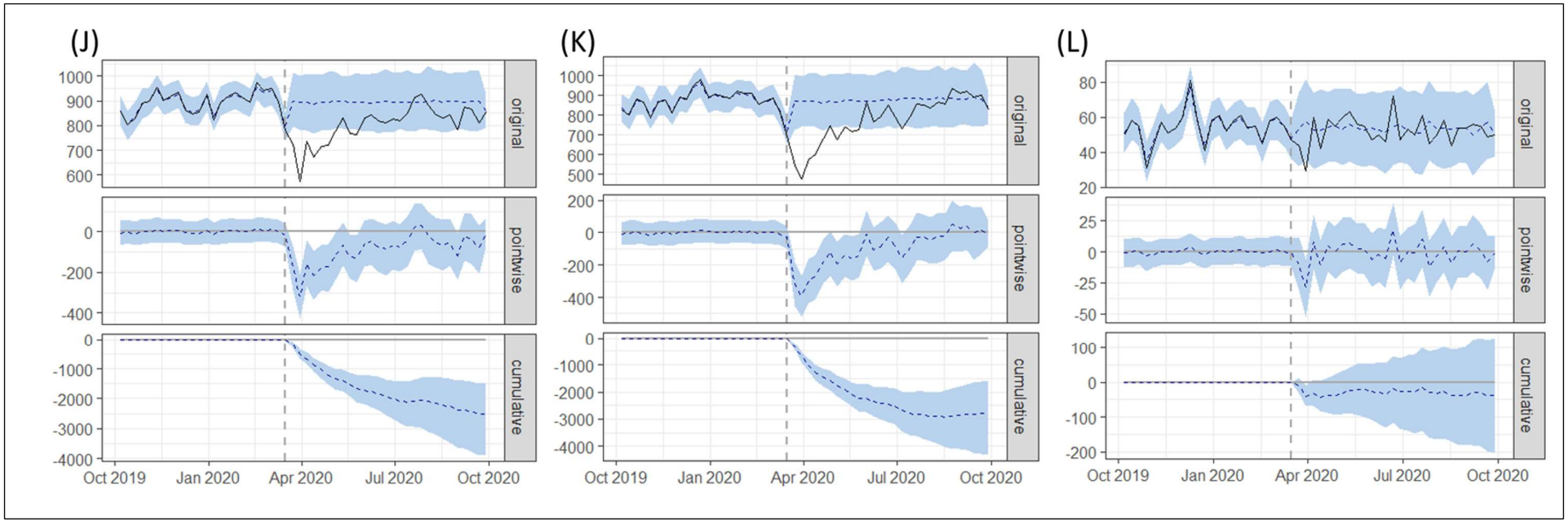

Figure 11 cont: Weekly emergency department presentations in Western Australia for (A) Diseases of the blood and blood-forming organs, (B) Diseases of the circulatory system, (C) Diseases of the digestive system, (D) Diseases of the ear and mastoid process, (E) Endocrine, nutritional and metabolic diseases, (F) Diseases of the eye and adnexa, (G) Diseases of the genitourinary system, (H) Infectious and parasitic disorders, (I) Injury, poisoning and certain other consequences of external causes, (J) Mental and behavioural disorders, (K) Diseases of the musculoskeletal system and connective tissue, (L) Neoplasms, (M) Diseases of the nervous system, (N) Certain conditions originating in the perinatal period, (O) Pregnancy, childbirth and the puerperium, (P) Diseases of the respiratory system, and (Q) Diseases of the skin and subcutaneous tissue.

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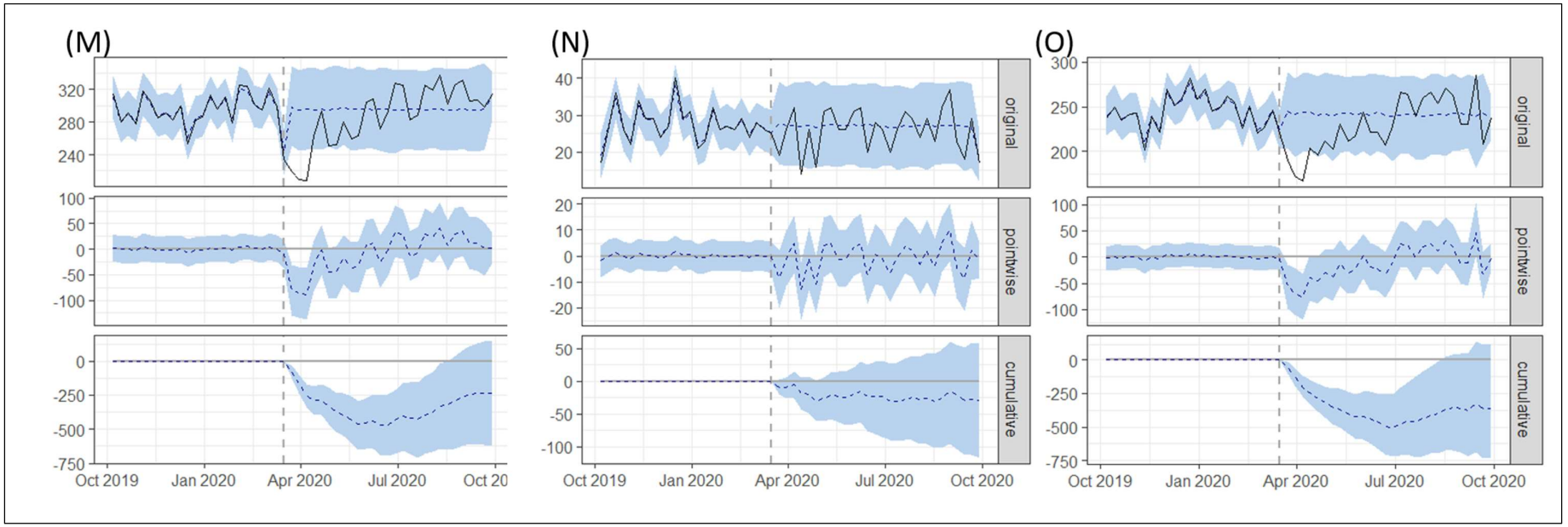

Figure 11 cont: Weekly emergency department presentations in Western Australia for (A) Diseases of the blood and blood-forming organs, (B) Diseases of the circulatory system, (C) Diseases of the digestive system, (D) Diseases of the ear and mastoid process, (E) Endocrine, nutritional and metabolic diseases, (F) Diseases of the eye and adnexa, (G) Diseases of the genitourinary system, (H) Infectious and parasitic disorders, (I) Injury, poisoning and certain other consequences of external causes, (J) Mental and behavioural disorders, (K) Diseases of the musculoskeletal system and connective tissue, (L) Neoplasms, (M) Diseases of the nervous system, (N) Certain conditions originating in the perinatal period, (O) Pregnancy, childbirth and the puerperium, (P) Diseases of the respiratory system, and (Q) Diseases of the skin and subcutaneous tissue.

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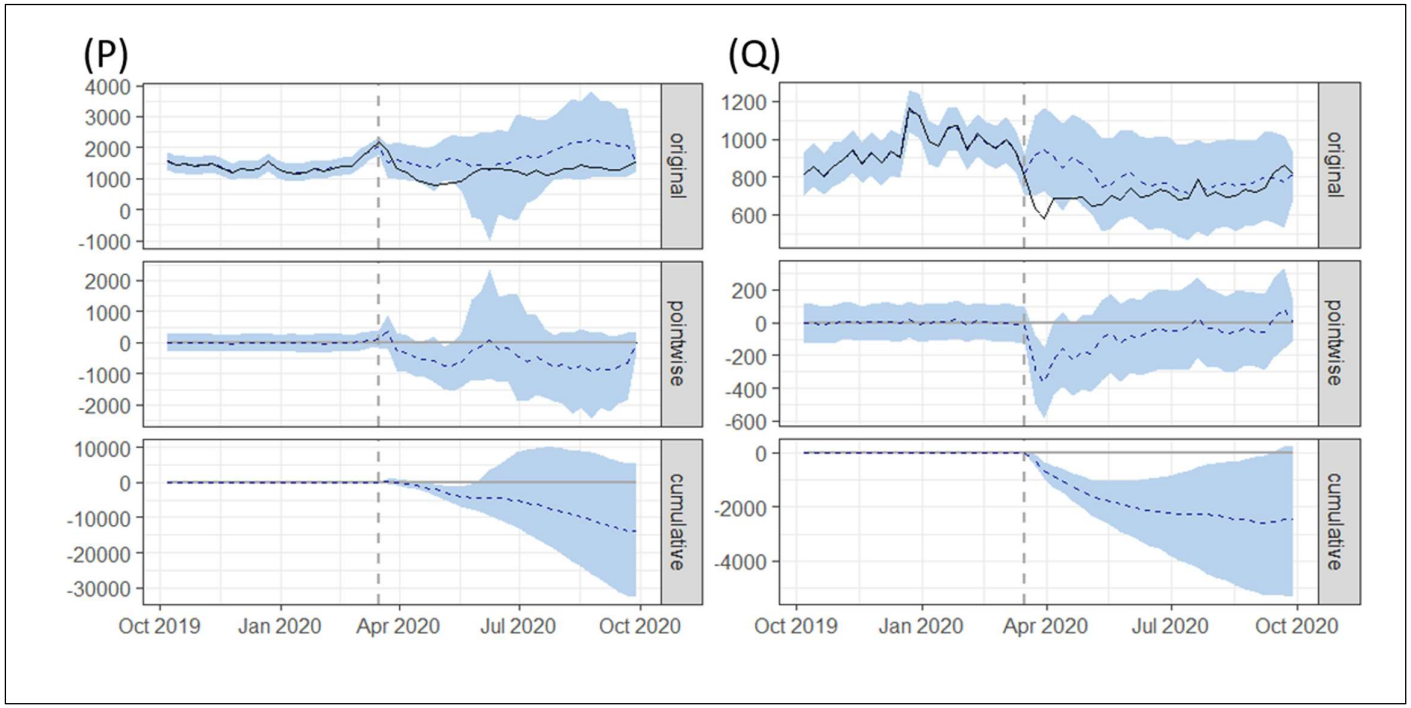

Figure 11 cont: Weekly emergency department presentations in Western Australia for (A) Diseases of the blood and blood-forming organs, (B) Diseases of the circulatory system, (C) Diseases of the digestive system, (D) Diseases of the ear and mastoid process, (E) Endocrine, nutritional and metabolic diseases, (F) Diseases of the eye and adnexa, (G) Diseases of the genitourinary system, (H) Infectious and parasitic disorders, (I) Injury, poisoning and certain other consequences of external causes, (J) Mental and behavioural disorders, (K) Diseases of the musculoskeletal system and connective tissue, (L) Neoplasms, (M) Diseases of the nervous system, (N) Certain conditions originating in the perinatal period, (O) Pregnancy, childbirth and the puerperium, (P) Diseases of the respiratory system, and (Q) Diseases of the skin and subcutaneous tissue.

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External cause of injury

For each external cause of injury, an initial decline in ED presentations immediately after introducing public health measures was followed by elevated presentation numbers relative to the pre-pandemic period. There were differences between injury causes at the time presentation counts began to exceed pre-pandemic levels. For injuries caused by transport, this change happened approximately one month after the introduction of lockdowns (Figure 12 panel A), and hence the count of presentations throughout the follow-up period exceeded expectations (11% increase; 95%CI 3%, 20%) (Table 12). For injuries with "other and unknown" causes, the weekly count began to exceed pre-pandemic levels in approximately August 2020; hence, across the entire follow-up, there was a decline in presentations of 8% (-12%, -4%). For presentations due to injuries caused by force and falls did not differ significantly from pre-pandemic levels across the 6-month follow-up.

Table 12: Changes in counts of injury-related emergency department presentations in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020 by external causes of injury.

Posterior inference	Average number of presentations per week				Cumulative number of presentations over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
Transport and pedestrian								
Actual	175				4,906			
Prediction	158	6	146	171	4,437	167	4,099	4,779
Absolute effect	17	6	5	29	469	167	127	807
Relative effect (%)	11%	4%	3%	20%	11%	4%	3%	20%
Fall								
Actual	656				18,360			
Prediction	652	19	613	687	18,255	539	17,162	19,248
Absolute effect	4	19	-32	43	105	539	-888	1,198
Relative effect (%)	0.7%	3%	-5%	7%	0.7%	3%	-5%	7%
Force								
Actual	690				19,323			
Prediction	698	21	654	738	19,556	599	18,304	20,652
Absolute effect	-8	21	-47	36	-233	599	-1,329	1,019
Relative effect (%)	-1%	3%	-6%	6%	-1%	3%	-6%	6%
Others and unknown								
Actual	3,825				107,109			
Prediction	4,138	91	3,968	4343	115,869	2,546	111,108	121,592
Absolute effect	-313	91	-517	-143	-8,760	2,546	-14,483	-3,999
Relative effect (%)	-8%	2%	-12%	-4%	-8%	2%	-12%	-4%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

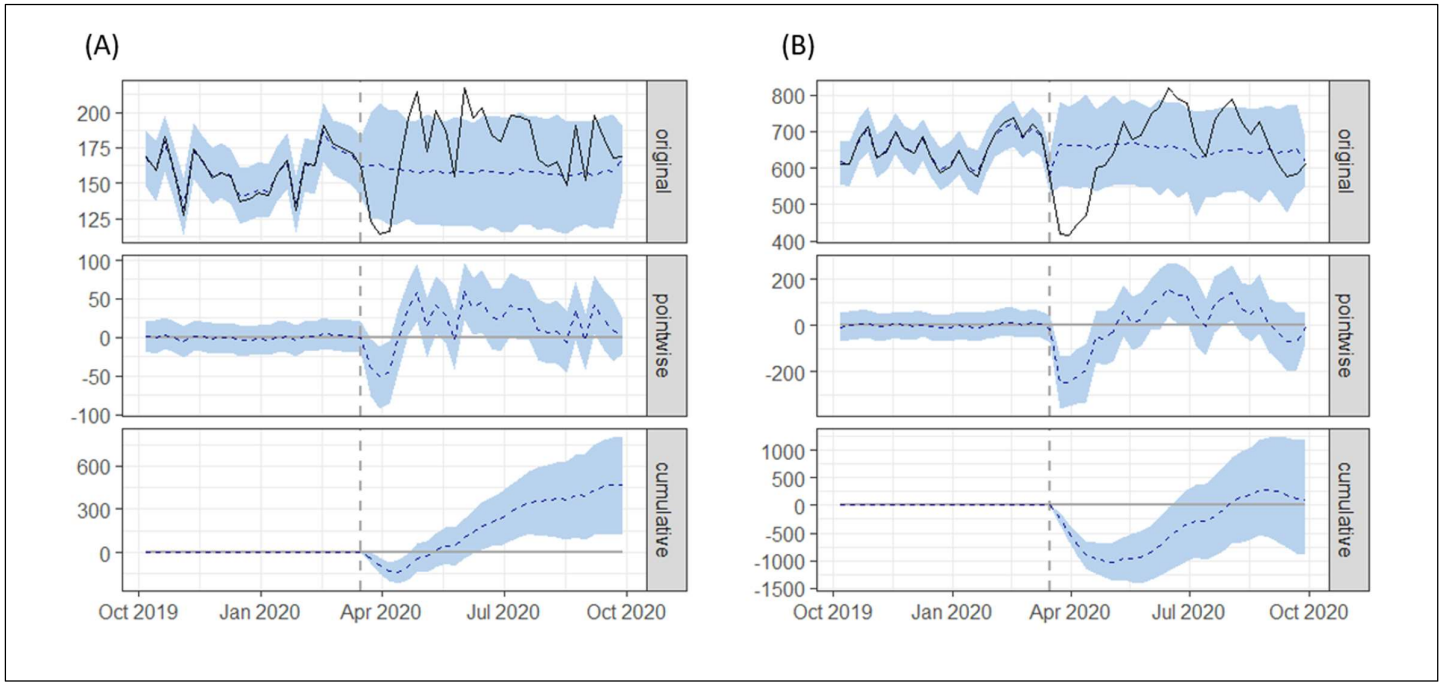

Figure 12: Weekly injury-related emergency department presentations in Western Australia by external cause of injury: (A) Transport and pedestrian, (B) Falls, (C) Force, and (D) Others and unknown.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

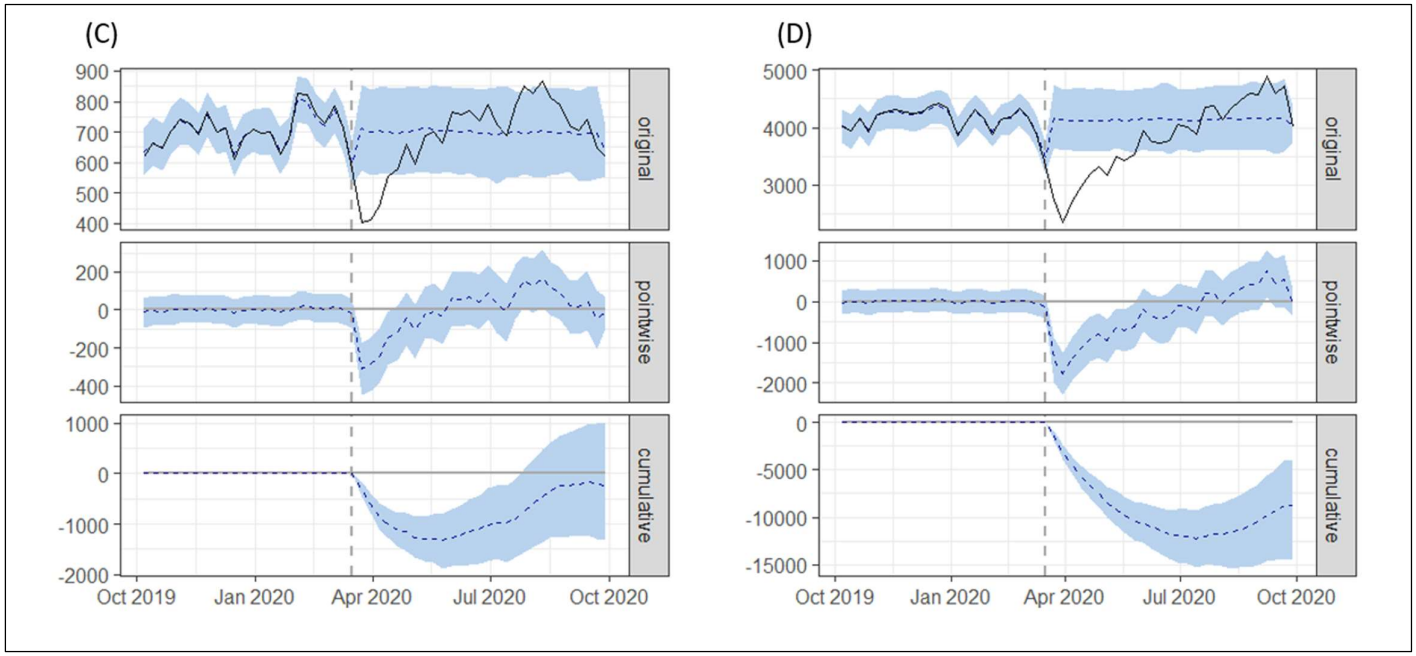

Figure 12 cont: Weekly injury-related emergency department presentations in Western Australia by external cause of injury: (A) Transport and pedestrian, (B) Falls, (C) Force, and (D) Others and unknown.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Section summary

The overall pattern of emergency department presentations during the COVID-19 pandemic showed a substantial decline immediately following the introduction of public health measures in March 2020, followed by a gradual return to pre-pandemic levels by the end of the follow-up period in October 2020. ED presentations had ceased to differ significantly from expected levels from approximately July 2020, soon after the majority of internal public health measures had been lifted at the end of June (with the exception of some social distancing). There was little difference from this overall pattern for most demographic subgroups (i.e. by age, remoteness and socioeconomic status of patient residence). The exception was age. Those aged 0-18 recorded a larger drop in emergency department presentations than overall, while those aged 19-64 had a smaller reduction.

The effect of the pandemic was similar on weekends and weekdays, though night-time presentations and those during the evening reduced to a greater extent than those during working hours. Working hours presentations showed a faster return to pre-pandemic levels than those in the evening and at night.

There were slightly larger reductions for non-ambulance arrivals than for arrivals by ambulance, and for non-admitted than admitted episodes, with admitted episodes returning to pre-pandemic levels more quickly. This could be explained by non-ambulance arrivals representing less severe events. Patients experiencing these events may have opted to avoid attending the ED out of concerns about COVID-19 exposure. However, there was no clear gradient of greater reduction in ED presentations with decreasing urgency in triage categories. Instead, there was a significant reduction across the entire follow-up period for all triage categories except the non-urgent group, which recorded an initial decrease in presentation followed by an increase, relative to pre-pandemic levels, at the end of the follow-up period. The semi-urgent category recorded the greatest reduction in presentations.

Presentations for injury differed substantially from presentations overall. Presentations due to injuries resulting from transport and pedestrian activity were the only category of presentations that significantly increased throughout the follow-up period (following a small initial reduction), while presentations due to injuries caused by falls or force had only minor changes. Researchers elsewhere have found a decline in injuries due to motor vehicle collisions, though have noted the potential for lockdowns to reduce injuries by reducing traffic volumes, alongside the potential for empty roads to allow for driving at higher speeds.[25]

Different diagnostic categories had different changes in emergency department presentations during the pandemic. Neoplasms and conditions originating in the perinatal period showed minimal changes in emergency department presentations throughout follow-up, likely because presentations of these conditions ultimately follow on from diagnoses/pregnancies occurring months earlier. For infectious and parasitic conditions and diseases of the ear and mastoid process, there were reductions in presentation substantially greater than for other categories, caused by presentations for these conditions not recovering to pre-pandemic levels following the initial reduction immediately following the introduction of public health measures. The substantial reductions in presentations for infectious and parasitic conditions are likely caused by infection control measures introduced to reduce COVID-19 infection also influencing transmission of other infectious conditions e.g. influenza.

Hospitalisations

Overall

Following the introduction of public health measures in April 2020, there was an immediate drop in weekly hospital admissions. However, these quickly increased again and reached pre-COVID levels in July 2020, after which admissions remained steady and aligned with expectations (Figure 13). Hospital admissions were lower than expected levels by 2,106 per week through the follow-up period, equivalent to a statistically significant 9% reduction (95% CI -16%, -04%) compared to expectations based on pre-pandemic levels (Table 13).

Table 13: Changes in counts of all-cause hospitalisations in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020

Posterior inference	Average number of admissions per week				Cumulative number of admissions over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
Actual	21,214				593,989			
Prediction	23,320	1,009	21,303	25,262	652,963	28,254	596,482	707,349
Absolute effect	-2,106	1,009	-4,049	-89	-58,974	28,254	-113,360	-2,493
Relative effect (%)	-9%	4%	-16%	-0.4%	-9%	4%	-16%	-0.4%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

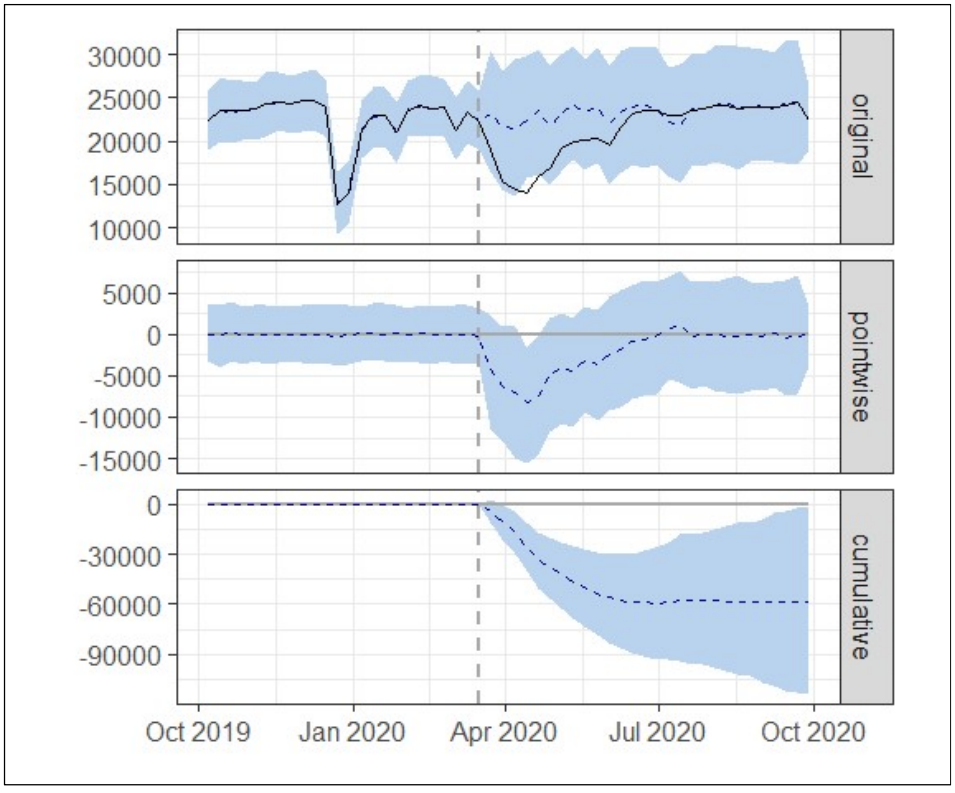

Figure 13: Weekly all-cause hospitalisations in Western Australia.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Sex

The reduction in hospital admissions following the introduction of COVID-19 public health measures was almost identical for males and females. Amongst both sexes, there was a significant reduction across follow-up. The reduction was 9% (95% CI -16%, -0.9%) in both groups (Table 14) and for the population overall (Table 13). In both groups, weekly admissions appeared to reach pre-pandemic levels in July 2020 and remain at that level for the remainder of the follow-up period (Figure 14).

Table 14: Changes in counts of all-cause hospitalisations in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020 by sex.

Posterior inference	Average number of admissions per week				Cumulative number of admissions over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
Females								
Actual	10,967				307,068			
Prediction	12,047	504	11,043	13,008	337,309	14,116	309,211	364,233
Absolute effect	-1,080	504	-2042	-77	-30,241	14,116	-57,165	-2,143
Relative effect (%)	-9%	4%	-16%	-0.7%	-9%	4%	-16%	-0.7%
Males								
Actual	10,247				286,919			
Prediction	11,274	473	10,342	12,217	315,661	13,243	289,586	342,085
Absolute effect	-1,026	473	-1970	-95	-28742	13,243	-55,166	-2,667
Relative effect (%)	-9%	4%	-16%	-0.9%	-9%	4%	-16%	-0.9%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

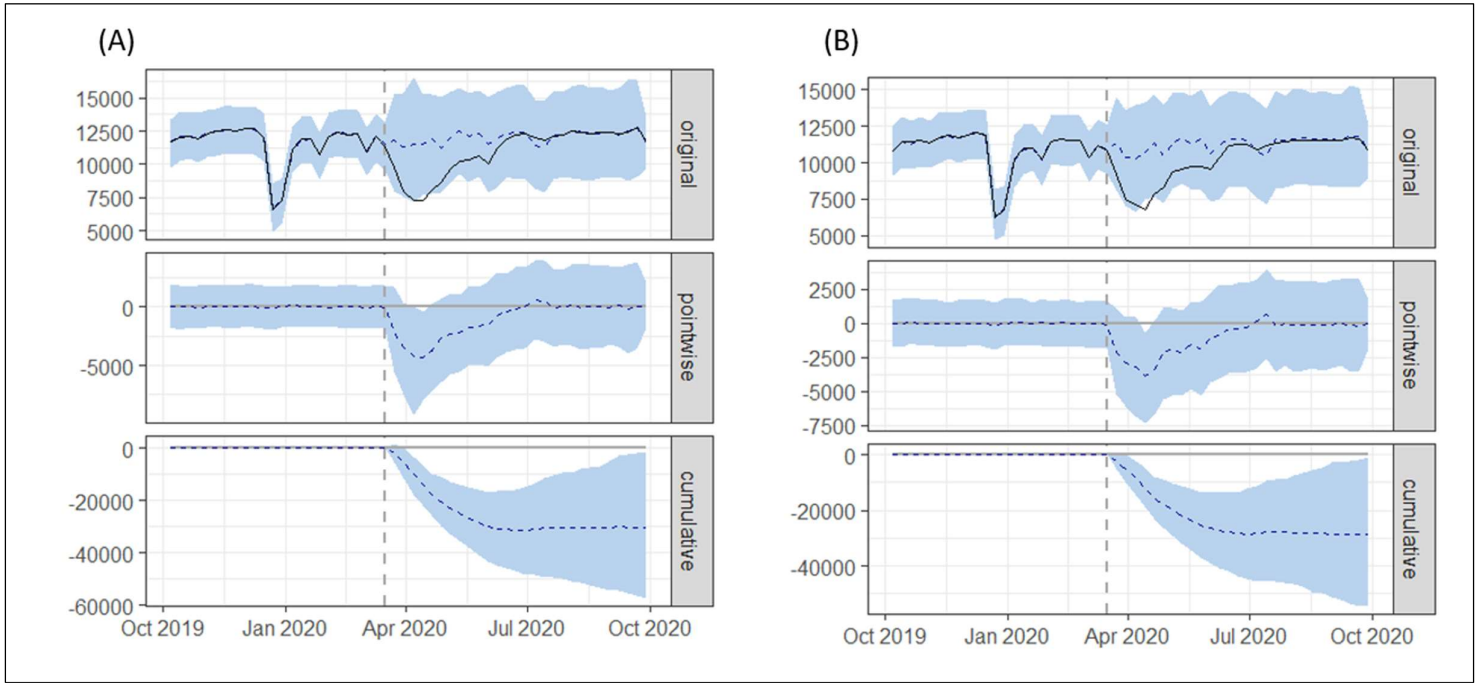

Figure 14: Weekly all-cause hospitalisations in Western Australia among (A) Females, (B) Males.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Socioeconomic status

Changes in weekly hospitalisations during the COVID-19 pandemic did not differ notably according to socioeconomic status. In all groups, an initial reduction in hospitalisations was followed by a return to pre-COVID levels in approximately July 2020 (Figure 15). This reduction was significant in the medium and low SES groups and borderline significant in the high SES group (medium SES 8% reduction, 95%CI -15%, -0.8%; low SES 9% reduction, -15%, -1%; high SES 8% reduction, -17%, 1% (Table 15).

Table 15: Changes in counts of all-cause hospitalisations in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020 by socioeconomic status of patients' residential area.

Posterior inference	Average number of admissions per week				Cumulative number of admissions over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
High SES								
Actual	8,377				234,552			
Prediction	9,155	448	8,295	10,051	256,330	12,542	232,271	281,423
Absolute effect	-778	448	-1,674	81	-21,778	12,542	-46,871	2,281
Relative effect (%)	-8%	5%	-17%	1%	-8%	5%	-17%	1%
Medium SES								
Actual	6,827				191,152			
Prediction	7,463	297	6,885	8,033	208,973	8,313	192,774	224,911
Absolute effect	-636	297	-1,206	-58	-17,821	8,313	-33,759	-1,622
Relative effect (%)	-8%	4%	-15%	-0.8%	-8%	4%	-15%	-0.8%
Low SES								
Actual	5,821				162,985			
Prediction	6,382	241	5,900	6,866	178,703	6,759	165,194	192,253
Absolute effect	-561	241	-1,045	-79	-15718	6,759	-29,268	-2,209
Relative effect (%)	-9%	4%	-15%	-1%	-9%	4%	-15%	-1%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

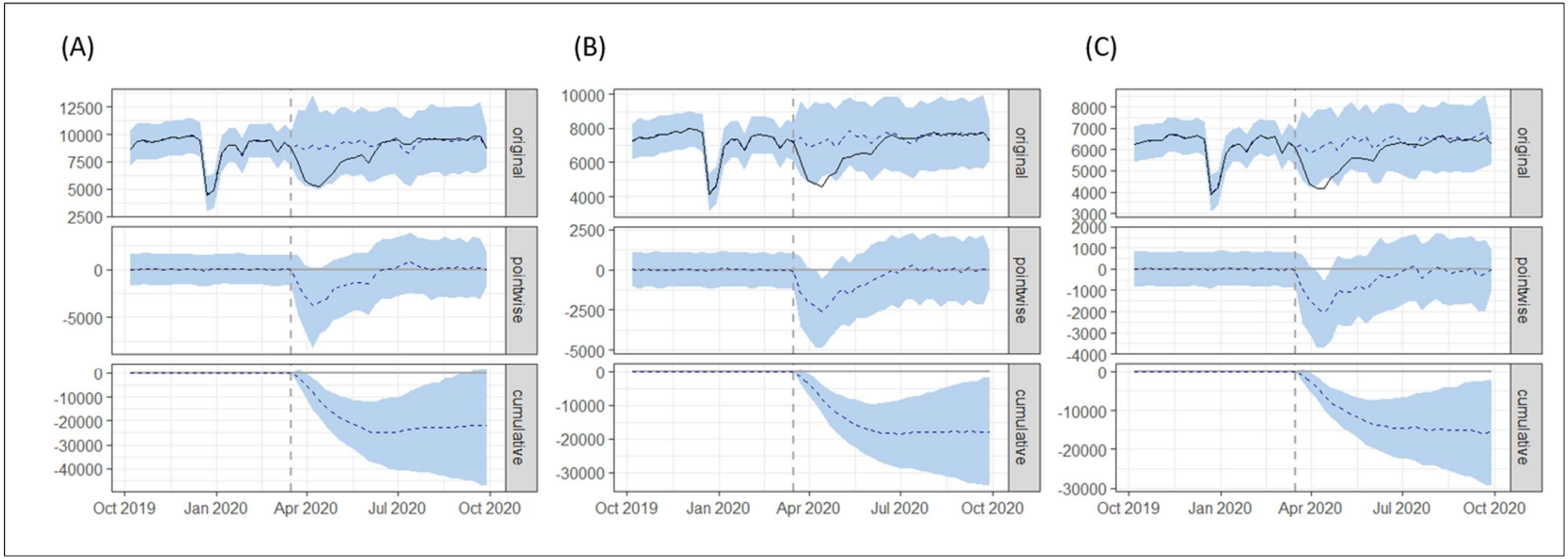

Figure 15: Weekly all-cause hospitalisations in Western Australia among patients in areas of (A) High, (B) Medium, and (C) Low Socioeconomic Status.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Remoteness

Reductions in hospitalisation were very similar for residents of metropolitan and non-metropolitan areas. A statistically significant reduction of 8% (95%CI -16%, -0.1%) was recorded for residents of metropolitan areas, compared to a reduction of 9% (95%CI -15%, -2%) for those in non-metropolitan areas (Table 16). For both groups, hospitalisation counts returned to pre-pandemic levels in approximately July 2020 (Figure 16).

Table 16: Changes in counts of all-cause hospitalisations in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020 by remoteness of patient residence.

Posterior inference	Average number of admissions per week				Cumulative number of admissions over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
Metropolitan								
Actual	15,925				445,904			
Prediction	17,420	767	15,946	18,938	487,752	21,478	446,475	530,260
Absolute effect	-1,495	767	-3,013	-20	-41,848	21,478	-84,356	-571
Relative effect (%)	-8%	4%	-16%	-0.1%	-8%	4%	-16%	-0.1%
Non-Metropolitan								
Actual	4,980				139,449			
Prediction	5,498	205	5,089	5,875	153,931	5,748	142,483	164,513
Absolute effect	-517	205	-895	-108	-14,482	5,748	-25,064	-3,034
Relative effect (%)	-9%	3%	-15%	-2%	-9%	3%	-15%	-2%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

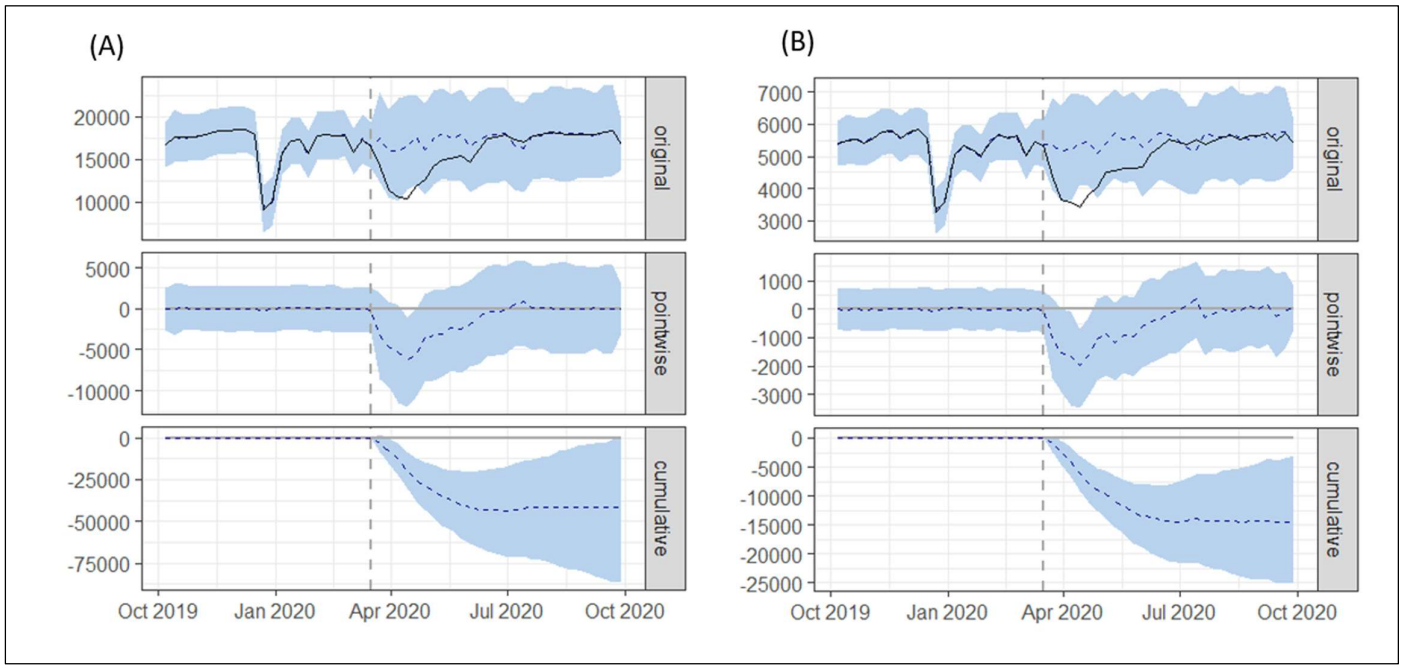

Figure 16: Weekly all-cause hospitalisations in Western Australia among patients residing in (A) Metropolitan and (B) Non-Metropolitan areas.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Age

There were substantial differences between age groups regarding the change in weekly hospitalisations during the pandemic. A larger reduction in hospitalisations was observed in children and adolescents than in any other age group (16% reduction, 95%CI -23%, -8%). In the 19-44 age group the reduction in hospitalisation through the follow-up was slightly smaller and not statistically significant (6% reduction, -14%, 2%). The 65+ age group recorded a statistically significant reduction in admission similar to those recorded overall, while in the 45-64 group there was a non-significant reduction (45-64 group 8% reduction, -15%, 2%; 65+ age group 9% reduction, -16%, -1%) (Table 17). For all age groups, weekly admissions returned to pre-pandemic levels in approximately July 2020 (Figure 17).

Table 17: Changes in counts of all-cause hospitalisations in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020 by age.

Posterior inference	**Average number of admissions per week**				**Cumulative number of admissions over follow up**			
	Count	SD	95% CI		Count	SD	95%CI	
Ages 0-18								
Actual	1,662				46,529			
Prediction	1,976	90	1,803	2,153	55,326	2,525	50,487	60,271
Absolute effect	-314	90	-491	-141	-8,797	2,525	-13,742	-3,958
Relative effect (%)	-16%	4%	-23%	-8%	-16%	4%	-23%	-8%
Ages 19-44								
Actual	4,679				131,005			
Prediction	5,008	209	4,597	5,435	140,234	5,859	128,718	152,189
Absolute effect	-330	209	-757	82	-9,229	5,859	-21,184	2,287
Relative effect (%)	-6%	4%	-14%	2%	-6%	4%	-14%	2%
Ages 45-64								
Actual	6,211				173,907			
Prediction	6,729	299	6,116	7,301	188,405	8,370	171,257	204,420
Absolute effect	-518	299	-1,090	95	-14,498	8,370	-30,513	2,650
Relative effect (%)	-8%	4%	-15%	2%	-8%	4%	-15%	2%
Ages 65+								
Actual	8,662				242,548			
Prediction	9,554	402	8,747	10,339	267,518	11,263	244,909	289,483
Absolute effect	-892	402	-1,676	-84	-24,970	11,263	-46,935	-2,361
Relative effect (%)	-9%	4%	-16%	-1%	-9%	4%	-16%	-1%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

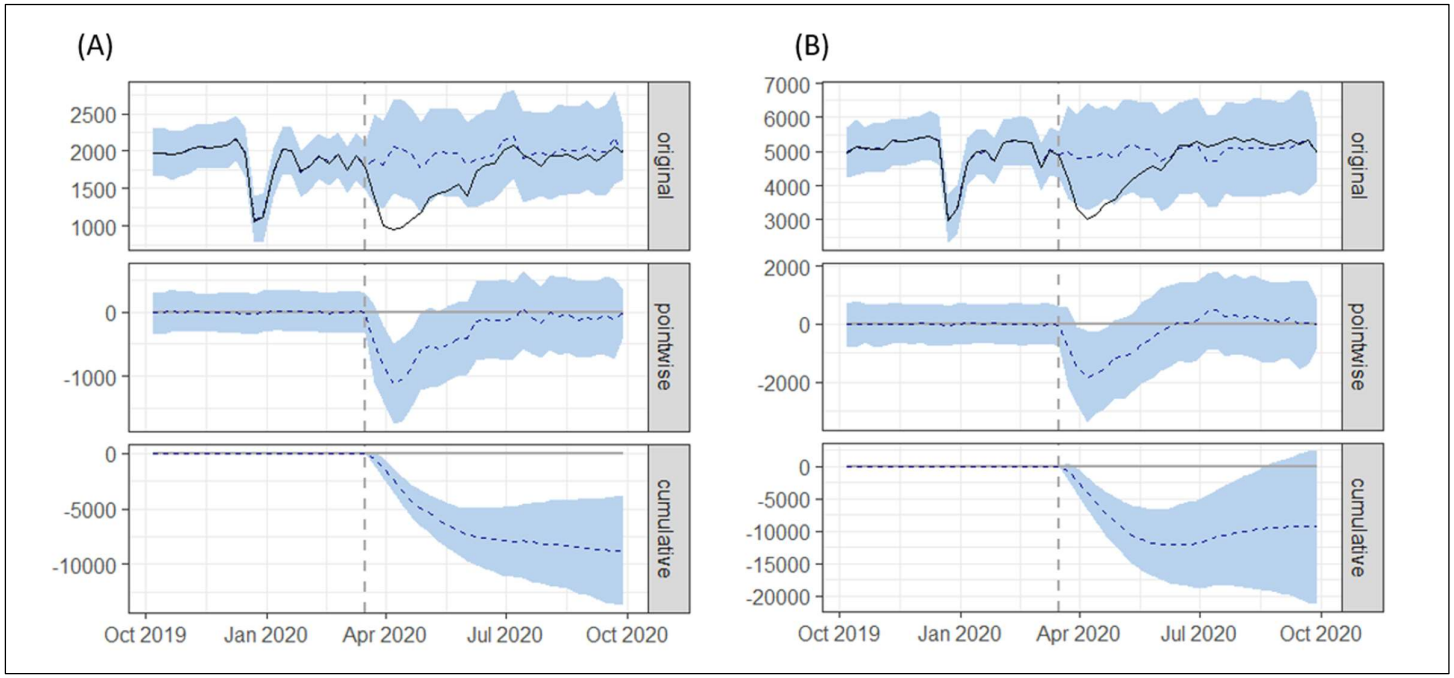

Figure 17: Weekly all-cause hospitalisations in Western Australia among patients aged (A) 0-18, (B) 19-44, (C) 45-64, and (D) 65+.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

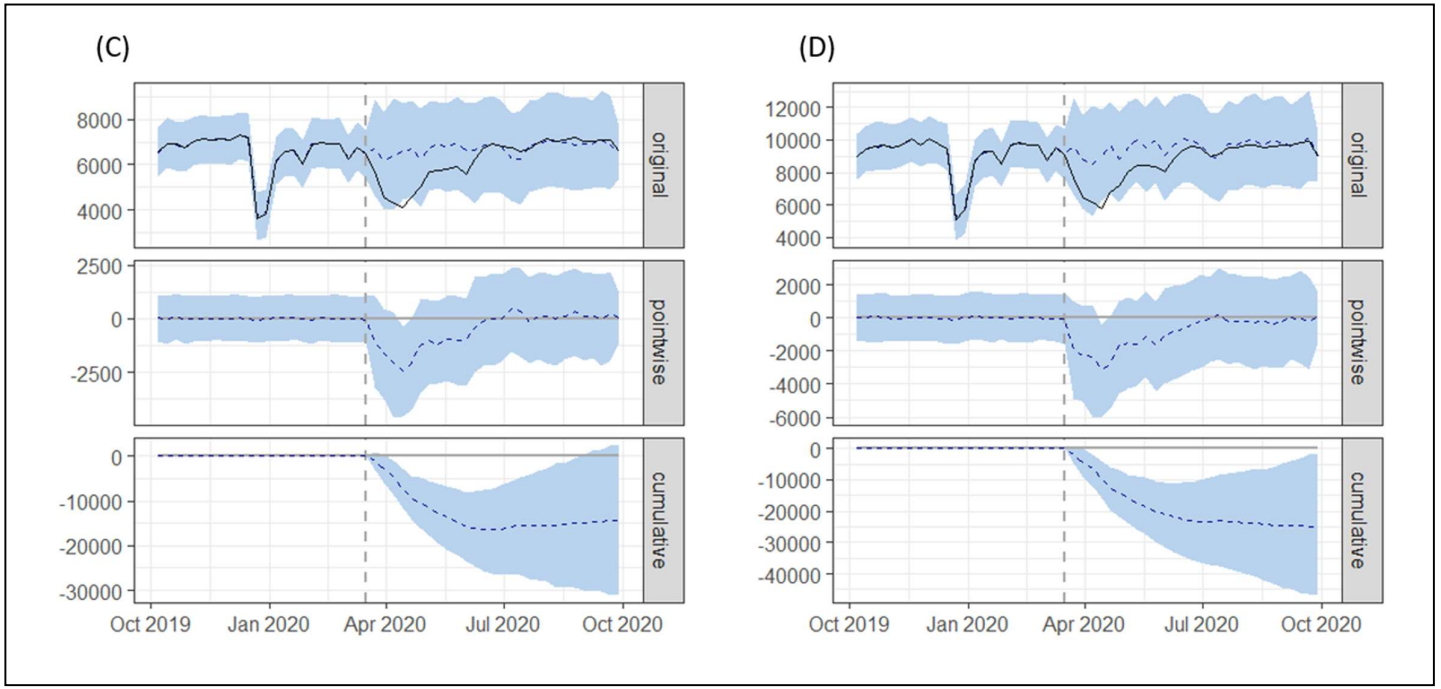

Figure 17 cont.: Weekly all-cause hospitalisations in Western Australia among patients aged (A) 0-18, (B) 19-44, (C) 45-64, and (D) 65+.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Planned procedures

For patients being admitted for chemotherapy and dialysis, there was no significant change in weekly admissions during the COVID-19 pandemic (Table 18). Figure 18 shows a vastly different admission pattern over time for these groups compared to all-cause admissions reported in Figure 13. For dialysis, there was no immediate change in weekly admissions following the introduction of public health measures, and these remained in line with pre-pandemic levels throughout follow-up. For chemotherapy, there was no immediate change in weekly admissions. However, these showed a slight decline towards the end-of follow-up (Figure 18), with a cumulative reduction of just over 1,000 admissions through these 6 months, though this decline was not statistically significant (95% CI -7%, 3%) (Table 18).

Table 18: Changes in counts of hospitalisations in Western Australia for Dialysis and Chemotherapy procedures following the introduction of strict COVID-19 public health measures on 23 March 2020.

Posterior inference	**Average number of admissions per week**				**Cumulative number of admissions over follow up**			
	Count	SD	95% CI		Count	SD	95%CI	
Dialysis								
Actual	3,314				92,800			
Prediction	3,321	34	3,256	3,386	92,981	960	91,166	94,801
Absolute effect	-7	34	-71	58	-181	960	-2,001	1,634
Relative effect (%)	-0.1%	1%	-2%	2%	-0.1%	1%	-2%	2%
Chemotherapy								
Actual	1,741				48,736			
Prediction	1,781	43	1,697	1,863	49,860	1191	47,518	52,163
Absolute effect	-40	43	-122	43	-1,124	1191	-3,427	1,218
Relative effect (%)	-2%	2%	-7%	3%	-2%	2%	-7%	3%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

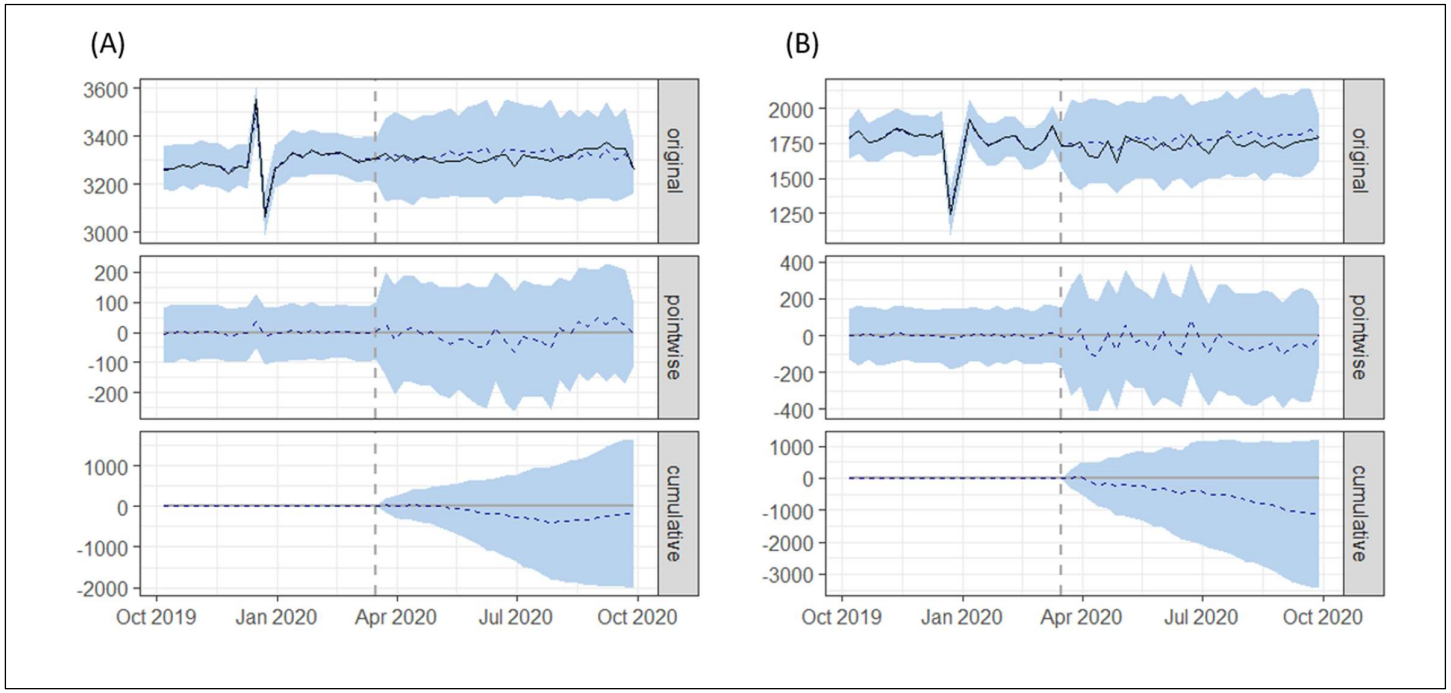

Figure 18: Weekly all-cause hospitalisations in Western Australia among patients admitted for (A) Dialysis and (B) Chemotherapy.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

With and without procedures

When comparing those hospitalisations with and without any associated procedure, there was a substantial difference in how admissions for these groups changed during the pandemic. Those admissions without procedures (which accounted for a small minority of overall admissions) reported a substantially larger weekly reduction of 15% (95%CI -17%, -13%), while those with procedures recorded a non-significant reduction of 8% (-15%, 1%) (Table 19). For admissions with procedures, weekly counts returned to pre-COVID levels in July 2020, as recorded for hospitalisations overall, while admissions without procedures remained below pre-COVID levels throughout the 6-month follow-up (Figure 19).

Table 19: Changes in counts of hospitalisations in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020 among hospitalisations with and without procedures.

Posterior inference	Average number of admissions per week				Cumulative number of admissions over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
Without procedures								
Actual	2,367				66,277			
Prediction	2,784	39	2,708	2,859	77,944	1,090	75,816	80,063
Absolute effect	-417	39	-492	-341	-11,667	1,090	-13,786	-9,539
Relative effect (%)	-15%	1%	-17%	-13%	-15%	1%	-17%	-13%
With procedures								
Actual	18,847				527,712			
Prediction	20,501	935	18,601	22,288	574,024	26,170	520,826	624,052
Absolute effect	-1,654	935	-3,441	246	-46,312	26,170	-96,340	6,886
Relative effect (%)	-8%	4%	-15%	1%	-8%	4%	-15%	1%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

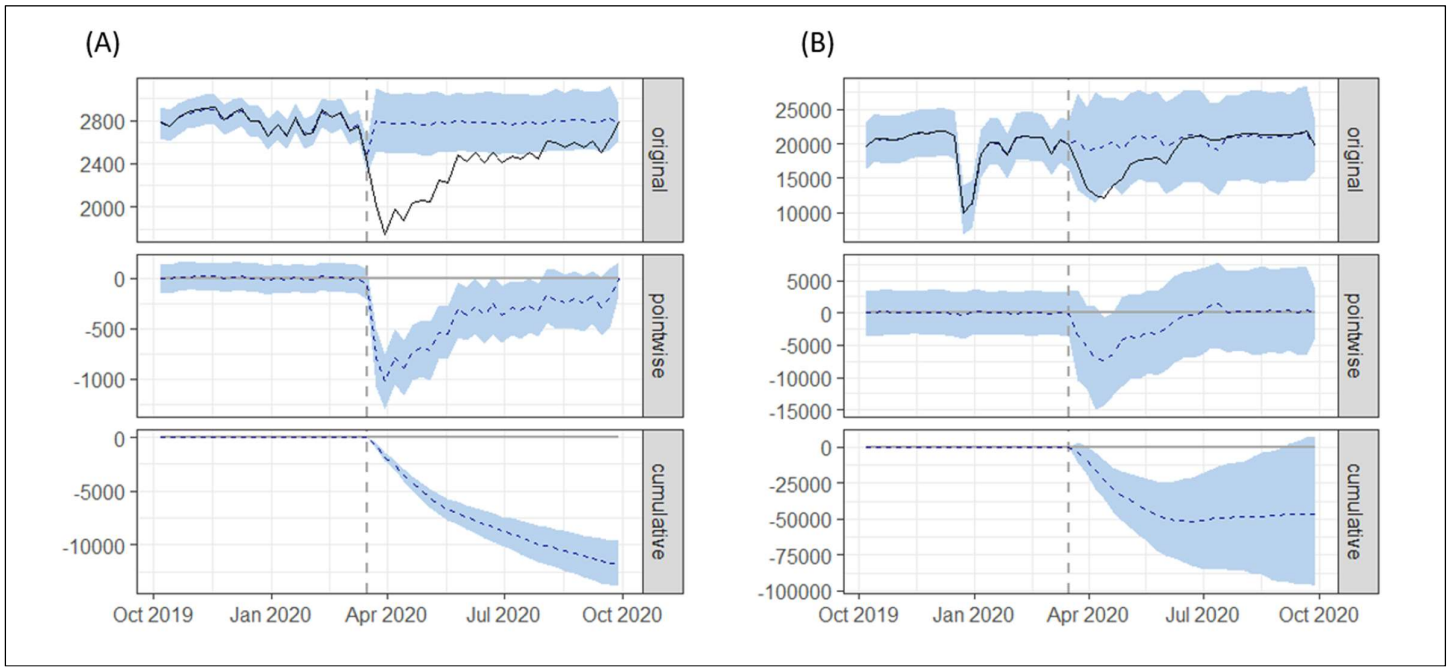

Figure 19: Weekly all-cause hospitalisations in Western Australia among patients, for hospitalisations (A) Without and (B) With procedures.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Major diagnostic categories (ICD chapters)

The pattern of change in weekly admissions during the COVID-19 pandemic differed substantially depending on the condition responsible for the admission (Table 20, Figure 20). For several conditions, the pattern of admissions reflected overall admissions, that is, a significant reduction in admissions through the follow-up period characterised by an initial reduction returning to pre-COVID levels after a few months (i.e. diseases of the circulatory system (Figure 20 panel B); injury, poisoning and other consequences of external causes (panel I); diseases of the eye and adnexa (panel F)). For some conditions, the general pattern was similar to that observed overall but changes were non-significant (which may result from smaller numbers) (i.e. diseases of the digestive system (Figure 20, panel C), endocrine, nutritional and metabolic disorders (panel E); diseases of the genitourinary system (panel G); diseases of the musculoskeletal system and connective tissue (K); diseases of the skin and subcutaneous tissue (Q)). Particularly large decreases were recorded for diseases of the ear and mastoid process (21% reduction, 95%CI -31%, -8%); infectious and parasitic diseases (26% reduction, -30%, -18%); and diseases of the respiratory system (31% reduction, -39%, -21%) (Table 20). Some chapters recorded substantially smaller changes that were non-significant (i.e. diseases of the blood and blood-forming organs; mental and behavioural disorders; neoplasms; diseases of the nervous system; and pregnancy, childbirth and the puerperium; Table 20). The only chapter to record an increase in admission relative to the pre-pandemic period was conditions arising in the perinatal period, which recorded a 4% increase through follow-up (0.2%, 8%) (Table 20).

Table 20: Changes in counts of hospital admissions in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020 by major diagnostic category.

Posterior inference	Average number of admissions per week				Cumulative number of admissions over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
Diseases of the blood and blood-forming organs								
Actual	400				11,198			
Prediction	418	18	382	452	11,710	504	10,710	12,657
Absolute effect	-18	18	-52	17	-512	504	-1,459	488
Relative effect (%)	-4%	4%	-12%	5%	-4%	4%	-12%	5%
Diseases of the circulatory system								
Actual	1,404				39,320			
Prediction	1,508	63	1,378	1,635	42,220	1,768	38,576	45,772
Absolute effect	-104	63	-230	27	-2,900	1,768	-6,452	744
Relative effect (%)	-7%	4%	-14%	2%	-7%	4%	-14%	2%
Diseases of the digestive system								
Actual	3,277				91,747			
Prediction	3,724	239	3,255	4,168	104,280	6,700	91,133	116,696
Absolute effect	-448	239	-891	22	-12,533	6,700	-24,949	614
Relative effect (%)	-12%	6%	-21%	0.7%	-12%	6%	-21%	0.7%
Diseases of the ear and mastoid process								
Actual	788				22,064			
Prediction	997	71	860	1,136	27,924	1,987	24,082	31,819
Absolute effect	-209	71	-348	-72	-5,860	1,987	-9,755	-2,018
Relative effect (%)	-21%	6%	-31%	-8%	-21%	6%	-31%	-8%
Endocrine, nutritional and metabolic diseases								
Actual	551				15,428			
Prediction	599	38	522	675	16,779	1,075	14,615	18,904
Absolute effect	-48	38	-124	29	-1,351	1,075	-3,476	813
Relative effect (%)	-8%	6%	-18%	6%	-8%	6%	-18%	6%
Diseases of the eye and adnexa								
Actual	926				25,918			
Prediction	1,111	96	922	1,290	31,114	2,700	25,825	36,132
Absolute effect	-186	96	-365	3	-5,196	2,700	-10,214	94
Relative effect (%)	-16%	8%	-28%	0.4%	-16%	8%	-28%	0.4%
Diseases of the genitourinary system								
Actual	1,299				36,377			
Prediction	1,460	100	1,254	1,652	40,876	2,795	35,107	46,262
Absolute effect	-161	100	-353	45	-4,499	2,795	-9,885	1,270
Relative effect (%)	-11%	6%	-21%	4%	-11%	6%	-21%	4%
Certain infectious and parasitic diseases								
Actual	319				8,929			
Prediction	431	17	391	458	12,060	464	10,955	12,823
Absolute effect	-112	17	-139	-72	-3,131	464	-3,894	-2,026
Relative effect (%)	-26%	3%	-30%	-18%	-26%	3%	-30%	-18%
Injury, poisoning and certain other consequences of external causes								
Actual	1,434				40,146			

Posterior inference	Average number of admissions per week				Cumulative number of admissions over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
Prediction	1,511	35	1,439	1,580	42,315	976	40,280	44,235
Absolute effect	-77	35	-146	-5	-2,169	976	-4,089	-134
Relative effect (%)	-5%	2%	-9%	-0.3%	-5%	2%	-9%	-0.3%
Mental and behavioural disorders								
Actual	642				17,962			
Prediction	655	21	615	696	18,345	577	17,233	19,478
Absolute effect	-14	21	-54	26	-383	577	-1,516	729
Relative effect (%)	-2%	3%	-8%	4%	-2%	3%	-8%	4%
Diseases of the musculoskeletal system and connective tissue								
Actual	1,963				54,977			
Prediction	2,146	137	1,876	2,419	60,102	3,832	52,531	67,726
Absolute effect	-183	137	-455	87	-5,125	3,832	-12,749	2,446
Relative effect (%)	-8%	6%	-19%	5%	-8%	6%	-19%	5%
Neoplasms								
Actual	3,193				89,410			
Prediction	3,363	145	3,065	3,640	94,156	4,073	85,816	101,906
Absolute effect	-170	145	-446	128	-4,746	4,073	-12,496	3,594
Relative effect (%)	-5%	4%	-12%	4%	-5%	4%	-12%	4%
Diseases of the nervous system								
Actual	1,031				28,865			
Prediction	1,077	56	960	1,184	30,162	1,561	26,887	33,151
Absolute effect	-46	56	-153	71	-1,297	1,561	-4,286	1,978
Relative effect (%)	-4%	5%	-13%	7%	-4%	5%	-13%	7%
Certain conditions originating in the perinatal period								
Actual	373				10,449			
Prediction	360	7	347	372	10,079	181	9,723	10,430
Absolute effect	13	7	0.7	26	370	181	19	726
Relative effect (%)	4%	2%	0.2%	8%	4%	2%	0.2%	8%
Pregnancy, childbirth and the puerperium								
Actual	967				27,087			
Prediction	992	15	961	1,021	27,766	432	26,920	28,582
Absolute effect	-24	15	-53	6	-679	432	-1,495	167
Relative effect (%)	-2%	2%	-5%	0.6%	-2%	2%	-5%	0.6%
Diseases of the respiratory system								
Actual	893				24,998			
Prediction	1,304	81	1,137	1,463	36,504	2,279	31,834	40,978
Absolute effect	-411	81	-571	-244	-11,506	2,279	-15,980	-6,836
Relative effect (%)	-31%	4%	-39%	-21%	-31%	4%	-39%	-21%
Diseases of the skin and subcutaneous tissue								
Actual	961				26,906			
Prediction	1,062	66	927	1,195	29,723	1,845	25,947	33,447
Absolute effect	-101	66	-234	34	-2,817	1,845	-6,541	959
Relative effect (%)	-9%	6%	-20%	4%	-9%	6%	-20%	4%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

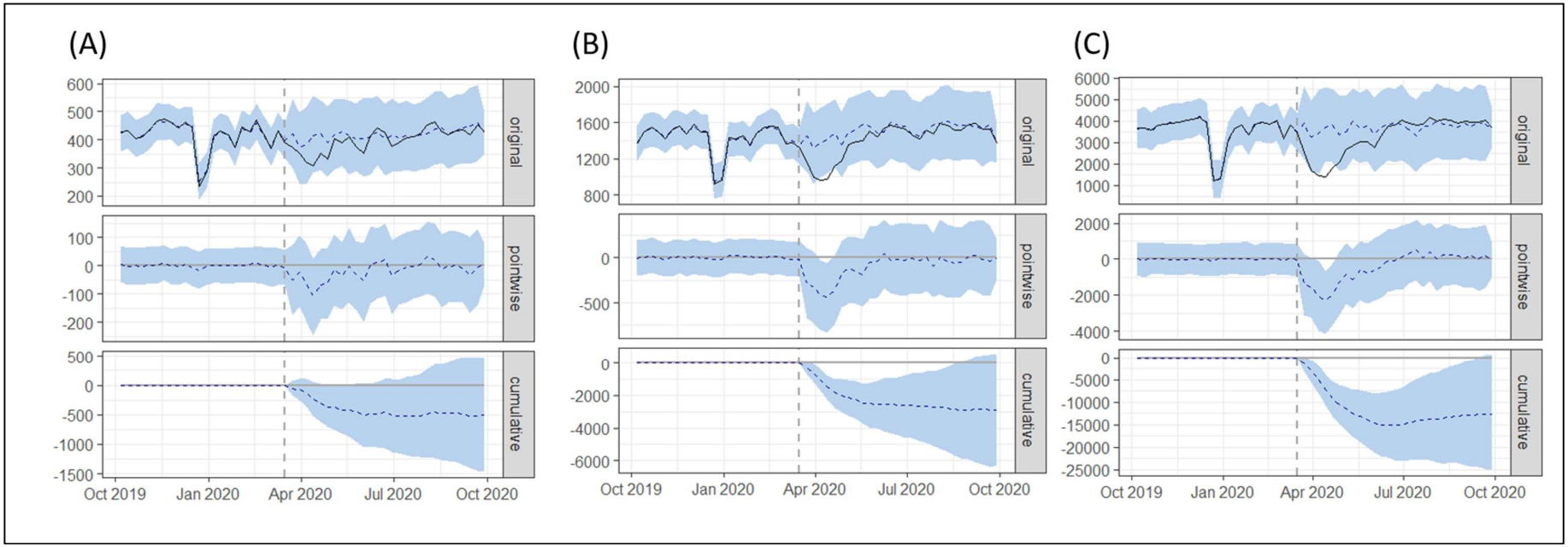

Figure 20: Weekly hospitalisations in Western Australia for (A) Diseases of the blood and blood-forming organs, (B) Diseases of the circulatory system, (C) Diseases of the digestive system, (D) Diseases of the ear and mastoid process, (E) Endocrine, nutritional and metabolic diseases, (F) Diseases of the eye and adnexa, (G) Diseases of the genitourinary system, (H) Infectious and parasitic disorders, (I) Injury, poisoning and certain other consequences of external causes, (J) Mental and behavioural disorders, (K) Diseases of the musculoskeletal system and connective tissue, (L) Neoplasms, (M) Diseases of the nervous system, (N) Certain conditions originating in the perinatal period, (O) Pregnancy, childbirth and the puerperium, (P) Diseases of the respiratory system, and (Q) Diseases of the skin and subcutaneous tissue.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

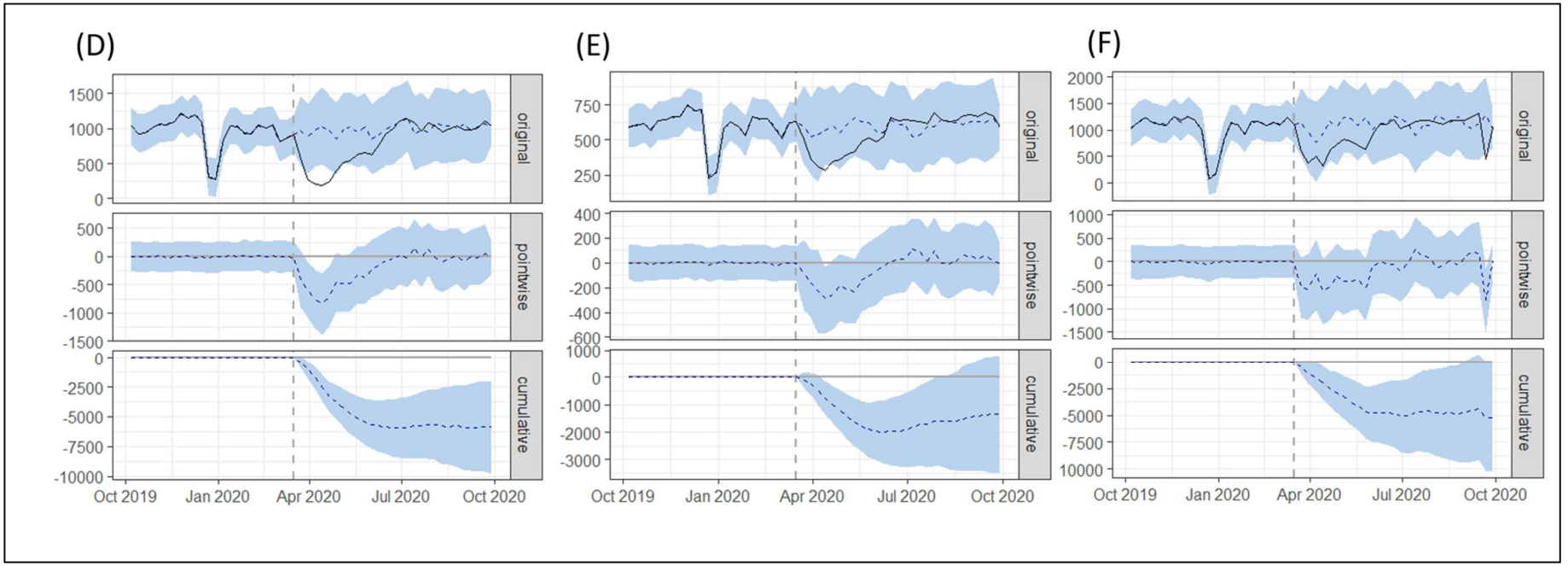

Figure 20 cont.: Weekly hospitalisations in Western Australia among (A) Blood, (B) Circulatory system, (C) Digestive system, (D) Ear, (E) Endocrine system, (F) Eye, (G) Genitourinary system, (H) Infectious and parasitic disorders, (I) Injury and poisoning, (J) Mental, (K) Musculoskeletal disorders, (L) Neoplasms, (M) Nervous system, (N) Perinatal conditions, (O) Pregnancy, (P) Respiratory system, and (Q) Skin disorders.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

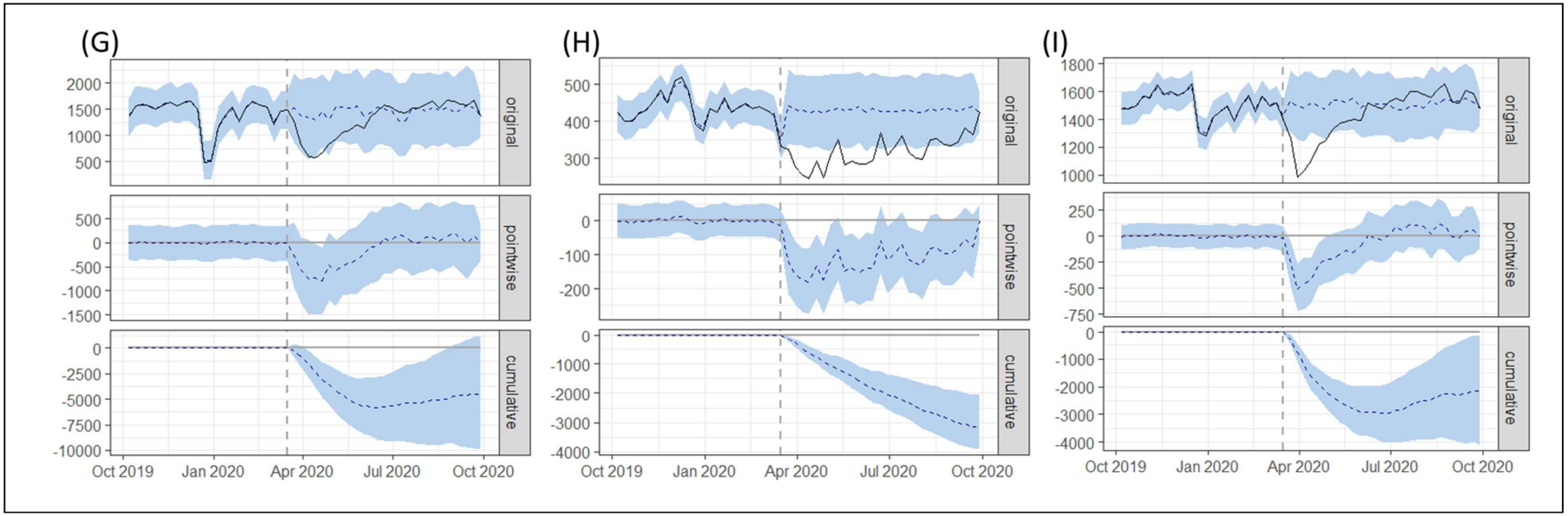

Figure 20 cont.: Weekly hospitalisations in Western Australia among (A) Blood, (B) Circulatory system, (C) Digestive system, (D) Ear, (E) Endocrine system, (F) Eye, (G) Genitourinary system, (H) Infectious and parasitic disorders, (I) Injury and poisoning, (J) Mental, (K) Musculoskeletal disorders, (L) Neoplasms, (M) Nervous system, (N) Perinatal conditions, (O) Pregnancy, (P) Respiratory system, and (Q) Skin disorders.

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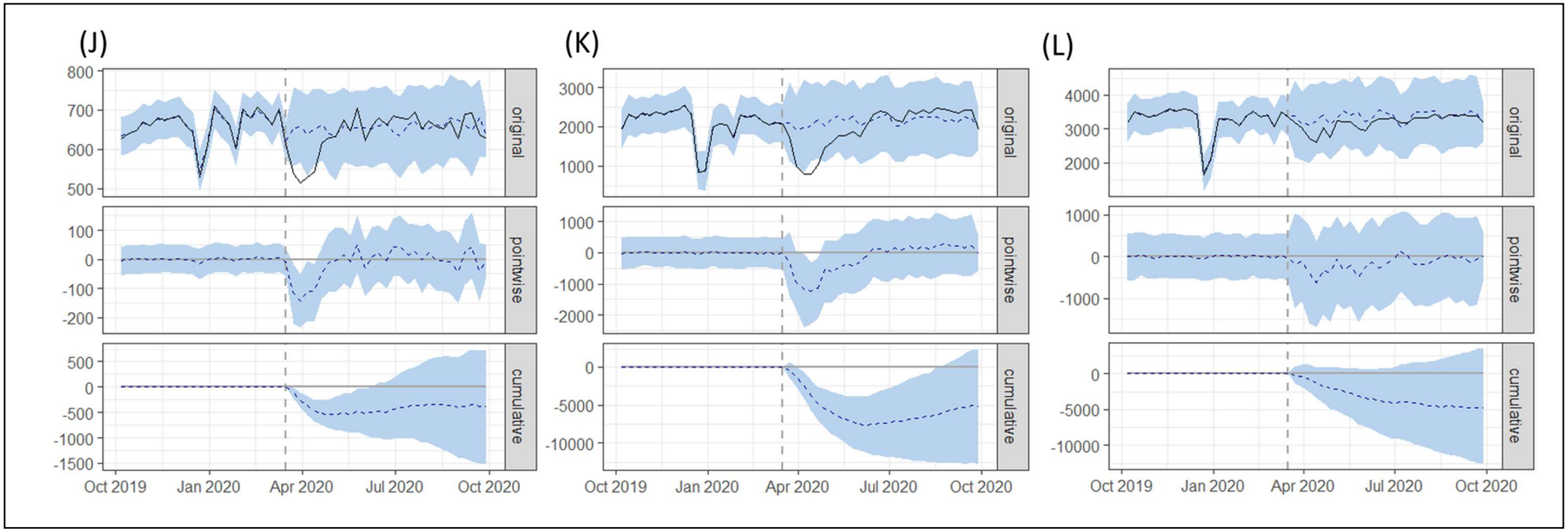

Figure 20 cont.: Weekly hospitalisations in Western Australia among (A) Blood, (B) Circulatory system, (C) Digestive system, (D) Ear, (E) Endocrine system, (F) Eye, (G) Genitourinary system, (H) Infectious and parasitic disorders, (I) Injury and poisoning, (J) Mental, (K) Musculoskeletal disorders, (L) Neoplasms, (M) Nervous system, (N) Perinatal conditions, (O) Pregnancy, (P) Respiratory system, and (Q) Skin disorders.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

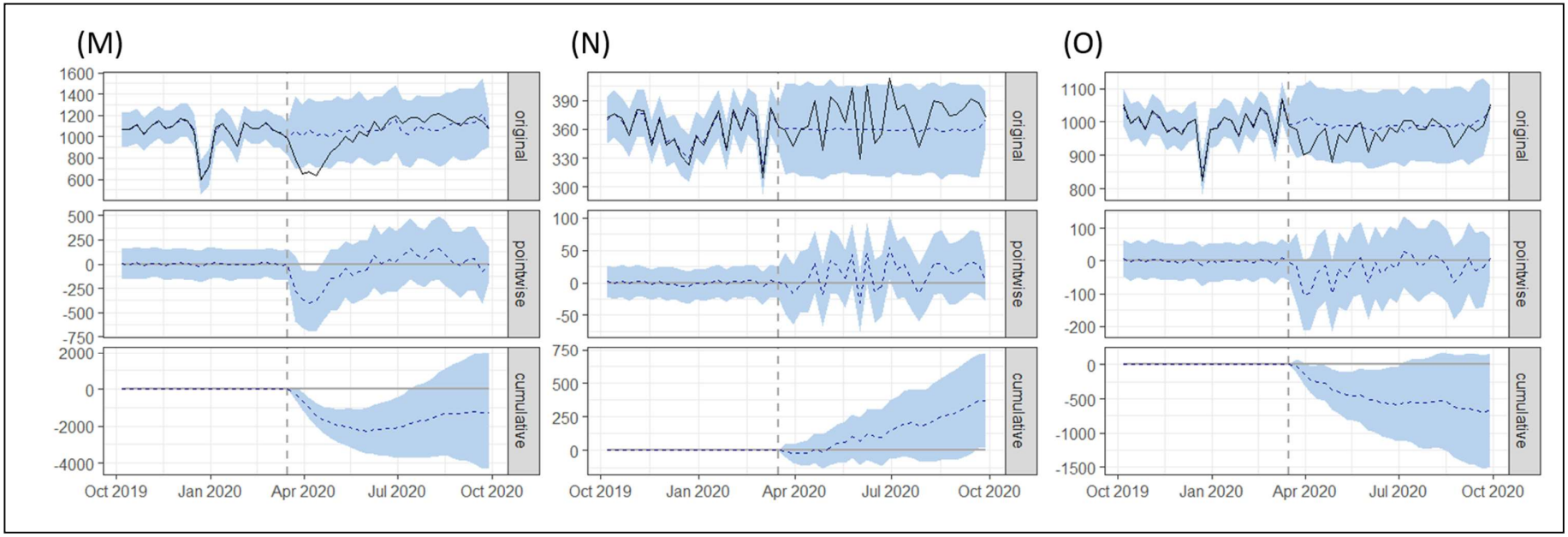

Figure 20 cont.: Weekly hospitalisations in Western Australia among (A) Blood, (B) Circulatory system, (C) Digestive system, (D) Ear, (E) Endocrine system, (F) Eye, (G) Genitourinary system, (H) Infectious and parasitic disorders, (I) Injury and poisoning, (J) Mental, (K) Musculoskeletal disorders, (L) Neoplasms, (M) Nervous system, (N) Perinatal conditions, (O) Pregnancy, (P) Respiratory system, and (Q) Skin disorders.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

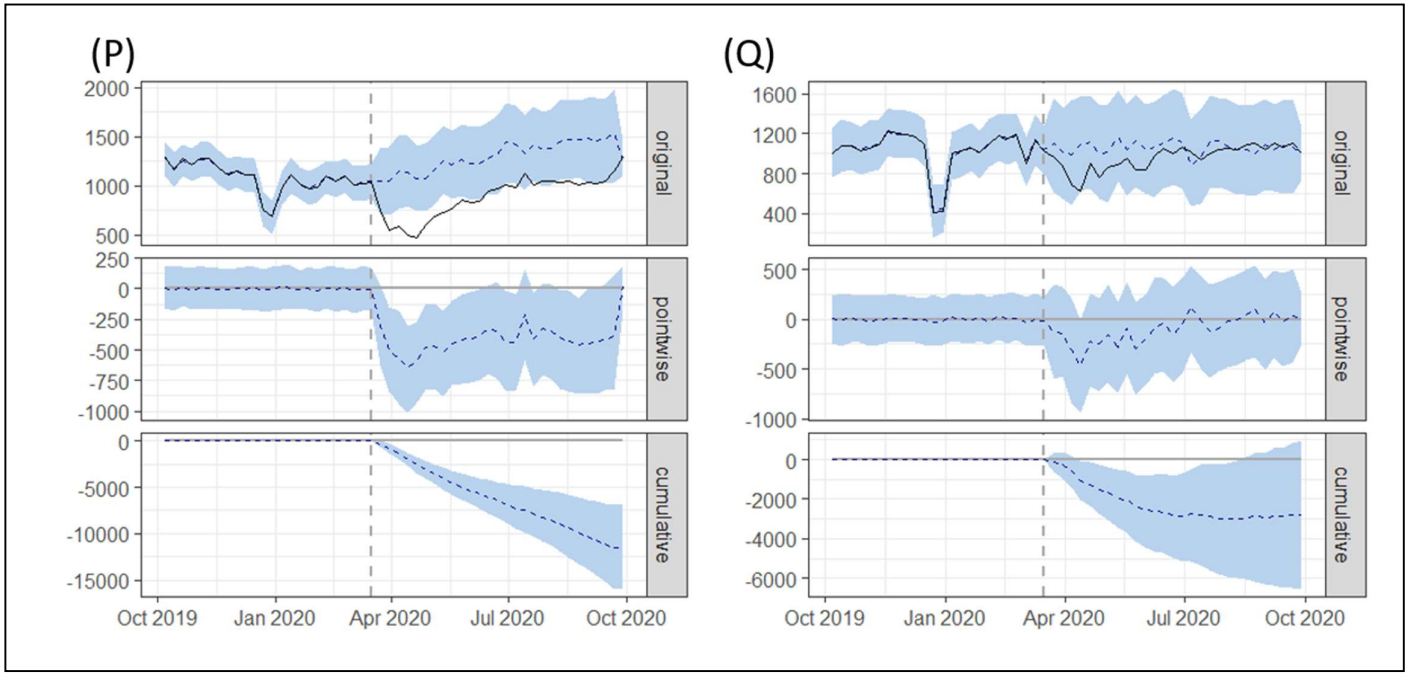

Figure 20 cont.: Weekly hospitalisations in Western Australia among (A) Blood, (B) Circulatory system, (C) Digestive system, (D) Ear, (E) Endocrine system, (F) Eye, (G) Genitourinary system, (H) Infectious and parasitic disorders, (I) Injury and poisoning, (J) Mental, (K) Musculoskeletal disorders, (L) Neoplasms, (M) Nervous system, (N) Perinatal conditions, (O) Pregnancy, (P) Respiratory system, and (Q) Skin disorders.

Footnote: Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the weekly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Overall length of stay during hospitalisations

The average LOS for hospitalisations admitted during the COVID-19 pandemic reported a small, non-significant increase (1% increase, 95%CI -3%, 6%) relative to pre-pandemic levels (Table 21). From June 2020, the LOS appeared to reflect the pre-COVID LOS (Figure 21).

Table 21: Changes in the average length of stay during hospitalisation in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020.

Posterior inference	**Average length of stay of hospitalisations**			
	Count (days)	SD	95% CI	
Actual	2			
Prediction	2	0.1	2	2
Absolute effect	0.0	0.1	-0.1	0.2
Relative effect (%)	1%	2%	-3%	6%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

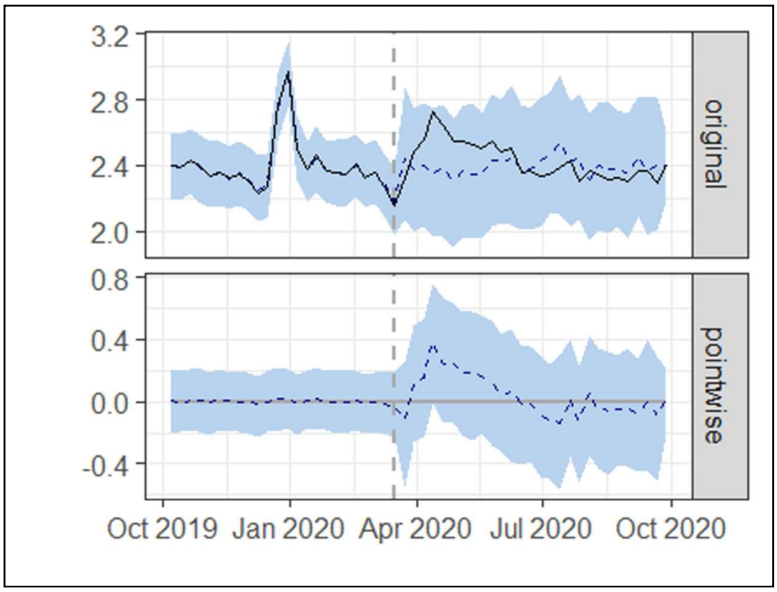

Figure 21: Weekly average length of stay during hospitalisations in Western Australia.

Footnote: Top panel displays average length of stay of hospitalisations admitted each week from October 2019 to end September 2020 (solid line) and the expected ALOS based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Lower panel displays the weekly difference between observed and expected ALOS. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Average cost per hospitalisation

Based on the diagnostic-related group allocated to the hospitalisation, the average cost per hospitalisation stayed the same after COVID-19 public health measures were introduced. However, through the latter half of the 6-month follow-up period, the average hospitalisation cost increased relative to expected levels (Figure 22). Across the entire follow-up, the average cost per hospitalisation was $158 above pre-pandemic levels, translating to a 3% increase (95%CI 1%, 7%) (Table 22).

Table 22: Changes in the average cost per hospitalisation in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020.

Posterior inference	**Average cost per hospitalisation**			
	Count ($)	SD	95% CI	
Actual	5,069			
Prediction	4,911	73	4,758	5,029
Absolute effect	158	73	40	311
Relative effect (%)	3%	2%	0.8%	7%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

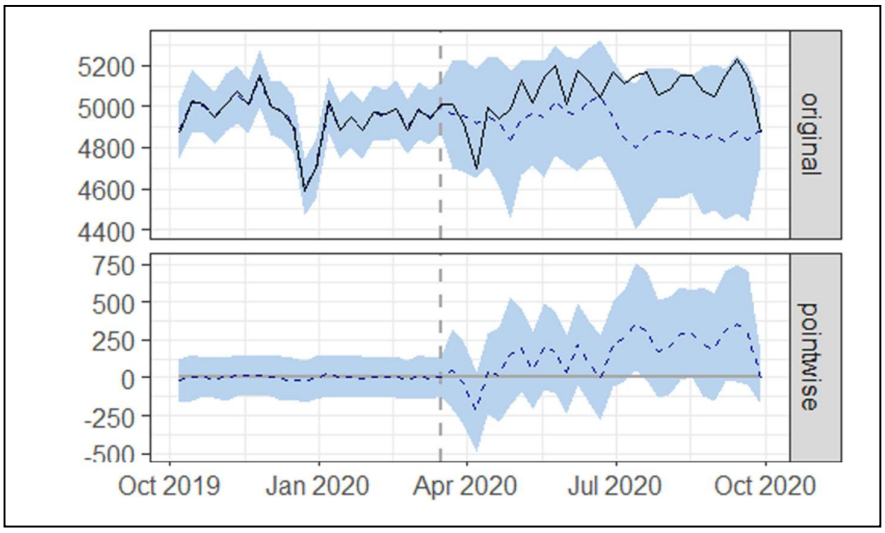

Figure 22: Average cost of hospitalisations in Western Australia, per week.

Footnote: Top panel displays average cost per hospitalisation for each week from October 2019 to end September 2020 (solid line) and the expected average cost based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Lower panel displays the weekly difference between observed and expected costs. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Section summary

The overall pattern of hospital admissions following the introduction of COVID-19 control measures in March 2020 was an immediate reduction, followed by a relatively quick recovery to pre-pandemic levels in July 2020. This was relatively soon after the relaxation of most public health measures, apart from some social distancing measures and border controls, at the end of June 2020. Through the six-month follow-up, hospitalisations did not reduce to the same extent as emergency department presentations.

There were no notable differences in the effect of the pandemic between males and females, by remote/non-remote residence, or by the socioeconomic status of patients' residential area. There were differences between age groups, as there were for emergency department presentations, with those aged 0-18 having a greater reduction than other age groups and those aged 19-44 and 45-64 having smaller reductions with borderline statistical significance.

For hospitalisations without procedures, there was a substantially greater reduction than observed for hospitalisations with procedures. The reduction in admissions with procedures had borderline statistical significance. Admissions for dialysis and chemotherapy each showed almost no change through the follow-up period; these were some of the only admission types that did not record an immediate drop following the introduction of COVID-19 control measures. These admissions result from conditions that likely developed prior to the pandemic in most cases and cannot be delayed, which likely explains the lack of effect for these admissions.

There were substantial differences in the response to the COVID-19 pandemic between broad diagnostic categories. For several diagnostic categories, the pattern of changes in admission during the follow-up period reflected the pattern for overall hospitalisations. In some cases, reductions were not statistically significant due to the reduced sample size when analysing a single condition. There were substantially larger reductions in admissions for infectious and parasitic diseases and for diseases of the ear and mastoid process (as was the case for emergency department presentations). At the same time, diseases of the respiratory system also had a larger reduction than overall hospitalisations. The reduction in admissions for respiratory conditions and infectious and other parasitic conditions likely results from the decrease in infection rates for influenza and other transmissible conditions due to COVID-19 control measures. Other categories showed minimal changes in hospital admission during the pandemic, including neoplasms (as observed for emergency department presentations), pregnancy, childbirth and the puerperium, and mental and behavioural disorders. Many conditions across these categories would have arisen before the pandemic, hence the limited potential for the pandemic to influence admissions in these cases. Admissions for conditions arising in the perinatal period increased during follow-up; these were among the few conditions without a notable reduction in emergency department presentations.

The characteristics of those episodes admitted did not appear to change dramatically during follow-up. The average LOS (which may reflect the severity of admitted episodes or changes to discharge procedures) had an initially small, non-significant increase, which returned to pre-pandemic levels by June 2020. The average cost per hospitalisation (derived from the diagnostic related group allocated to each episode, also reflective of severity) had a statistically significant increase, though this increase was only 3%. This suggests that the complexity of admissions during the pandemic, or the resources required to manage these admissions, differed only slightly from expected levels based on the pre-pandemic period.

Cancer

Overall

Following the introduction of COVID-19 public health measures in Western Australia, there was no significant change in the number of new cancers diagnosed (Figure 23). There was a slight decline in new diagnoses, which persisted through the follow-up period, though this did not reach statistical significance at any point (Table 23, Figure 23).

Table 23: Changes in counts of cancer diagnoses in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020.

Posterior inference	Average number of diagnoses per month				Cumulative number of diagnoses over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
Actual	1,034				6,203			
Prediction	1,195	134	947	1,491	7,172	802	5,683	8,948
Absolute effect	-161	134	-458	87	-969	802	-2,745	520
Relative effect (%)	-12%	10%	-31%	9%	-12%	10%	-31%	9%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

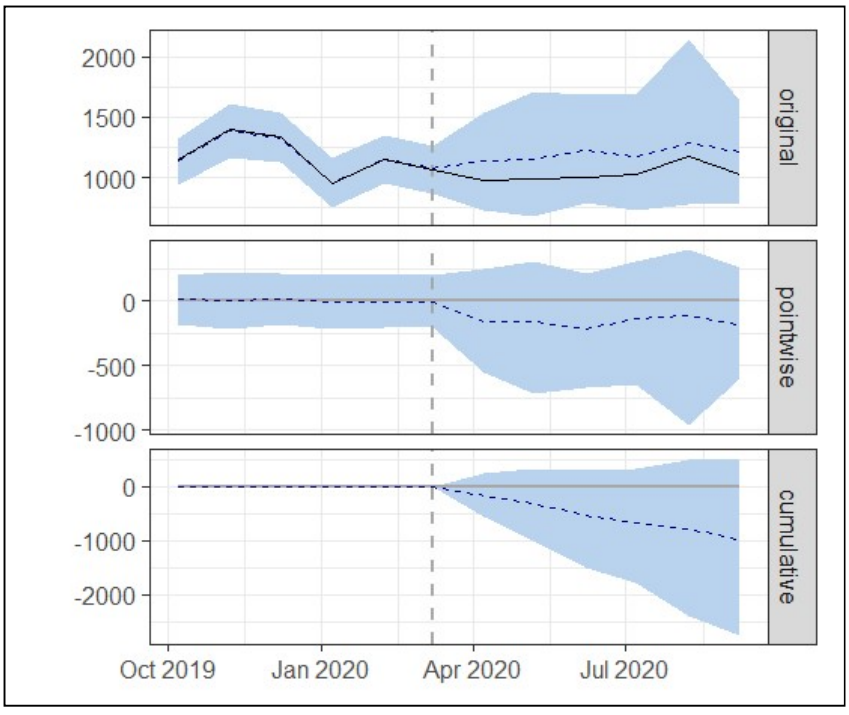

Figure 23: Monthly diagnoses of new cancers in Western Australia.

Footnote: Top panel displays monthly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Sex

Although the diagnoses of new cancers did not change during the COVID-19 pandemic for the population overall, there was a statistically significant decline in new cancer diagnoses among females. Among females, there was a 15% reduction in diagnoses (95%CI -29%, 0.4%) compared to a reduction of 9% (-26%, 16%) in males (Table 24). This decline was consistent throughout the 6-month follow-up period (Figure 24).

Table 24: Changes in diagnoses of new cancers in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020, by sex.

Posterior inference	Average number of diagnoses per month				Cumulative number of services over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
Females								
Actual	444				2,663			
Prediction	527	48	442	629	3,161	285	2,652	3,775
Absolute effect	-83	48	-185	2	-498	285	-1,112	11
Relative effect (%)	-15%	8%	-29%	0.4%	-15%	8%	-29%	0.4%
Males								
Actual	588				3,528			
Prediction	654	77	505	793	3,922	459	3,032	4,755
Absolute effect	-66	77	-205	83	-394	459	-1,227	496
Relative effect (%)	-9%	11%	-26%	16%	-9%	11%	-26%	16%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

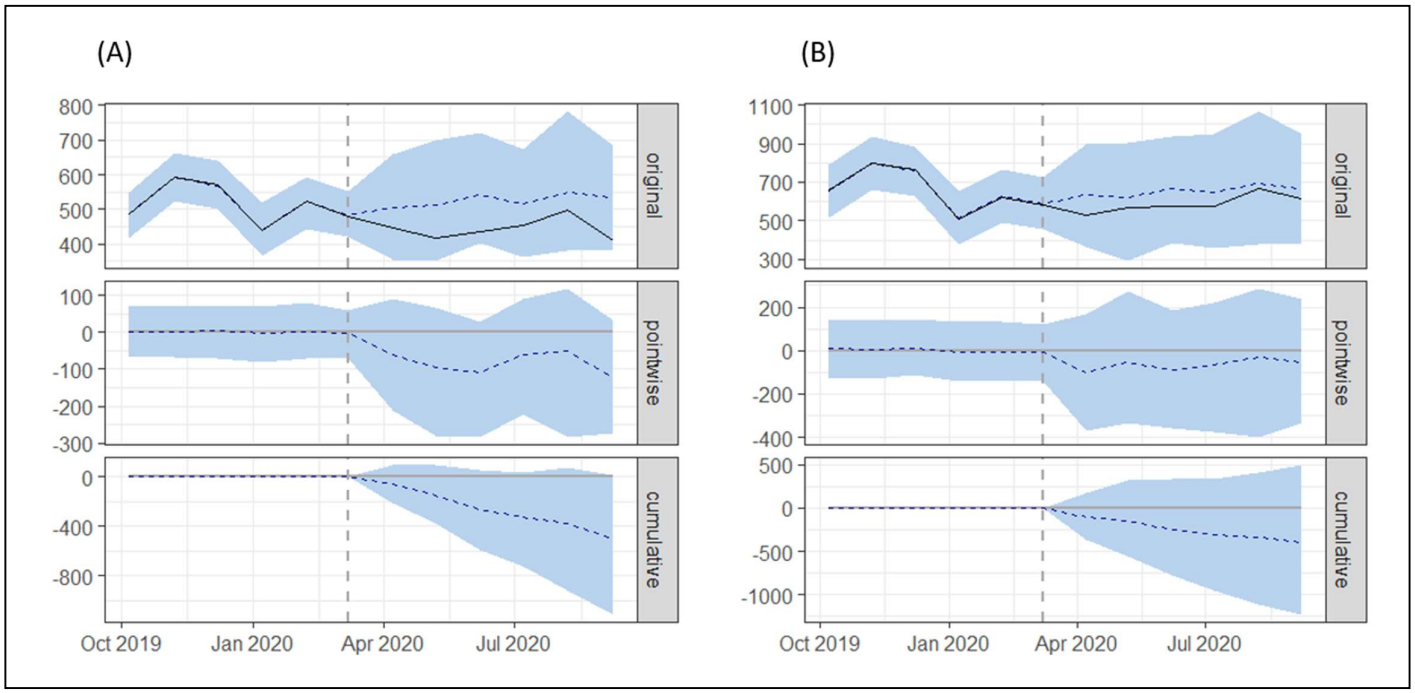

Figure 24: Monthly cancer diagnoses in Western Australia among (A) Females and (B) Males.

Footnote: Top panel displays monthly counts of cancer diagnoses observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Socioeconomic status

As was the case for the population overall, there was no significant change in new cancer diagnoses during the COVID-19 pandemic for people living in high, medium or low SES areas. For each of these groups, there was a slight decline in new cancer diagnoses following the introduction of public health measures, and these declines generally persisted through the follow-up period (Figure 25); however, these were not statistically significant in any case (Table 25).

Table 25: Changes in diagnoses of new cancers in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020, by socioeconomic status of patients' residential area.

Posterior inference	Average number of diagnoses per month				Cumulative number of services over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
High SES								
Actual	450				2,701			
Prediction	520	63	403	649	3,120	377	2,419	3,895
Absolute effect	-70	63	-199	47	-419	377	-1,194	282
Relative effect (%)	-12%	11%	-31%	12%	-12%	11%	-31%	12%
Medium SES								
Actual	298				1,785			
Prediction	323	36	253	395	1,937	216	1,518	2,372
Absolute effect	-25	36	-98	44	-152	216	-587	267
Relative effect (%)	-7%	11%	-25%	18%	-7%	11%	-25%	18%
Low SES								
Actual	286				1,716			
Prediction	328	37	256	401	1,970	223	1,533	2,405
Absolute effect	-42	37	-115	30	-254	223	-689	183
Relative effect (%)	-12%	11%	-29%	12%	-12%	11%	-29%	12%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

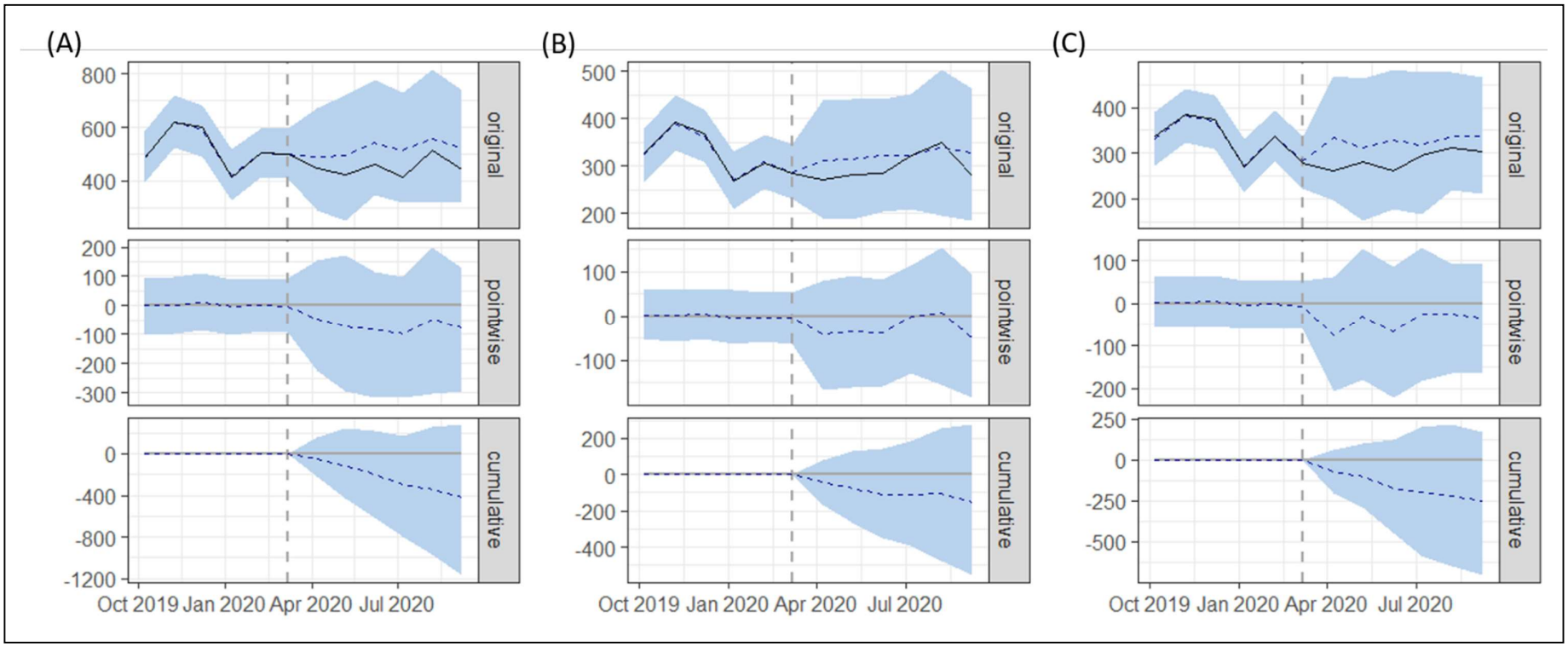

Figure 25: Monthly cancer diagnoses in Western Australia among residents of (A) High, (B) Medium, and (C) Low socioeconomic status areas.

Footnote: Top panel displays monthly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Age

Similarly, cancer diagnoses did not change throughout the COVID-19 pandemic for any age group (Figure 26, Table 26). There were some differences in the general patterns between age groups. The group aged 19-44 had a 2% increase in cancer diagnoses (95%CI -20%, 31%), while the 45-64 group recorded a 10% reduction (-27%, 15%) and the 65+ group a 13% reduction (-28%, 7%) though the differences between groups were not significant (Table 26).

Table 26: Changes in diagnoses of new cancers in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020, by age group.

Posterior inference	Average number of diagnoses per month				Cumulative number of services over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
Ages 19-44								
Actual	84				507			
Prediction	84	11	65	106	507	63	388	634
Absolute effect	0.0	11	-21	20	0.0	63	-127	119
Relative effect (%)	2%	14%	-20%	31%	2%	14%	-20%	31%
Ages 45-64								
Actual	352				2,109			
Prediction	396	46	307	481	2,376	275	1,841	2,886
Absolute effect	-45	46	-130	45	-267	275	-777	268
Relative effect (%)	-10%	11%	-27%	15%	-10%	11%	-27%	15%
Ages 65+								
Actual	590				3,542			
Prediction	684	71	552	820	4,106	423	3,313	4,923
Absolute effect	-94	71	-230	38	-564	423	-1,381	229
Relative effect (%)	-13%	9%	-28%	7%	-13%	9%	-28%	7%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval. Note the 0-18 age group was not included as low numbers prevented meaningful analysis.

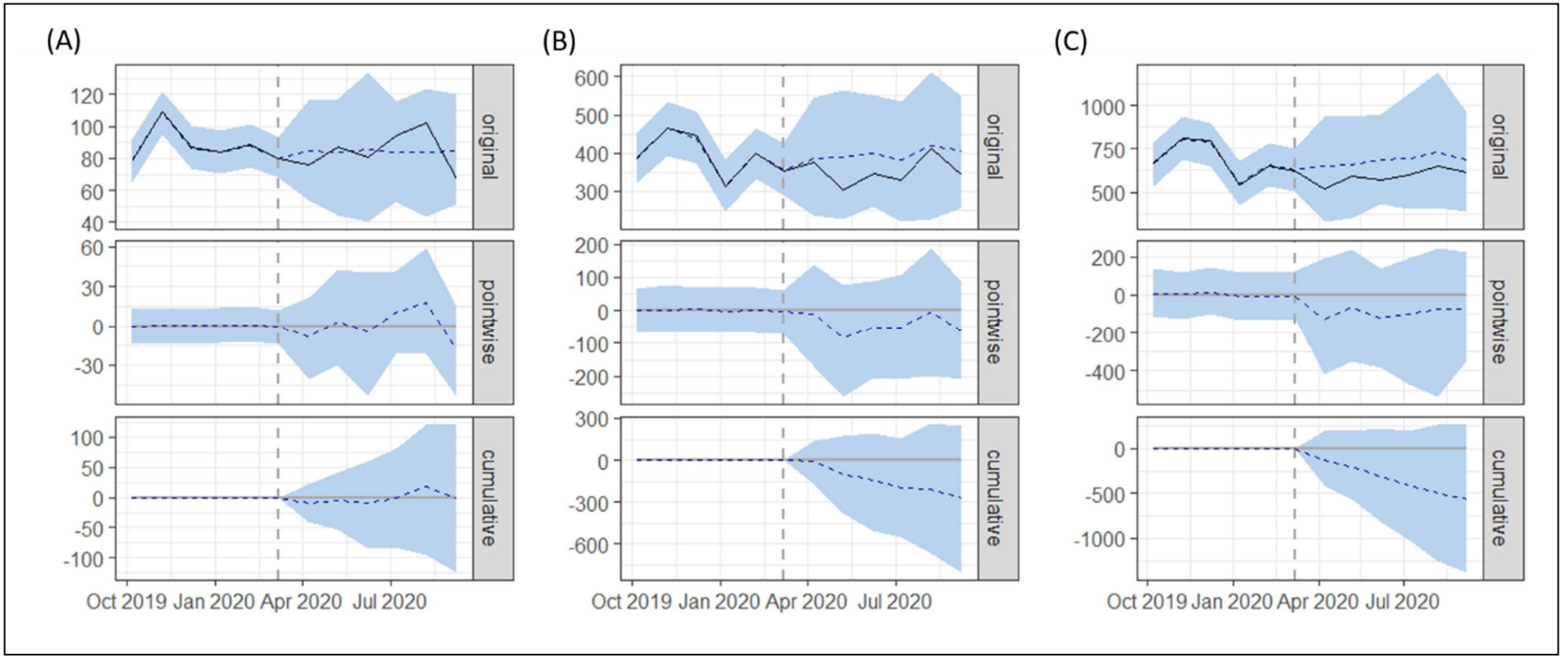

Figure 26: Monthly cancer diagnoses in Western Australia among patients aged (A) 19-44, (B) 45-64, and (C) 65+.

Footnote: Top panel displays monthly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020. Note that the 0-18 group is omitted due to low numbers.

Remoteness

Changes in cancer diagnoses during the COVID-19 pandemic were non-significant for residents of metropolitan and non-metropolitan areas. However, both groups showed a general decline in new diagnoses through follow-up (Figure 27). Residents of metropolitan areas showed an overall decline in new diagnoses of 10% (95%CI -26%, 9%), while for non-metropolitan residents, there was a decline of 15% (-30%, 6%) (Table 27).

Table 27: Changes in diagnoses of new cancers in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020 by, remoteness of patient residence.

Posterior inference	Average number of diagnoses per month				Cumulative number of services over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
Metropolitan areas								
Actual	798				4,791			
Prediction	899	93	731	1080	5,391	557	4,386	6,483
Absolute effect	-100	93	-282	67	-600	557	-1,692	405
Relative effect (%)	-10%	9%	-26%	9%	-10%	9%	-26%	9%
Non-metropolitan areas								
Actual	235				1,412			
Prediction	278	30	222	337	1,671	182	1,329	2,025
Absolute effect	-43	30	-102	14	-259	182	-613	83
Relative effect (%)	-15%	10%	-30%	6%	-15%	10%	-30%	6%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

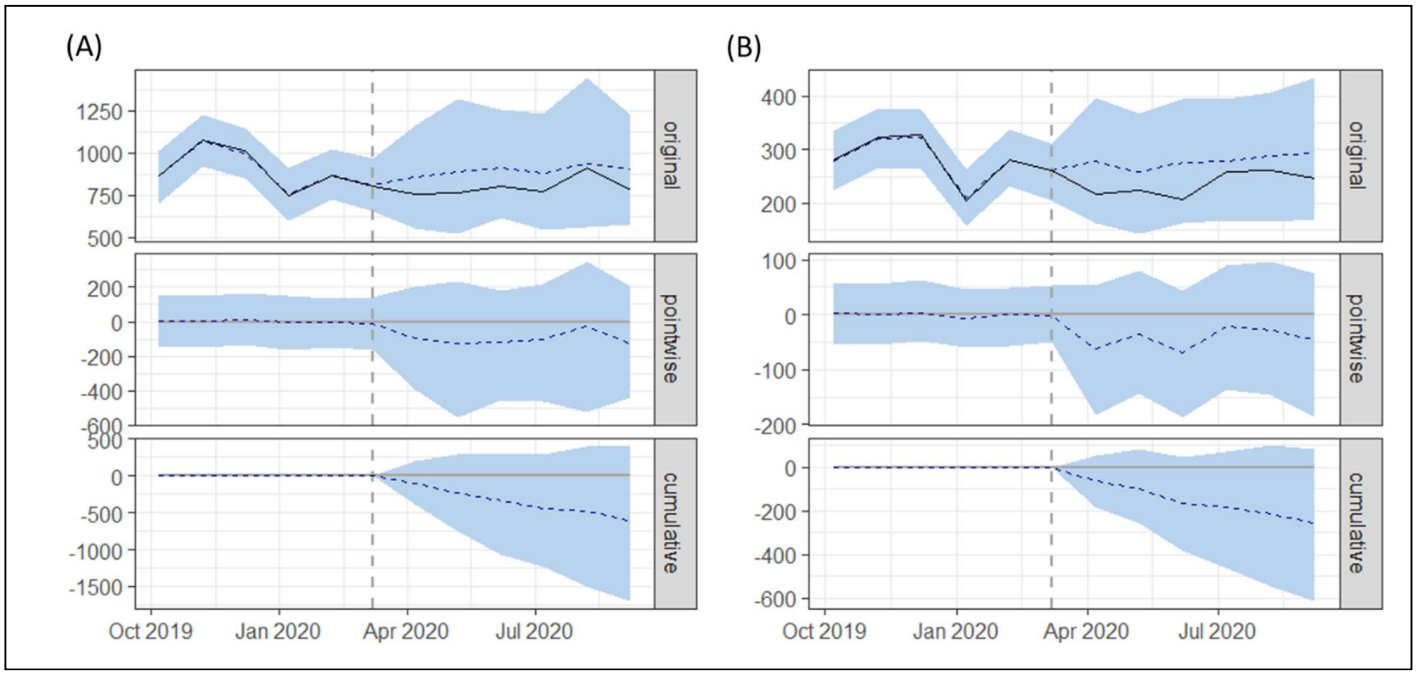

Figure 27: Monthly cancer diagnoses in Western Australia among patients living in (A) Metropolitan and (B) Non-Metropolitan areas.

Footnote: Top panel displays monthly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Cancer type

Amongst the five most common cancer types in Australia, there were substantial differences between cancer types in new diagnoses during the COVID-19 pandemic (Figure 28). Prostate cancer showed no change relative to expected levels (0.3% increase, 95%CI -30%, 52%) while melanoma and colorectal cancers showed moderate non-significant declines (melanoma 16% reduction, -41%, 37%; colorectal 5% reduction, -34%, 58%) (Table 28). Breast and lung cancers showed the most substantial differences, recording significant reductions in new cancer diagnoses. There was a reduction in breast cancer diagnoses of 12% (-21%, -2%) and in lung cancer of 23% (-39%, -2%) (Table 28). Breast cancer diagnoses declined to their minimum level in the two or three months following the introduction of COVID-19 control measures and did not fully return to pre-pandemic levels by the end of follow-up (Figure 28 Panel A), while lung cancer diagnoses showed no immediate decline, but instead recorded a steady reduction throughout the 6-months follow-up (Panel E).

Table 28: Changes in counts of new cancer diagnoses in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020 for the 5 most common cancer types.

Posterior inference	Average number of diagnoses per month				Cumulative number of services over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
Breast								
Actual	142				852			
Prediction	162	9	144	179	975	52	866	1,074
Absolute effect	-20	9	-37	-2	-123	52	-222	-14
Relative effect (%)	-12%	5%	-21%	-2%	-12%	5%	-21%	-2%
Prostate								
Actual	199				1,195			
Prediction	206	40	131	286	1,238	239	788	1,713
Absolute effect	-7	40	-86	68	-43	239	-518	407
Relative effect (%)	0.3%	22%	-30%	52%	0.3%	22%	-30%	52%
Melanoma								
Actual	106				636			
Prediction	132	25	77	181	789	152	464	1,087
Absolute effect	-26	25	-75	29	-153	152	-451	172
Relative effect (%)	-16%	22%	-41%	37%	-16%	22%	-41%	37%
Colorectal								
Actual	90				540			
Prediction	100	20	57	136	598	119	342	813
Absolute effect	-10	20	-46	33	-58	119	-273	198
Relative effect (%)	-5%	25%	-34%	58%	-5%	25%	-34%	58%
Lung								
Actual	79				476			
Prediction	105	13	81	129	629	77	486	777
Absolute effect	-26	13	-50	-2	-153	77	-301	-10
Relative effect (%)	-23%	10%	-39%	-2%	-23%	10%	-39%	-2%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

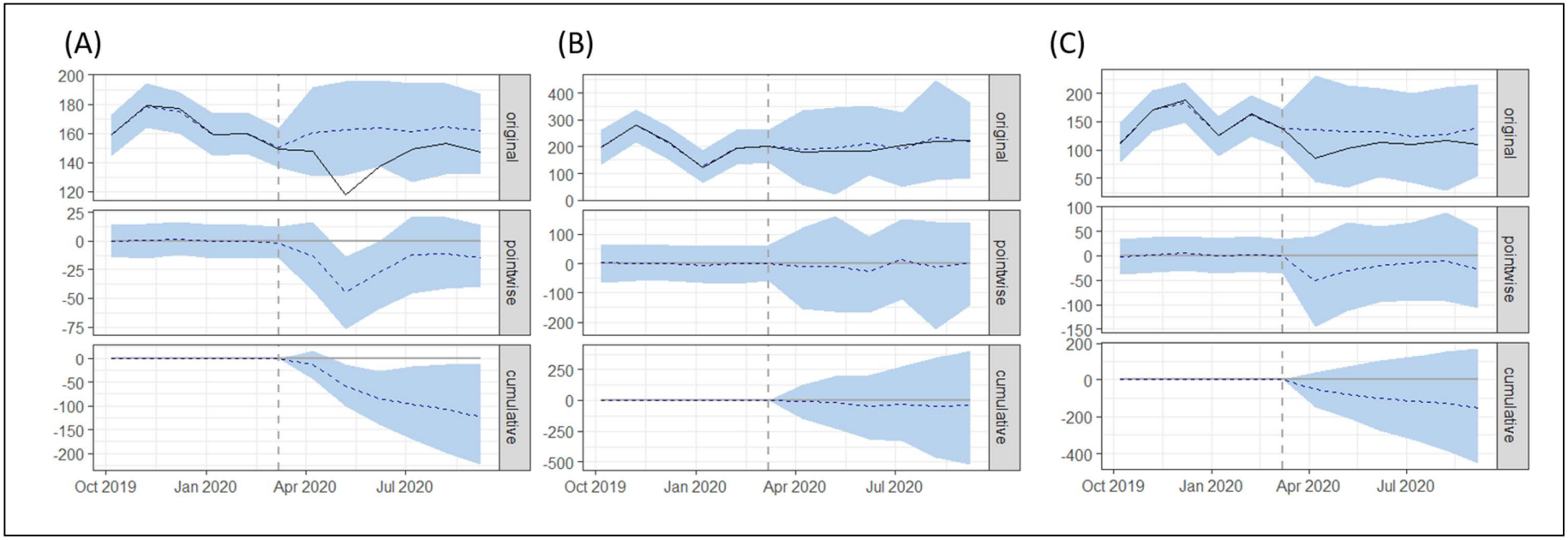

Figure 28: Monthly diagnoses in Western Australia of (A) Breast cancer, (B) Prostate cancer, (C) Melanoma, (D) Colorectal cancer, and (E) Lung cancer.

Footnote: Top panel displays monthly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

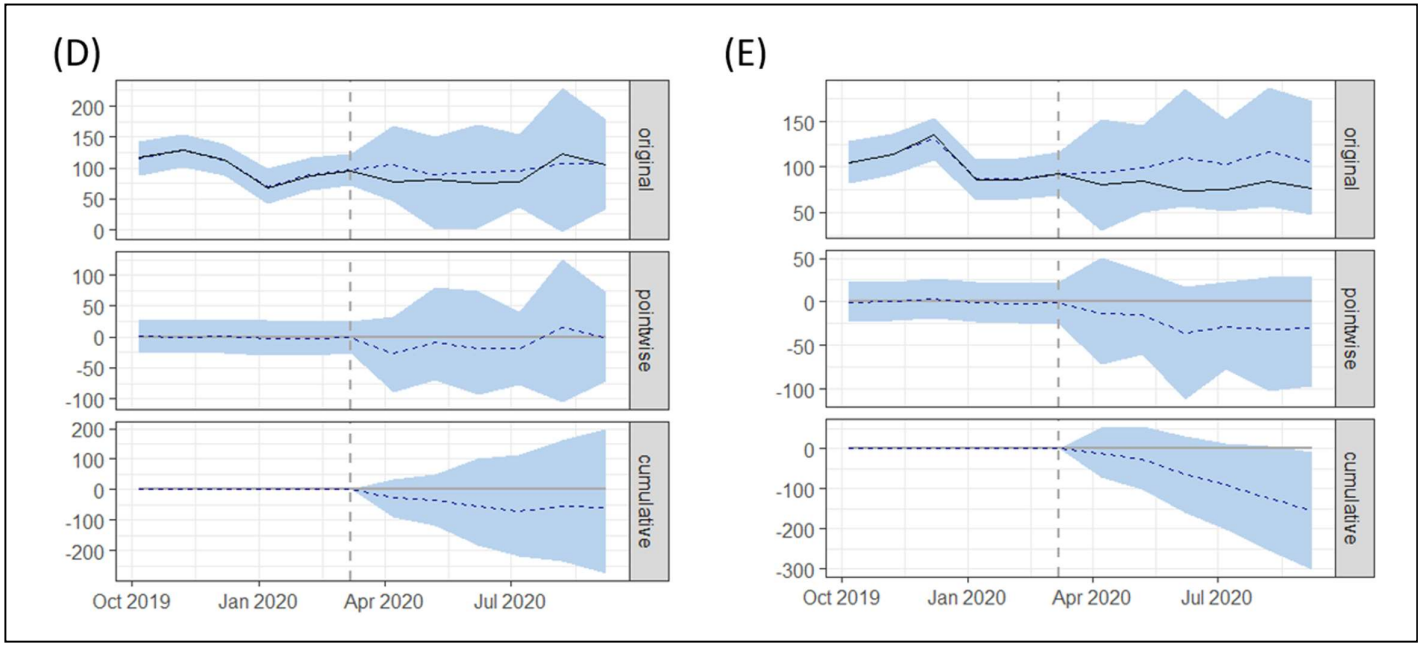

Figure 28 cont.: Monthly diagnoses in Western Australia of (A) Breast cancer, (B) Prostate cancer, (C) Melanoma, (D) Colorectal cancer, and (E) Lung cancer.

Footnote: Top panel displays monthly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' service data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Section summary

Following the introduction of COVID-19 public health control measures, there was a small decline in cancer diagnoses in Western Australia that did not reach statistical significance. This did differ between the sexes, with a statistically significant reduction in diagnoses recorded for females and no change for males. The significant reduction in females likely resulted from reduced breast cancer diagnoses. No age groups recorded statistically significant changes in cancer diagnoses, though the point estimates were greater in the 45-64 and 65+ age groups than for those aged 19-44. The youngest age group was not analysed due to insufficient numbers.

Those living in areas of medium socioeconomic status had a slightly smaller reduction in cancer diagnoses than those of low and high socioeconomic status. However, there was not a statistically significant reduction in any group, nor was there any significant difference between groups. Similarly, those living in metropolitan areas had a slightly smaller reduction in diagnoses than those in non-metropolitan areas though the difference between these groups was not statistically significant.

The most notable differences were between cancer types. The five most commonly diagnosed cancers were assessed to allow for sufficient group sizes for analysis. There were no significant reductions in diagnoses for prostate cancer, melanoma, and colorectal cancer. However, both breast cancer and lung cancer recorded significant reductions in new diagnoses. For breast cancer, this was characterised by a substantial reduction in monthly diagnoses in the two months following the introduction of public health measures, followed by a return to near pre-pandemic levels. For lung cancer the pattern was different, with a gradual decline throughout the follow-up, leading to a significant cumulative effect. The differences in patterns between breast and lung cancer may reflect how each is commonly identified. Breast cancer is often first identified via the national breast screening program, which was suspended during the initial months of the COVID-19 pandemic.[26] Notably, the national bowel cancer screening program was not suspended, possibly because this program operates via post rather than requiring face-to-face contact between staff and patients. Following a positive screening test a colonoscopy would be required for diagnosis, but concerns about colorectal cancer following a positive screening may have generally outweighed concerns about COVID-19 during this examination, resulting in the lack of change in new diagnoses. There is no lung cancer screening program, and diagnoses of these cancers may have reduced because the reduction in respiratory illness through the pandemic resulted in fewer chest examinations and hence fewer opportunities for incidental findings of lung cancers. A non-significant reduction in diagnostic imaging services was observed during the pandemic (section Medicare funded services, by type of service), consistent with this.

Deaths

Overall

The monthly count of deaths recorded in Western Australia did not change significantly following the introduction of COVID-19 related public health measures. Monthly counts remained close to expected levels (Figure 29). Across the entire follow-up period, there was a relative increase of 2% in the count of deaths, although this was not statistically significant (95%CI -11%, 14%) (Table 29).

Table 29: Changes in counts of all-cause deaths in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020.

Posterior inference	**Average number of deaths per month**				**Cumulative number of deaths over follow up**			
	Count	SD	95% CI		Count	SD	95%CI	
Actual	1,297				7,781			
Prediction	1,272	88	1,137	1,459	7,633	530	6,819	8,752
Absolute effect	25	88	-162	160	148	530	-971	962
Relative effect (%)	2%	7%	-11%	14%	2%	7%	-11%	14%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

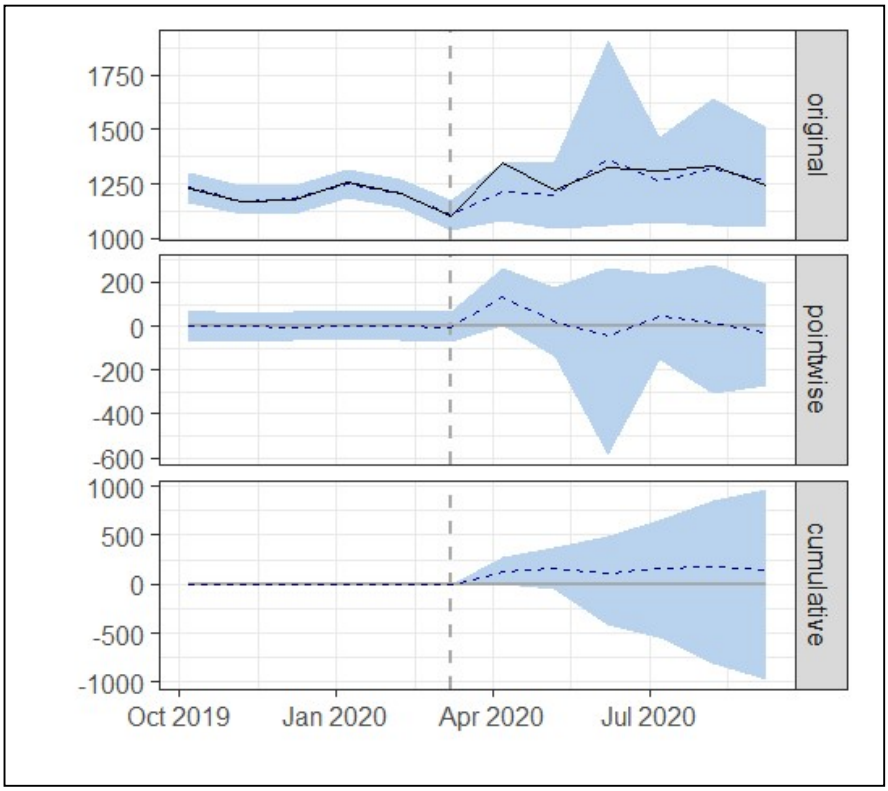

Figure 29: Monthly deaths in Western Australia following introduction of COVID-19 public health measures.

Footnote: Top panel displays monthly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts, and bottom panel displays the cumulative difference between observed and expected counts. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Sex

In females, there was a transient increase in all-cause deaths in the month following the introduction of COVID-19 public health measures, though monthly deaths returned to expected levels soon afterwards (Figure 30, panel A). Throughout the follow-up period, the count of deaths did not differ significantly compared to expected levels (7% increase, 95%CI -3%, 15%) (Table 30). For males, monthly deaths were close to expected levels in each month (Figure 30 panel B), and no significant change was observed during the follow-up period (1% decrease, -20%, 21) (Table 30).

Table 30: Changes in counts of all-cause deaths in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020, by sex.

Posterior inference	**Average number of deaths per month**				**Cumulative number of deaths over follow up**			
	Count	SD	95% CI		Count	SD	95%CI	
Females								
Actual	615				3,690			
Prediction	577	26	536	633	3,461	156	3,216	3,795
Absolute effect	38	26	-18	79	229	156	-105	474
Relative effect (%)	7%	5%	-3%	15%	7%	5%	-3%	15%
Males								
Actual	681				4,088			
Prediction	696	74	563	856	4,174	446	3,377	5,134
Absolute effect	-14	74	-174	118	-86	446	-1,046	711
Relative effect (%)	-1%	10%	-20%	21%	-1%	10%	-20%	21%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

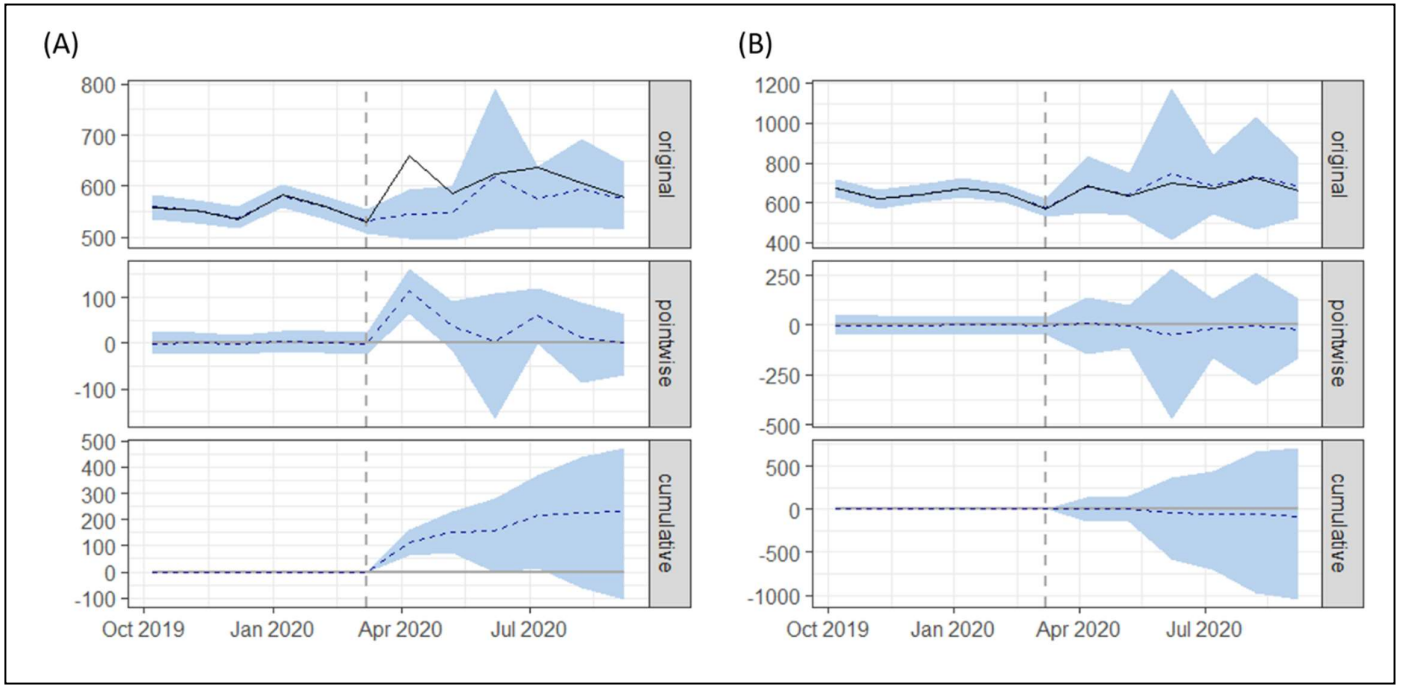

Figure 30: Monthly deaths in Western Australia following introduction of COVID-19 public health measures, among (A) Females and (B) Males.

Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Age

All age groups recorded minor deviations in monthly deaths from expected levels. However, these were generally non-significant, except for a possible minor brief increase in deaths amongst those aged 19-44 in July 2020 (Figure 31). No age group showed a significant change in the count of deaths across the 6-month follow-up period (age 19-44 0.2% change, 95%CI -7, 10; age 45-64 4% increase, -5%, 15%; age 65+ 3% increase, -15%, 17%) (Table 31).

Table 31: Changes in counts of all-cause deaths in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020, by age.

Posterior inference	**Average number of deaths per month**				**Cumulative number of deaths over follow up**			
	Count	SD	95% CI		Count	SD	95%CI	
Ages 19-44								
Actual	64				382			
Prediction	64	3	58	69	382	16	348	412
Absolute effect	0.0	3	-5	6	-0.1	16	-30	34
Relative effect (%)	0.2%	4%	-74%	10%	0.2%	4%	-7%	10%
Ages 45 - 64								
Actual	181				1,086			
Prediction	174	9	157	191	1,043	52	943	1,147
Absolute effect	7	9	-10	24	43	52	-61	143
Relative effect (%)	4%	5%	-5%	15%	4%	5%	-5%	15%
Ages 65 and above								
Actual	1,041				6,244			
Prediction	1,018	84	890	1,225	6,106	506	5,338	7,349
Absolute effect	23	84	-184	151	138	506	-1,105	906
Relative effect (%)	3%	8%	-15%	17%	3%	8%	-15%	17%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

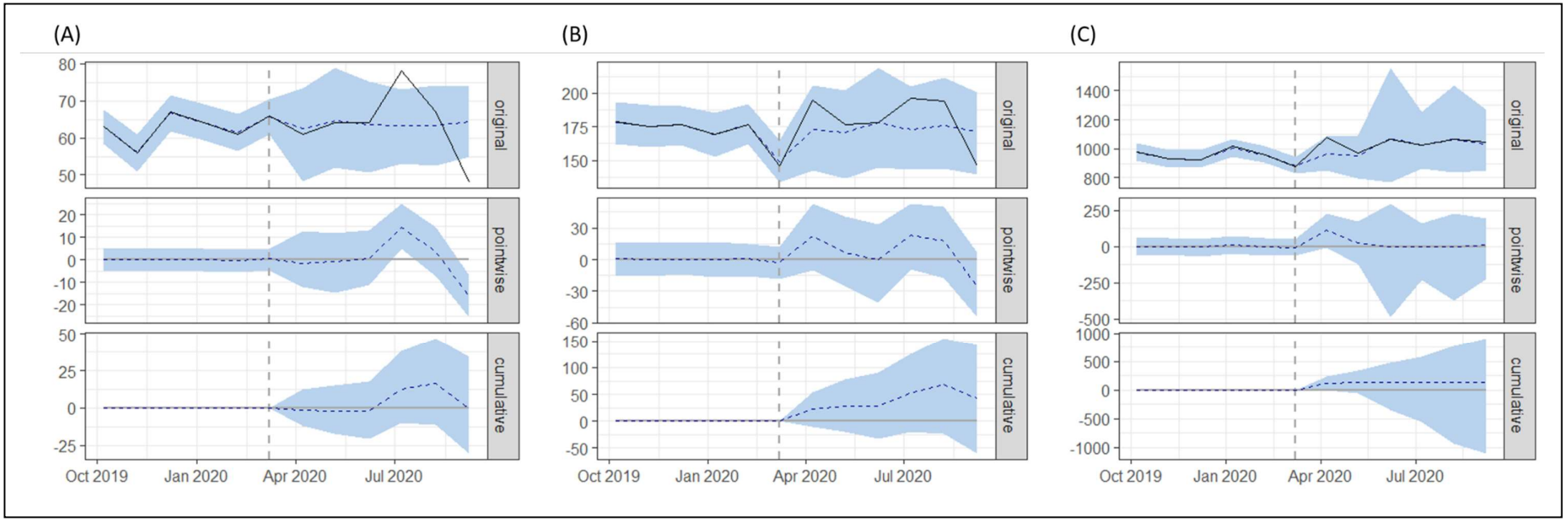

Figure 31: Monthly deaths in Western Australia following introduction of COVID-19 public health measures amongst those aged (A) 19-44, (B) 45-64, and (C) 65+.

Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Socioeconomic status

Residents of areas of high, medium, and low socioeconomic status recorded minor fluctuations in the count of deaths relative to expected levels through the follow-up period. These fluctuations were not significant in any group at any point (Figure 32), nor were there any significant effects across the 6-month follow-up period (Table 32).

Table 32: Changes in counts of all-cause deaths in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020, by socioeconomic status of area of residence.

Posterior inference	Average number of deaths per month				Cumulative number of deaths over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
High SES								
Actual	454				2,723			
Prediction	455	23	403	499	2,731	141	2,416	2,996
Absolute effect	-1	23	-45	51	-8	141	-273	307
Relative effect (%)	0.0%	5%	-9%	13%	0.0%	5%	-9%	13%
Medium SES								
Actual	381				2,288			
Prediction	405	46	316	496	2,433	273	1,896	2,974
Absolute effect	-24	46	-114	65	-145	273	-686	392
Relative effect (%)	-5%	11%	-23%	21%	-5%	11%	-23%	21%
Low SES								
Actual	508				3,046			
Prediction	522	24	481	573	3,129	143	2,885	3,439
Absolute effect	-14	24	-65	27	-83	143	-393	161
Relative effect (%)	-3%	4%	-11%	6%	-3%	4%	-11%	6%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

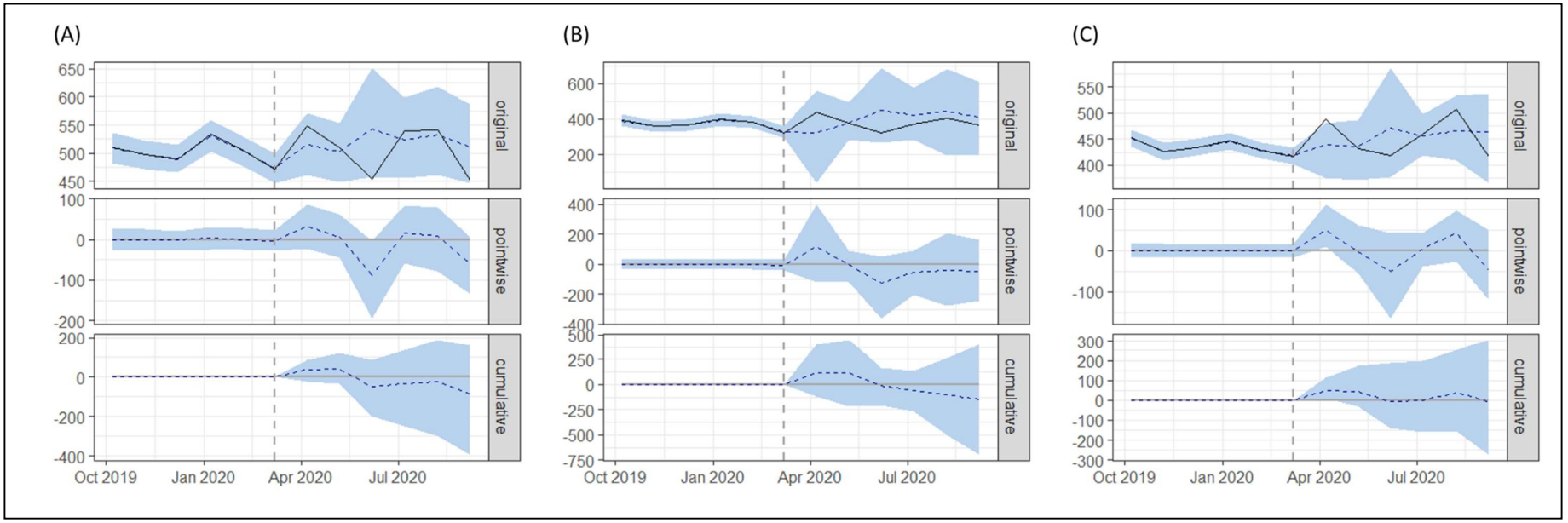

Figure 32: Monthly deaths in Western Australia following introduction of COVID-19 public health measures, amongst those living in areas of (A) High, (B) Medium, and (C) Low socioeconomic status.

Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Remoteness

Both metropolitan and non-metropolitan residents showed no significant change in the count of deaths following the introduction of COVID-19 public health measures (Figure 33, Table 33).

Table 33: Changes in counts of all-cause deaths in Western Australia following the introduction of strict COVID-19 public health measures on 23 March 2020, by remoteness of area of residence.

Posterior inference	Average number of deaths per month				Cumulative number of deaths over follow up			
	Count	SD	95% CI		Count	SD	95%CI	
Metropolitan								
Actual	931				5,584			
Prediction	950	103	760	1174	5,697	615	4,557	7,043
Absolute effect	-19	103	-243	171	-113	615	-1,459	1,027
Relative effect (%)	-0.8%	11%	-21%	23%	-0.8%	11%	-21%	23%
Non-metropolitan								
Actual	269				1,614			
Prediction	289	22	252	338	1,734	134	1,509	2,030
Absolute effect	-20	22	-69	17	-120	134	-416	105
Relative effect (%)	-6%	7%	-21%	7%	-6%	7%	-21%	7%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

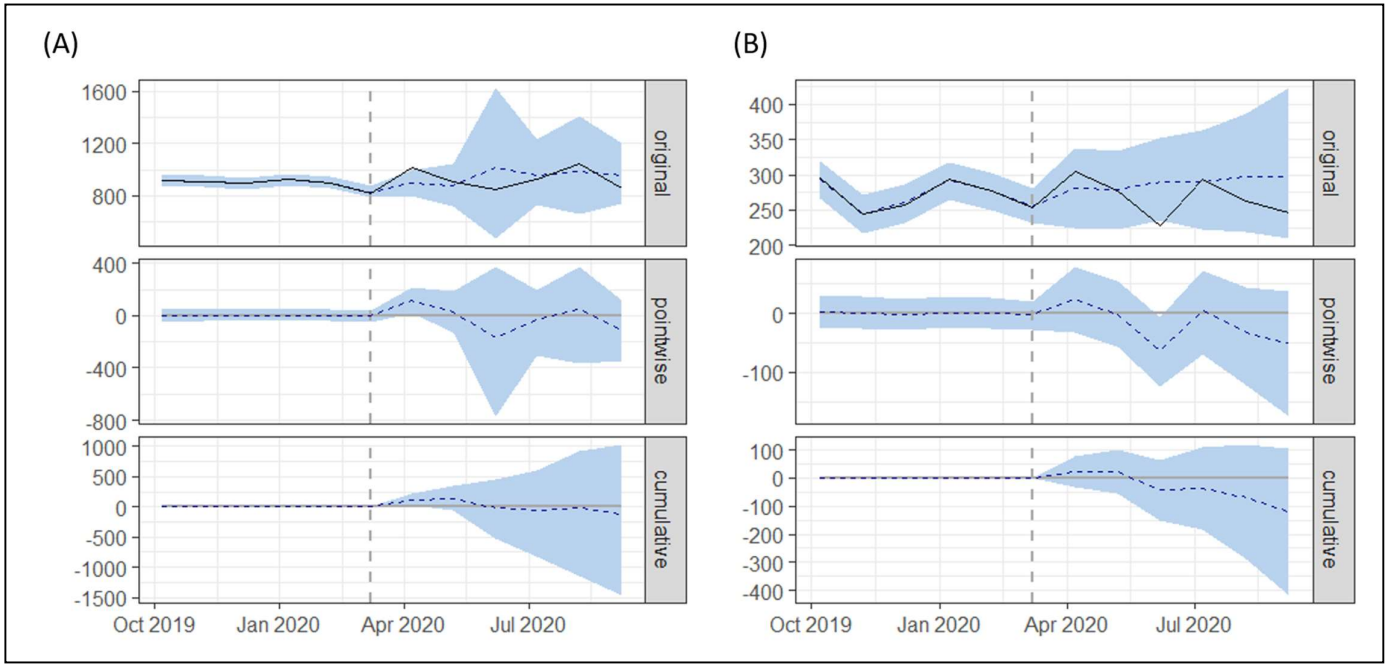

Figure 33: Monthly deaths in Western Australia following introduction of COVID-19 public health measures, amongst those living in (A) Metropolitan and (B) Non-metropolitan areas.

Top panel displays weekly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures on 23 March 2020.

Section summary

After introducing COVID-19 public health measures, the monthly count of all-cause deaths in Western Australia did not change relative to pre-COVID levels.

There was a minor difference between males and females. Although neither sex recorded a significant difference in deaths relative to expected levels through the 6-month follow-up, there was a brief (1-month) increase in deaths among females immediately following the start of the pandemic. However, counts quickly returned to pre-COVID levels. It is not clear what may have caused a temporary increase in the number of deaths among females, given that COVID case numbers were low in Western Australia at this time. Given that 95% confidence intervals allow for a 5% chance of a "false positive" finding on each monthly count, this increase may be a coincidental increase in the usual monthly variation in deaths among women unrelated to the COVID-19 pandemic.

Monthly deaths within each age group were similar to pre-COVID levels. No significant effects were observed, except for a possible small, brief increase in deaths amongst those aged 19-44. However, deaths in this group immediately returned to pre-COVID levels.

Similarly, no significant effects were observed for those living in areas of high, medium, or low socioeconomic status, nor for people living in either metropolitan or non-metropolitan areas.

As the cause of death data was not available, it was not possible to assess whether the counts of deaths differed between diagnostic categories, as was undertaken for both emergency department presentations and hospital admissions.

Medicare funded services

Medicare funded services, by state/territory

In the short-run analysis, the monthly volume of Medicare-funded services provided did not record a statistically significant change in any state or territory though the six-month follow-up period. The largest change in any state or territory in proportional terms was in Victoria, where monthly service volumes decreased by 6% (95%CI -33%, 9%) (Table 34). In Western Australia, there was a moderate decrease in monthly services of 3% (-23%, 14%), equivalent to 100,000 services per month. The only state or territory to record an increase was New South Wales where service volumes increased by 2% per month (-17%, 24%). Figure 34 indicates that there were no states or territories where service volumes changed dramatically following the beginning of the COVID-19 pandemic. It indicates that through six months of follow-up, monthly service volumes generally remained close to pre-pandemic levels, consistent with the lack of statistically significant change reported in Table 34.

Results were substantially different in the long-run analysis using a two-year follow-up. In this analysis, all states and territories except Western Australia and Tasmania had statistically significant changes in the volume of Medicare-funded services delivered (borderline statistical significance in Tasmania) (

Table 35). There was a decrease in service volumes in the Northern Territory (7% decrease, -11%, -3%) and increases elsewhere. The largest proportional increase was in the Australian Capital Territory, where there was a 14% increase in Medicare-funded services (10%, 18%), and the largest change in absolute terms was in New South Wales where monthly services increased by 1.3 million, a 10% increase (7%, 14%). In Western Australia, there was an estimated increase of 1% (-4%, 6%). Figure 35 indicates that in those states and territories with an increase in Medicare-funded services, this tended to be apparent from late 2020/early 2021. Exceptions were the Northern Territory (panel G) which showed a steady decline in services relative to expectation, and Western Australia (panel E), where an immediate decline in service volumes at the beginning of the pandemic was followed by a gradual increase, meaning that the cumulative service volumes remained close to expected levels. Several states showed a large spike in Medicare-funded services in approximately November 2021.

Table 34: Changes in counts of Medicare item claims in Australia following the introduction of strict COVID-19 public health measures in March 2020, by state/territory, short-run analysis.

Posterior inference	Average number of services per month				Cumulative number of services over follow up			
	Count	SD	95% CI		Count	SD	95% CI	
ACT								
Actual	522,318				3,656,228			
Prediction	527,875	72,297	375,653	685,935	3,695,122	506,082	2,629,573	4,801,544
Absolute effect	-5,556	72,297	-163,617	146,665	-38,894	506,082	-1,145,316	1,026,655
Relative effect (%)	-1%	14%	-31%	28%	-10%	14%	-31%	28%
NSW								
Actual	12,000,000				87,000,000			
Prediction	12,000,000	1,198,763	9,500,000	14,000,000	86,000,000	8,391,338	66,000,000	100,000,000
Absolute effect	216,350	1,198,763	-2,000,000	3,000,000	1,514,450	8,391,338	-14,000,000	21,000,000
Relative effect (%)	2%	10%	-17%	24%	2%	10%	-17%	24%
NT								
Actual	240,429				1,683,001			
Prediction	254,807	27,226	213,820	328,882	1,783,650	190,585	1,496,742	2,302,177
Absolute effect	-14,378	27,226	-88,454	26,608	-100,649	190,585	-619,176	186,259
Relative effect (%)	-6%	11%	-35%	10%	-6%	11%	-35%	10%
QLD								
Actual	7,800,000				55,000,000			
Prediction	8,000,000	704,916	6,700,000	9,400,000	56,000,000	4,934,415	47,000,000	66,000,000
Absolute effect	-168,365	704,916	-1,600,000	1,080,839	-1,178,552	4,934,415	-11,000,000	7,565,874
Relative effect (%)	-2%	9%	-20%	14%	-2%	9%	-20%	14%
SA								
Actual	2,700,000				19,000,000			
Prediction	2,700,000	313,076	2,200,000	3,500,000	19,000,000	2,191,533	15,000,000	25,000,000
Absolute effect	-7,115	313,076	-811,139	547,125	-49,802	2,191,533	-5,677,972	3,829,874
Relative effect (%)	-0.3%	12%	-30%	20%	-0.3%	12%	-30%	20%

Posterior inference	Average number of services per month				Cumulative number of services over follow up			
	Count	SD	95% CI		Count	SD	95% CI	
TAS								
Actual	742,644				5,198,509			
Prediction	770,393	90,059	620,350	990,321	5,392,753	630,414	4,342,453	6,932,249
Absolute effect	-27,749	90,059	-247,677	122,294	-194,244	630,414	-1,733,740	856,056
Relative effect (%)	-4%	12%	-32%	16%	-4%	12%	-32%	16%
VIC								
Actual	9,300,000				65,000,000			
Prediction	9,800,000	1,040,414	8,300,000	12,000,000	69,000,000	7,282,896	58,000,000	87,000,000
Absolute effect	-595,920	1,040,414	-3,200,000	907,643	-4,171,442	7,282,896	-23,000,000	6,353,502
Relative effect (%)	-6%	11%	-33%	9%	-6%	11%	-33%	9%
WA								
Actual	3,500,000				24,000,000			
Prediction	3,600,000	324,031	3,000,000	4,300,000	25,000,000	2,268,219	21,000,000	30,000,000
Absolute effect	-106,335	324,031	-824,087	493,005	-744,344	2,268,219	-5,768,607	3,451,038
Relative effect (%)	-3%	9%	-23%	14%	-3%	9%	-23%	14%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval

Table 35: Changes in counts of Medicare item claims in Australia following the introduction of strict COVID-19 public health measures in March 2020, by state/territory, long-run analysis.

Posterior inference	Average number of services per month				Cumulative number of services over follow up			
	Count	SD	95% CI		Count	SD	95% CI	
ACT								
Actual	580,000				18,000,000			
Prediction	510,000	10,925	490,000	530,000	15,000,000	327,749	15,000,000	16,000,000
Absolute effect	70,340	10,925	48,631	90,478	2,110,188	327,749	1,458,930	2,714,335
Relative effect (%)	14%	2%	10%	18%	14%	2%	10%	18%
NSW								
Actual	14,000,000				410,000,000			
Prediction	12,000,000	212,221	12,000,000	13,000,000	370,000,000	6,366,635	360,000,000	390,000,000
Absolute effect	1,300,000	212,221	880,000	1,700,000	39,000,000	6,366,635	26,000,000	51,000,000
Relative effect (%)	10%	2%	7%	14%	10%	2%	7%	14%
NT								
Actual	236,805				7,104,136			
Prediction	254,927	5,198	245,057	265,458	7,647,805	155,949	7,351,718	7,963,736
Absolute effect	-18,122	5,198	-28,653	-8,253	-543,669	155,949	-859,600	-247,582
Relative effect (%)	-7%	2%	-11%	-3%	-7%	2%	-11%	-3%
QLD								
Actual	8,100,000				240,000,000			
Prediction	7,800,000	134,882	7,500,000	8,100,000	230,000,000	4,046,475	230,000,000	240,000,000
Absolute effect	288,386	134,882	16,906	550,000	8,651,568	4,046,475	507,170	16,000,000
Relative effect (%)	4%	2%	0.2%	7%	4%	2%	0.2%	7%
SA								
Actual	2,800,000				83,000,000			
Prediction	2,600,000	51,300	2,500,000	2,700,000	79,000,000	1,539,006	76,000,000	81,000,000
Absolute effect	142,627	51,300	47,038	243,645	4,278,824	1,539,006	1,411,146	7,309,359
Relative effect (%)	5%	2%	2%	9%	5%	2%	2%	9%

Posterior inference	Average number of services per month				Cumulative number of services over follow up			
	Count	SD	95% CI		Count	SD	95% CI	
TAS								
Actual	760,000				23,000,000			
Prediction	740,000	12,911	710,000	760,000	22,000,000	387,316	21,000,000	23,000,000
Absolute effect	23,423	12,911	-1,939	48,119	702,700	387,316	-58,171	1,443,578
Relative effect (%)	3%	2%	-0.3%	7%	3%	2%	-0.3%	7%
VIC								
Actual	10,000,000				310,000,000			
Prediction	9,700,000	178,274	9,300,000	10,000,000	290,000,000	5,348,222	280,000,000	300,000,000
Absolute effect	700,000	178,274	350,000	1,000,000	21,000,000	5,348,222	10,000,000	31,000,000
Relative effect (%)	7%	2%	4%	11%	7%	2%	4%	11%
WA								
Actual	3,600,000				110,000,000			
Prediction	3,600,000	88,740	3,400,000	3,700,000	110,000,000	266,2206	100,000,000	110,000,000
Absolute effect	36,305	88,740	-132,630	205,699	1,089,146	266,2206	-3,978,906	6,170,959
Relative effect (%)	1%	3%	-4%	6%	1%	3%	-4%	6%

Footnote: Follow-up period ends at the end of August 2022. SD: standard deviation; CI: confidence interval.

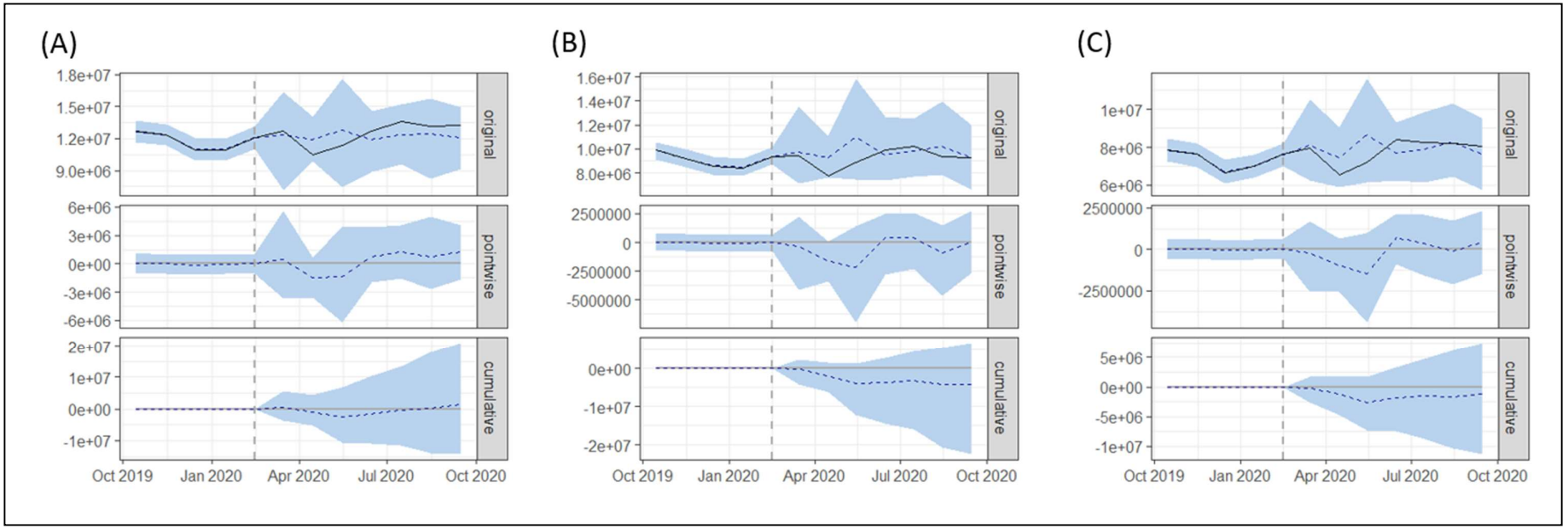

Figure 34: Use of Medicare-funded services following the introduction of COVID-19 public health measures, short-run analysis, in (A) New South Wales, (B) Victoria, (C) Queensland, (D) South Australia, (E) Western Australia, (F) Tasmania, (G) Northern Territory and (H) Australian Capital Territory.

Top panel displays monthly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures in March 2020.

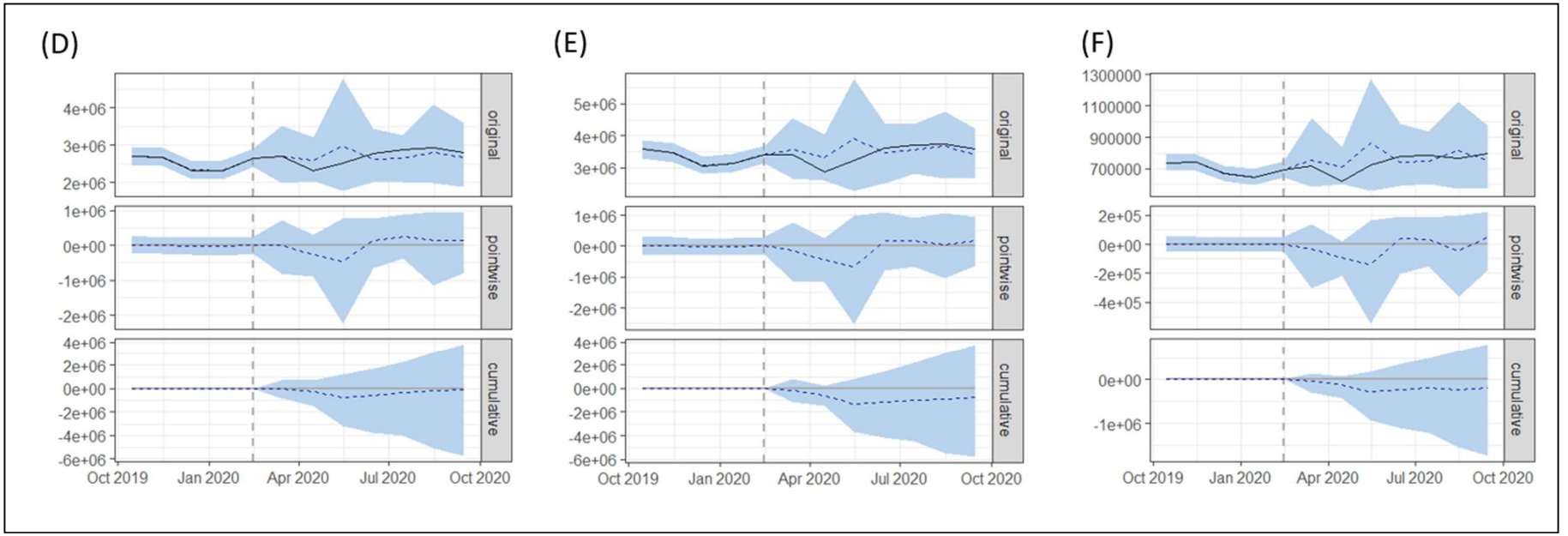

Figure 34 cont.: Use of Medicare-funded services following the introduction of COVID-19 public health measures, short-run analysis, in (A) New South Wales, (B) Victoria, (C) Queensland, (D) South Australia, (E) Western Australia, (F) Tasmania, (G) Northern Territory and (H) Australian Capital Territory.

Top panel displays monthly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures in March 2020.

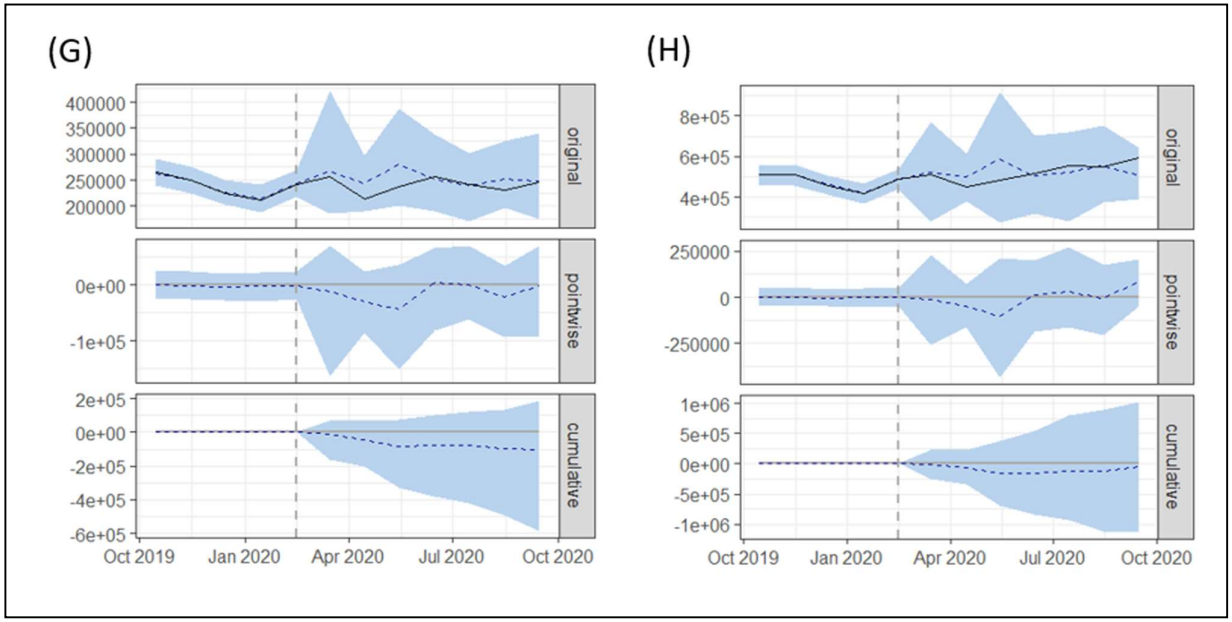

Figure 34 cont.: Use of Medicare-funded services following the introduction of COVID-19 public health measures, short-run analysis, in (A) New South Wales, (B) Victoria, (C) Queensland, (D) South Australia, (E) Western Australia, (F) Tasmania, (G) Northern Territory and (H) Australian Capital Territory.

Top panel displays monthly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures in March 2020.

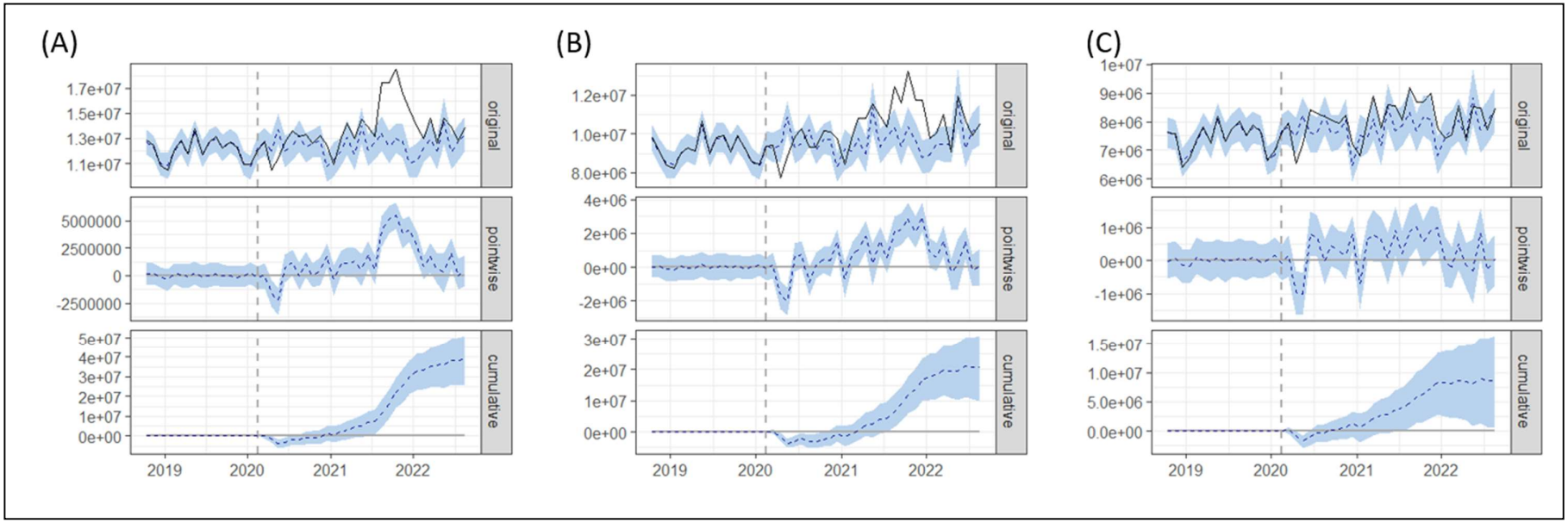

Figure 35: Use of Medicare-funded services following the introduction of COVID-19 public health measures, long-run analysis, in (A) New South Wales, (B) Victoria, (C) Queensland, (D) South Australia, (E) Western Australia, (F) Tasmania, (G) Northern Territory and (H) Australian Capital Territory.

Top panel displays monthly counts observed from October 2014 to August 2022 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures in March 2020.

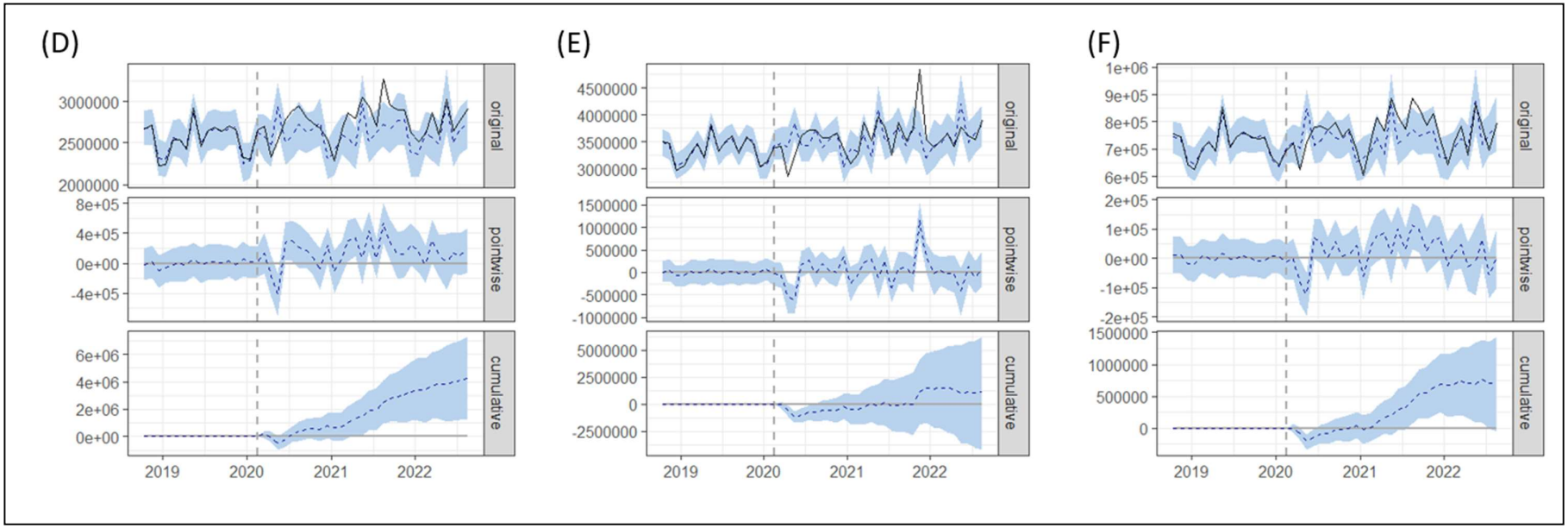

Figure 35 cont.: Use of Medicare-funded services following the introduction of COVID-19 public health measures, long-run analysis, in (A) New South Wales, (B) Victoria, (C) Queensland, (D) South Australia, (E) Western Australia, (F) Tasmania, (G) Northern Territory and (H) Australian Capital Territory.

Top panel displays monthly counts observed from October 2014 to August 2022 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures in March 2020.

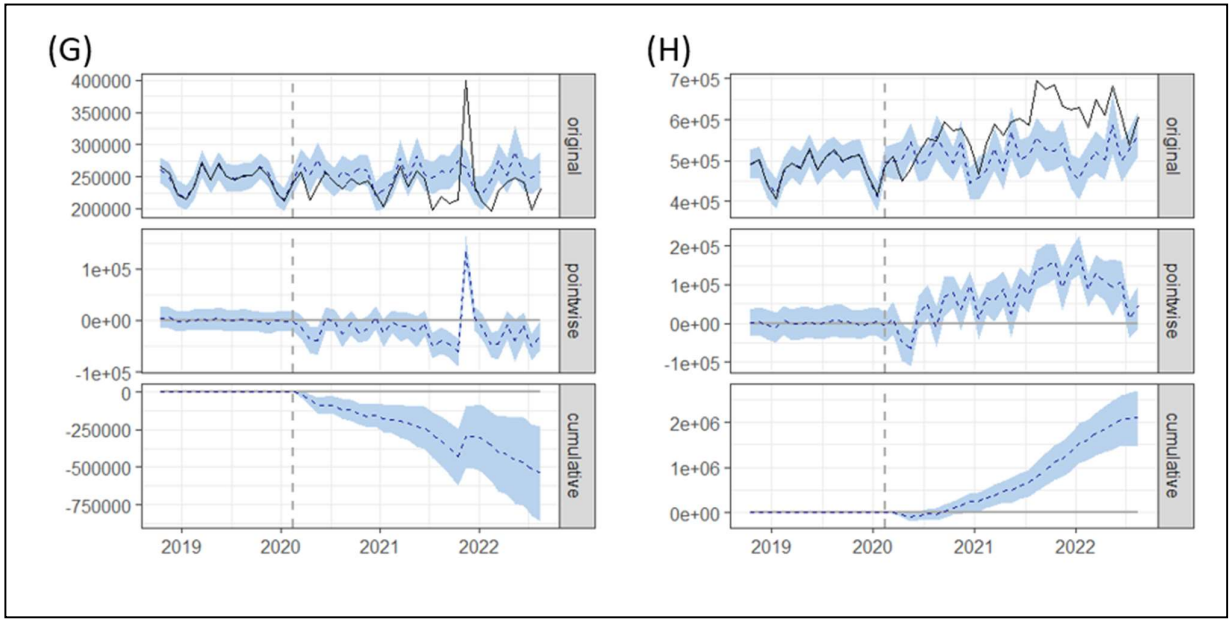

Figure 35 cont.: Use of Medicare-funded services following the introduction of COVID-19 public health measures, long-run analysis, in (A) New South Wales, (B) Victoria, (C) Queensland, (D) South Australia, (E) Western Australia, (F) Tasmania, (G) Northern Territory and (H) Australian Capital Territory.

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Medicare funded services, by type of service

The degree to which service volumes changed in Western Australia during the COVID-19 pandemic differed substantially between service types, though service volumes did not statistically significantly differ from pre-pandemic levels for any service type, though for diagnostic procedures there was a borderline statistically significant effect in the short-run analysis (Table 36). For diagnostic procedures, there was a 22% decrease (95%CI -47%, 1%).

The most common Medicare-funded services were General Practitioner attendances and Pathology items[1], both with approximately 1.2 million services per month. General Practitioner attendances had an increase in service volume of 0.5% (-19%, 18%), while pathology items decreased by 5% (-27%, 9%) (Table 36). The only service type to record an increase in service volumes other than general practitioner attendances was practice nurse items, recording a 3% increase (-32%, 34%) (Table 36). All other service types recorded non-significant declines in volume. The largest decreases were for diagnostic procedures and for oral and maxillofacial services which recorded a decrease of 18% (-56%, 11%) though these were the most rarely used services with only approximately 500 claims per month. The largest change in absolute terms was for pathology items, which decreased by approximately 65,000 services per month.

Figure 36 shows that for the majority of service types, there was a reduction in service volumes in the two to three months following the introduction of COVID-19 related public health measures, generally followed by volumes returning to or slightly exceeding pre-pandemic levels. Confidence intervals generally contained reference values through the majority of follow-up apart from a brief period immediately after the introduction of lockdowns, consistent with the lack of statistical significance reported for most service types in Table 36.

When using the long-run analysis with two years of follow-up, significant changes in service volumes relative to expected levels were observed for diagnostic procedures, with borderline statistically significant changes for dental benefits schedule services (

[1] Note that a single pathology sample can be subject to multiple tests and therefore result in multiple MBS claims.

Table 37). The largest change was among diagnostic procedures which had a reduction of 14,000 service per month, a 22% decrease (-32%, -13%), though a reduction of 11% (-23%, 1%) was recorded for dental benefits schedule items. All other service types had no significant difference in service volumes relative to pre-pandemic levels. General practitioner attendances had a 2% increase (-5%, 10%) and pathology items a 0.1% increase (-2%, 3%). No other service types had increases in volume through the follow-up. Small, non-significant decreases were observed for allied health services, diagnostic imaging, chronic disease management items, obstetric items, oral and maxillofacial services, specialist attendances and therapeutic procedures.

Figure 37 shows that immediately following the introduction of COVID-19 control measures, there was no initial change in monthly counts of in all MBS funded services (panel A), GP attendances (panel B) or practice nurse items (panel E), though these both began to increase in late 2021. For many service types there was an initial drop in service counts followed by a return to expected levels of use (e.g. specialist attendances (Figure 37 panel C), chronic disease management items (panel D), allied health (panel F), diagnostic imaging (panel G), dental items (panel I), therapeutic procedures (panel K), obstetric items (panel L) and oral and maxillofacial services (panel M)). Pathology items (panel H) had a similar pattern except for a large spike in November 2021 (responsible for the spike in overall Medicare claims in some states demonstrated in Figure 35). For diagnostic procedures and investigations, the only service type with a statistically significant change, following the initial drop in service use there was not a recovery to expected levels, resulting in a large cumulative reduction (panel J).

Table 36: Changes in counts of Medicare item claims in Australia following the introduction of strict COVID-19 public health measures in March 2020, by type of service, short-run analysis.

Posterior inference	Average number of services per month				Cumulative number of services over follow up			
	Count	SD	95% CI		Count	SD	95% CI	
Allied Health								
Actual	114,430				801,011			
Prediction	121,582	14,482	94,082	149,371	851,077	101,377	658,571	1,045,595
Absolute effect	-7,152	14,482	-34,941	20,349	-50,066	101,377	-244,584	142,440
Relative effect (%)	-6%	12%	-29%	17%	-6%	12%	-29%	17%
Dental								
Actual	21,086				147,599			
Prediction	24,934	4,348	15,179	32,964	174,537	30,438	106,255	230,749
Absolute effect	-3,848	4,348	-11,879	5,906	-26,938	30,438	-83,150	41,344
Relative effect (%)	-15%	170%	-48%	24%	-15%	17%	-48%	24%
Diagnostic imaging								
Actual	210,359				1,472,515			
Prediction	224,587	18,413	187,977	260,948	1,572,110	128,891	1,315,838	1,826,636
Absolute effect	-14,228	18,413	-50,589	22,382	-99,595	128,891	-354,121	156,677
Relative effect (%)	-6%	8%	-23%	10%	-6%	8%	-23%	10%
Diagnostic procedures								
Actual	47,199				330,393			
Prediction	60,536	7,355	46,497	75,713	423,752	51,485	325,480	529,993
Absolute effect	-13,337	7,355	-28,514	702	-93,359	51,485	-199,600	4,913
Relative effect (%)	-22%	12%	-47%	1%	-22%	12%	-47%	1%
Chronic Disease Management items								
Actual	117,119				819,836			
Prediction	122,044	12,677	97,307	147,879	854,311	88,738	681,150	1,035,150
Absolute effect	-4,925	12,677	-30,759	19,812	-34,475	88,738	-215,314	138,686
Relative effect (%)	-4%	10%	-25%	16%	-4%	10%	-25%	16%

Posterior inference	Average number of services per month				Cumulative number of services over follow up			
	Count	SD	95% CI		Count	SD	95% CI	
GP attendances								
Actual	1,204,360				8,430,523			
Prediction	1,199,016	113,548	989468	1.4e+06	8,393,110	794,839	6926273	1.0e+07
Absolute effect	5,345	113,548	-225814	214,893	37,413	794,839	-1580701	1,504,250
Relative effect (%)	0.5%	10%	-19%	18%	0.5%	10%	-19%	18%
Obstetric items								
Actual	17,154				120,081			
Prediction	18,064	831	16,530	19,729	126,447	5,815	115,708	138,102
Absolute effect	-909	831	-2,574	625	-6,366	5,815	-18,021	4,373
Relative effect (%)	-5%	5%	-14%	4%	-5%	5%	-14%	4%
Oral and maxillofacial services								
Actual	507				3,549			
Prediction	621	104	437	853	4,348	725	3,061	5,973
Absolute effect	-114	104	-346	70	-799	725	-2,424	488
Relative effect (%)	-18%	17%	-56%	11%	-18%	17%	-56%	11%
Pathology items								
Actual	1,171,696				8,201,875			
Prediction	1,236,870	105,062	1,066,498	1,500,000	8,658,090	735,434	7,465,486	11,000,000
Absolute effect	-65,174	105,062	-337,857	105,198	-456,215	735,434	-2,364,999	736,389
Relative effect (%)	-5%	9%	-27%	9%	-5%	9%	-27%	9%
Practice nurse items								
Actual	33,139				231,972			
Prediction	32,104	5,563	22,356	43,433	224,731	38,939	156,493	304,028
Absolute effect	1,034	5,563	-10,294	10,783	7,241	38,939	-72,056	75,479
Relative effect (%)	3%	17%	-32%	34%	3%	17%	-32%	34%

Posterior inference	Average number of services per month				Cumulative number of services over follow up			
	Count	SD	95% CI		Count	SD	95% CI	
Specialist attendances								
Actual	215,668				1,509,673			
Prediction	232,443	21,029	193,456	277,221	1,627,102	147,206	1,354,193	1,940,546
Absolute effect	-16,776	21,029	-61,553	22,211	-117,429	147,206	-430,873	155,480
Relative effect (%)	-7%	9%	-26%	10%	-7%	9%	-26%	10%
Therapeutic procedures								
Actual	215,856				1,510,993			
Prediction	234,765	16,091	204,928	266,891	1,643,357	112,638	1,434,493	1,868,238
Absolute effect	-18,909	16,091	-51,035	10,929	-132,364	112,638	-357,245	76,500
Relative effect (%)	-8%	7%	-22%	5%	-8%	7%	-22%	5%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval.

Table 37: Changes in counts of Medicare item claims in Australia following the introduction of strict COVID-19 public health measures in March 2020, by type of service, long-run analysis.

Posterior inference	Average number of services per month				Cumulative number of services over follow up			
	Count	SD	95% CI		Count	SD	95% CI	
Allied Health								
Actual	121,583				3,647,501			
Prediction	123,823	6,524	111,078	136,770	3,714,695	195,715	3,332,329	4,103,095
Absolute effect	-2,240	6,524	-15,186	10,506	-67,194	195,715	-455,594	315,172
Relative effect (%)	-2%	5%	-12%	9%	-2%	5%	-12%	9%
Dental								
Actual	23,931				717,929			
Prediction	26,980	1,684	23,577	30,184	809,413	50,508	707,316	905,509
Absolute effect	-3,049	1,684	-6253	354	-91,484	50,508	-187,580	10,613
Relative effect (%)	-11%	6%	-23%	1%	-11%	6%	-23%	1%
Diagnostic imaging								
Actual	230,616				6,918,488			
Prediction	231,303	9,339	212,803	248,629	6,939,104	280,184	6,384,081	7,458,873
Absolute effect	-687	9,339	-18,013	17,814	-20,616	280,184	-540,385	534,407
Relative effect (%)	-0.3%	4%	-8%	8%	-0.3%	4%	-8%	8%
Diagnostic procedures								
Actual	48,762				1,462,861			
Prediction	62,662	3,073	56,753	68,610	1,879,870	92,186	1,702,581	2,058,287
Absolute effect	-13,900	3,073	-20,000	-7,991	-417,009	92,186	-600,000	-239,720
Relative effect (%)	-22%	5%	-32%	-13%	-22%	5%	-32%	-13%
Chronic Disease Management items								
Actual	117,355				3,520,651			
Prediction	123,581	6,439	110,954	136,735	3,707,422	193,177	3,328,635	4,102,052
Absolute effect	-6,226	6,439	-19,380	6,401	-186,771	193,177	-581,401	192,016
Relative effect (%)	-5%	5%	-16%	5%	-5%	5%	-16%	5%

Posterior inference	Average number of services per month				Cumulative number of services over follow up			
	Count	SD	95% CI		Count	SD	95% CI	
GP attendances								
Actual	1,300,000				38,000,000			
Prediction	1,200,000	47,098	1,100,000	1,300,000	37,000,000	1,412,937	34,000,000	40,000,000
Absolute effect	28,474	47,098	-64,806	117,268	854,221	1,412,937	-1,944,182	3,518,046
Relative effect (%)	2%	4%	-5%	10%	2%	4%	-5%	10%
Obstetric items								
Actual	17,185				515,556			
Prediction	17,662	343	16,969	18,351	529,873	10,296	50,9056	550,539
Absolute effect	-477	343	-1,166	217	-14,317	10,296	-34,983	6,500
Relative effect (%)	-3%	2%	-7%	1%	-3%	2%	-7%	1%
Oral and maxillofacial services								
Actual	567				17,011			
Prediction	604	29	546	662	18,121	871	16,384	19,864
Absolute effect	-37	29	-95	21	-1,110	871	-2853	627
Relative effect (%)	-6%	5%	-16%	4%	-6%	5%	-16%	4%
Pathology items								
Actual	1,200,000				36,000,000			
Prediction	1,200,000	16,040	1,200,000	1,200,000	36,000,000	481,188	35,000,000	37,000,000
Absolute effect	1,614	16,040	-29,552	31,851	48,405	481,188	-886,562	955,527
Relative effect (%)	0.1%	1%	-2%	3%	0.1%	1%	-2%	3%
Practice nurse items								
Actual	30,412				912,374			
Prediction	36,100	3,560	29,490	43,105	1,083,009	106,789	884,706	1,293,135
Absolute effect	-5,688	3,560	-12,692	922	-170,635	106,789	-380,761	27,668
Relative effect (%)	-16%	10%	-35%	3%	-16%	10%	-35%	3%

Posterior inference	Average number of services per month				Cumulative number of services over follow up			
	Count	SD	95% CI		Count	SD	95% CI	
Specialist attendances								
Actual	224,827				6,744,807			
Prediction	235,529	8,930	218,578	252,558	7,065,857	267,904	6,557,349	7,576,744
Absolute effect	-10,702	8,930	-27,731	6,249	-321,050	267,904	-831,937	187,458
Relative effect (%)	-4%	4%	-12%	3%	-4%	4%	-12%	3%
Therapeutic procedures								
Actual	225,253				6,757,594			
Prediction	233,711	5,973	221732	245632	7,011,321	179,185	6651952	7368960
Absolute effect	-8,458	5,973	-20379	3,521	-253,727	179,185	-611366	105,642
Relative effect (%)	-4%	3%	-9%	2%	-4%	3%	-9%	2%

Footnote: Follow-up period ends at the end of August 2022. SD: standard deviation; CI: confidence interval.

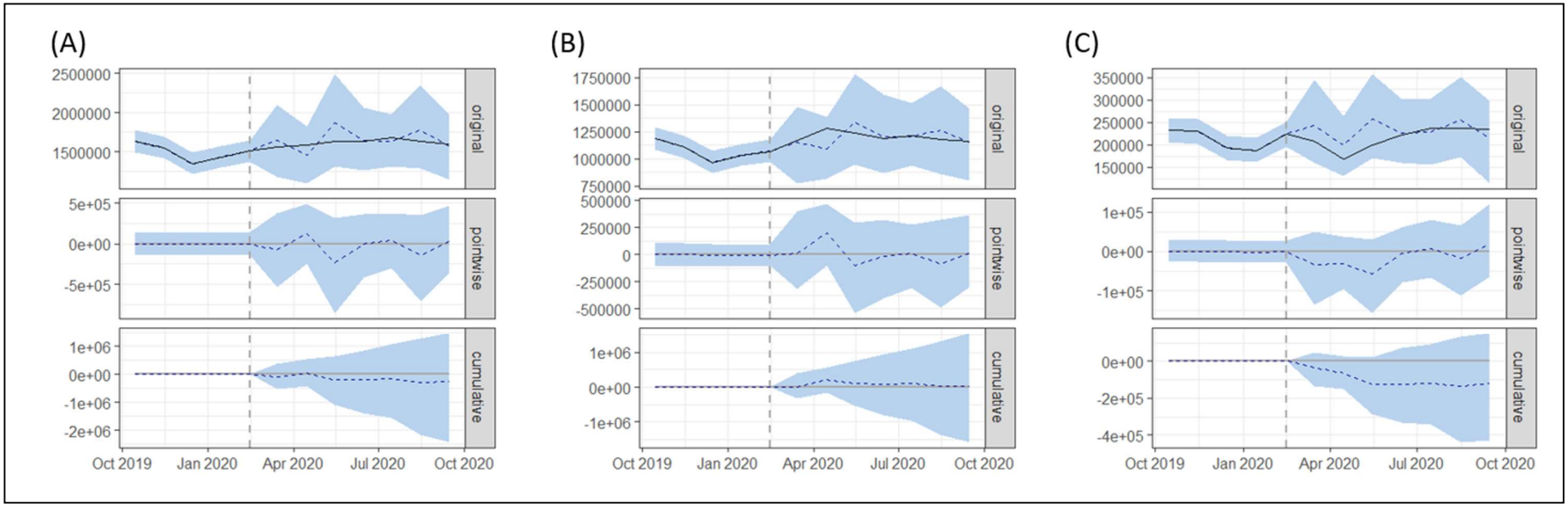
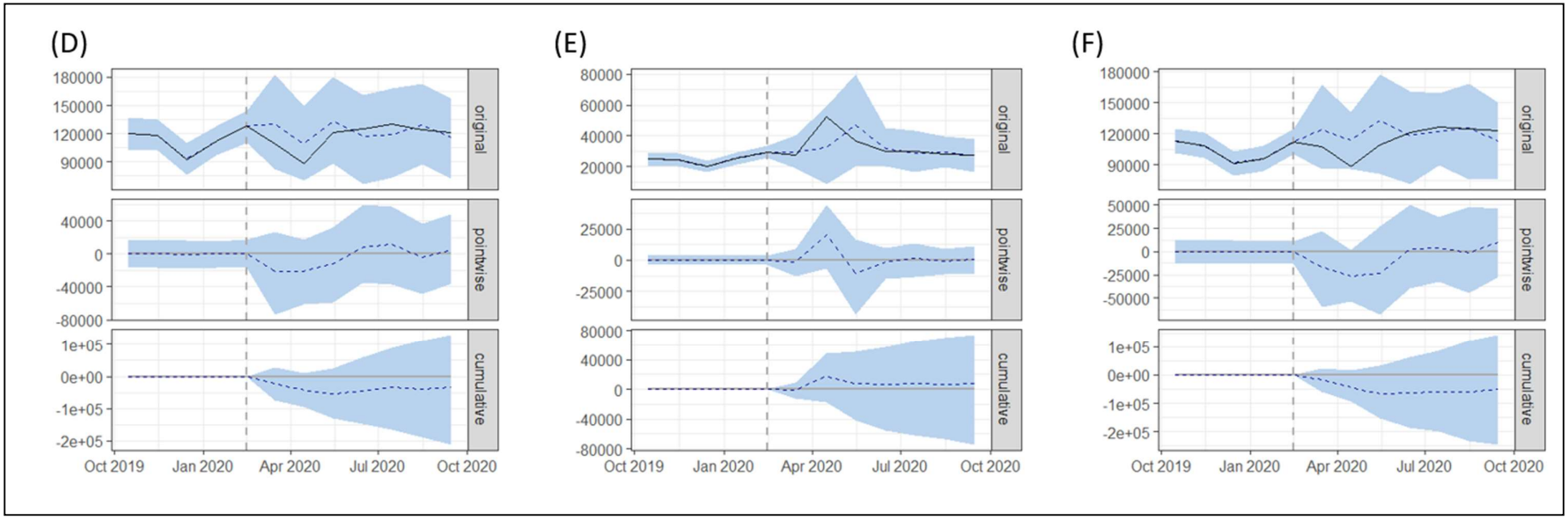


Figure 36: Use of Medicare-funded services following the introduction of COVID-19 public health measures, short-run analysis, for (A) All professional attendances, (B) GP attendances, (C) Specialist attendances, (D) Chronic Disease Management items, (E) Practice Nurse Items, (F) Allied Health items, (G) Diagnostic Imaging services, (H) Pathology services, (I) Dental Benefits Schedule items, (J) Diagnostic Procedures and Investigations, (K) Therapeutic Procedures, (L) Obstetric items, and (M) Oral and Maxillofacial services.

Top panel displays monthly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures in March 2020.



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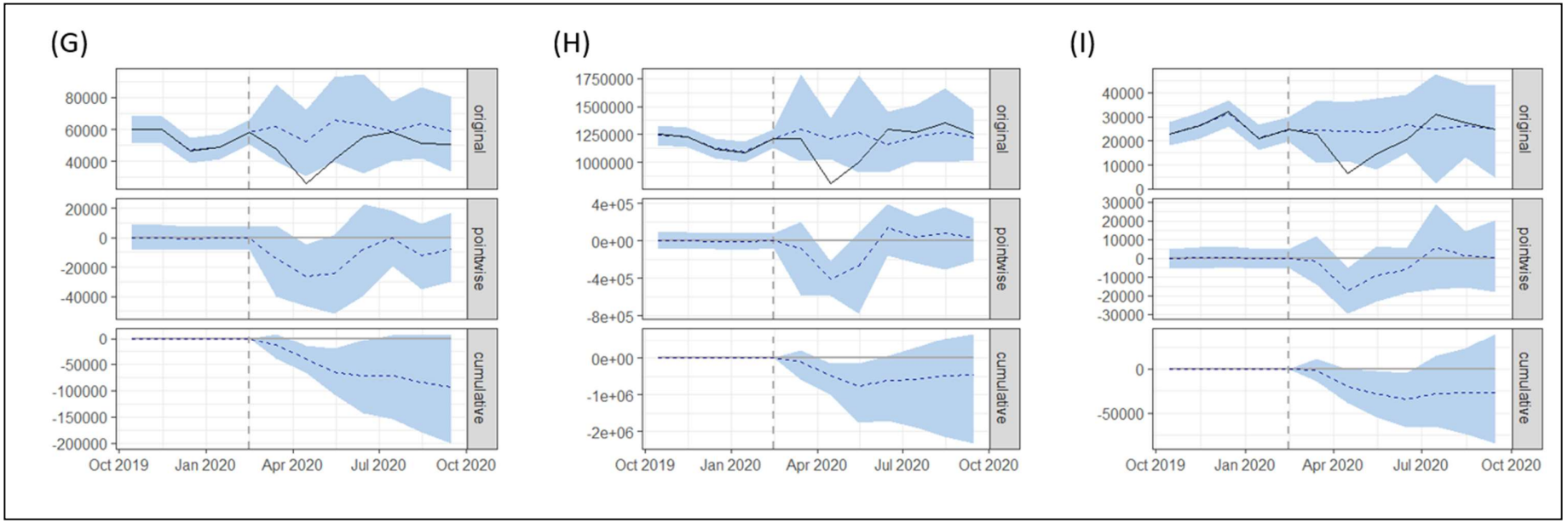

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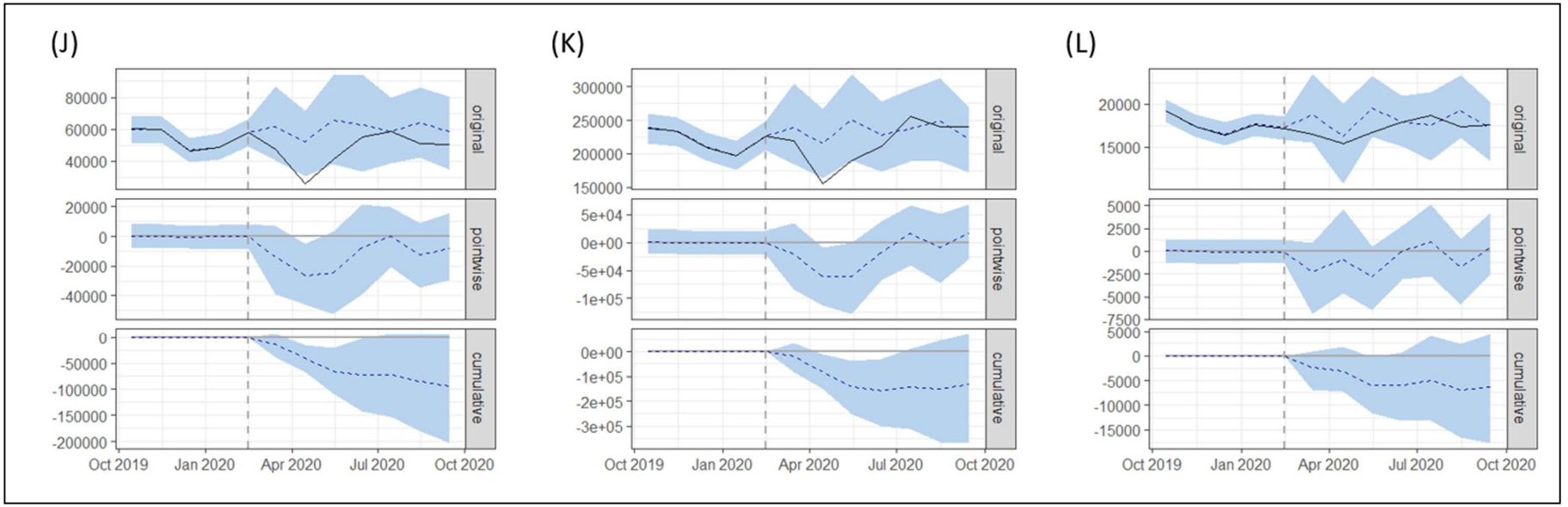

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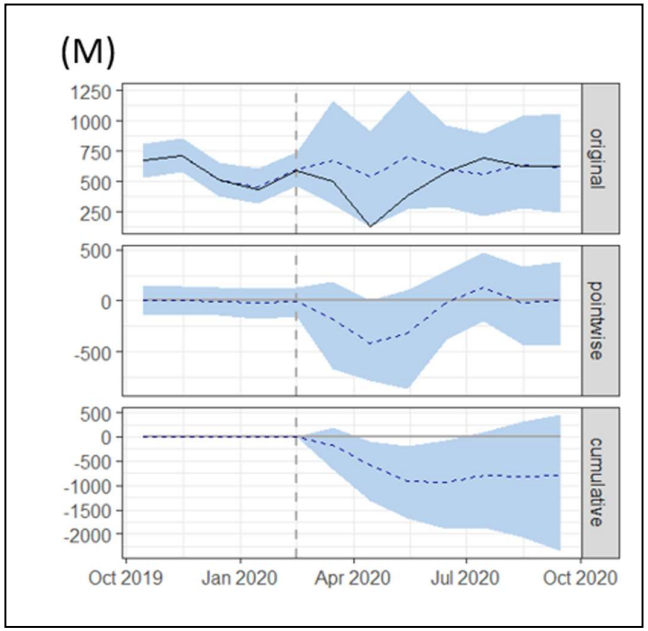

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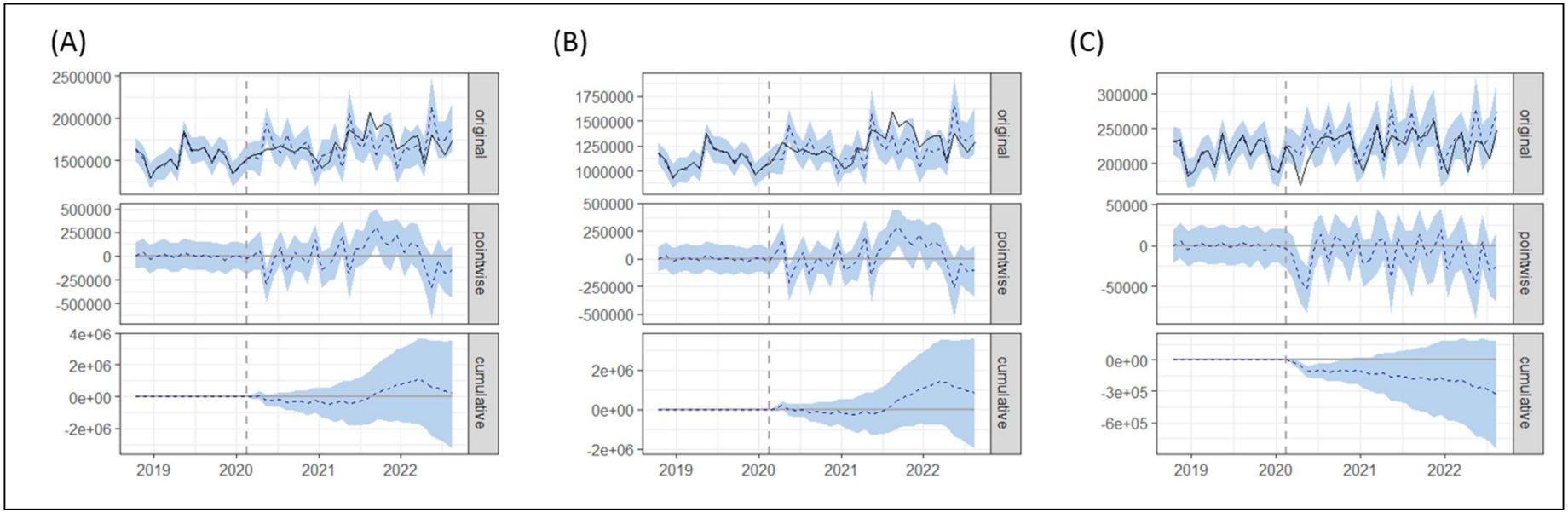

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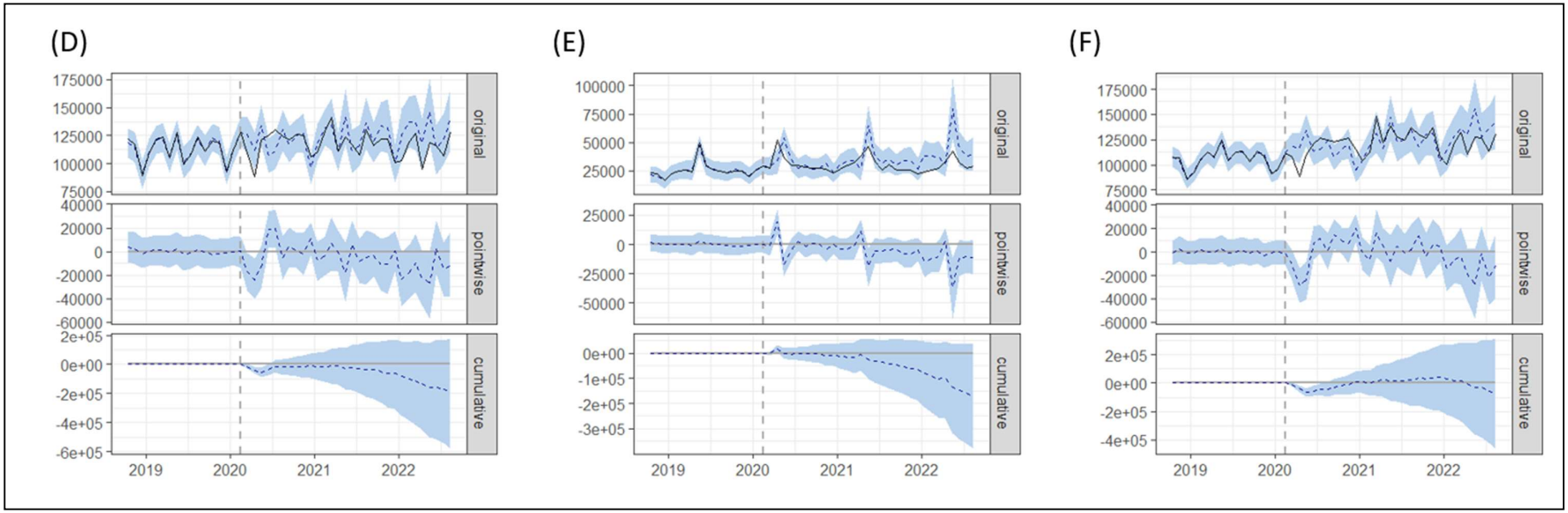

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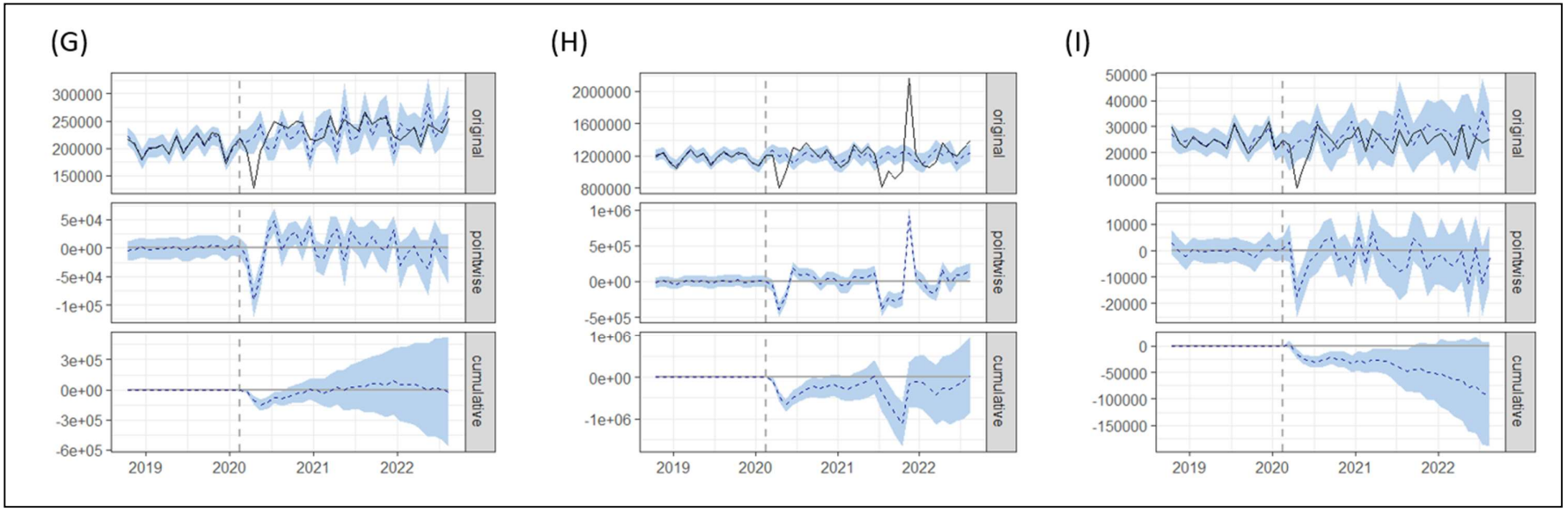

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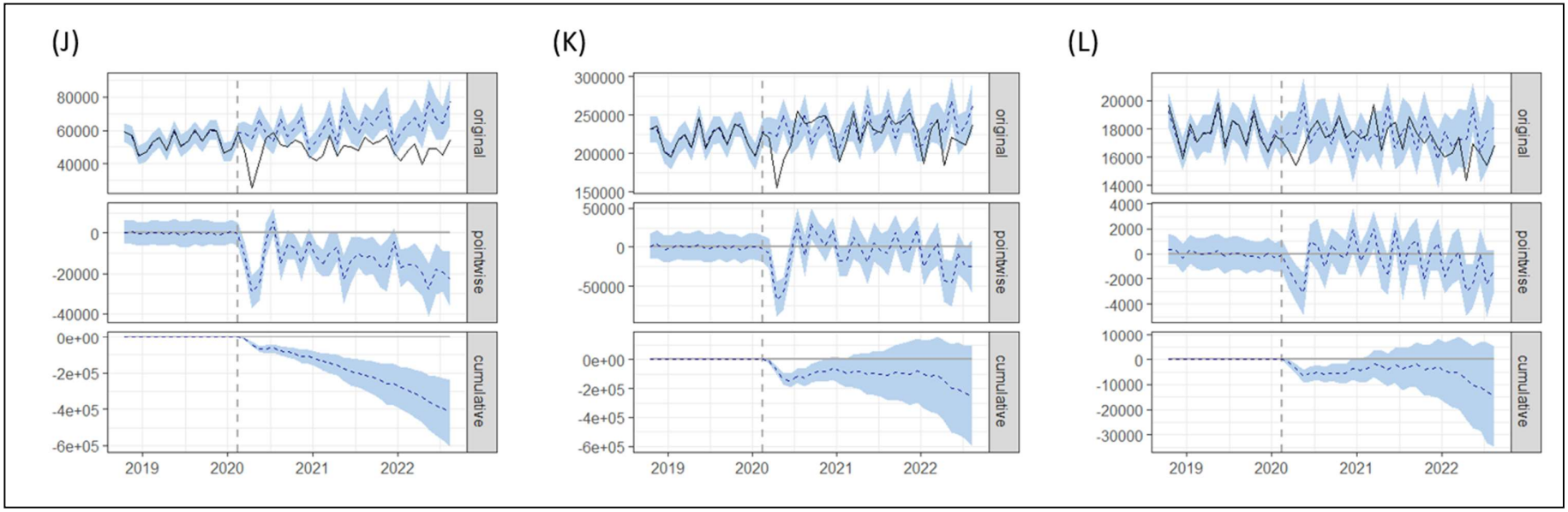

Figure 37 cont.: Use of Medicare-funded services following the introduction of COVID-19 public health measures, long-run analysis, for (A) All professional attendances, (B) GP attendances, (C) Specialist attendances, (D) Chronic Disease Management items, (E) Practice Nurse Items, (F) Allied Health items, (G) Diagnostic Imaging services, (H) Pathology services, (I) Dental Benefits Schedule items, (J) Diagnostic Procedures and Investigations, (K) Therapeutic Procedures, (L) Obstetric items, and (M) Oral and Maxillofacial services.

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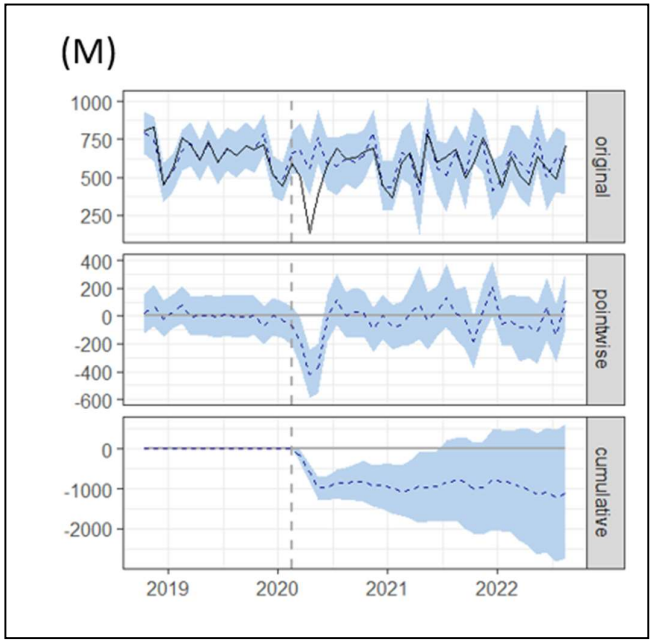

Figure 37 cont.: Use of Medicare-funded services following the introduction of COVID-19 public health measures, long-run analysis, for (A) All professional attendances, (B) GP attendances, (C) Specialist attendances, (D) Chronic Disease Management items, (E) Practice Nurse Items, (F) Allied Health items, (G) Diagnostic Imaging services, (H) Pathology services, (I) Dental Benefits Schedule items, (J) Diagnostic Procedures and Investigations, (K) Therapeutic Procedures, (L) Obstetric items, and (M) Oral and Maxillofacial services.

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Section summary

In the short-medium term following the introduction of COVID-19 public health measures, there was no statistically significant change in the total number of MBS-funded services provided in any state or territory, and the pattern of service use in Western Australia through this period did not differ appreciably from other jurisdictions.

However, through a two-year follow-up, Western Australia was the only jurisdiction without a statistically significant change in Medicare-funded service volumes. The Northern Territory recorded a statistically significant and substantial decrease in service volumes, while all other jurisdictions (aside from Western Australia) recorded increases, the largest being in the Australian Capital Territory. The lack of change in Western Australia may have resulted from relatively low COVID-19 case numbers throughout the years of the pandemic.

Within Western Australia, Medicare-funded diagnostic procedures recorded a borderline statistically significant reduction in monthly volumes through the six months following the introduction of the strictest public health measures. No other service types recorded significant changes. Some other service types recorded large changes in volume (e.g. oral and maxillofacial services, which reduced by 18%), none were statistically significant.

Through two years of follow-up, a statistically significant reduction was recorded for diagnostic procedures, with borderline significant reductions in the use of both dental benefits schedule services and practice nurse items. For other service types, short-term drops in volume were temporarily significant (e.g. specialist services, allied health items, diagnostic imaging, pathology) before returning to pre-COVID levels. The general lack of significant change in service volumes in most areas may result from the low COVID case numbers and relative lack of lockdown measures in place through most of this period. Note that the attendances assessed here are physical attendances only (such as, the non-significant change in GP attendances, specialist attendances etc.) and does not involve substituting attendances for Telehealth items introduced[27] during the pandemic.

Medication dispensations

Dispensations, by state/territory

The monthly counts of medications subsidised via the PBS/RPBS responded differently to the COVID-19 pandemic in different states and territories. However, no state or territory recorded a statistically significant change through the six-month follow-up used in the short-run analysis. Decreases in medication dispensations were recorded in New South Wales, South Australia, Tasmania, and the Australian Capital Territory, while increases were recorded in the others (Table 38). The largest increase was in Western Australia, which recorded a 10% increase (95%CI -10%, 32%), approximately 140,000 additional dispensations per month, while a decrease of 8% was recorded in NSW (-32%, 12%) and SA (-32%, 12%). Figure 38 suggests that the monthly counts of dispensations were generally close to pre-pandemic levels.

In the long-run analysis, changes were generally smaller in percentage terms but were more often statistically significant. Significant increases in dispensations, relative to expected levels based on pre-pandemic data, were recorded in all states except New South Wales and South Australia (

Table 39). There were significant increases in monthly dispensations in all other states and territories. In Western Australia, there was an average of 113,000 additional dispensations per month through the 1.5-year follow-up period, equivalent to a 7% increase compared to expectation (3%, 12%). This was the second-largest monthly increase in proportional terms after the Northern Territory (7% increase, 2%, 13%) and equal to the Australian Capital Territory (7% increase, 3%, 11%). Figure 39 suggests that in the states/territories that recorded an increase in dispensations through the two-year follow-up, this increase tended to occur from mid-late 2020 and continue consistently throughout the follow-up period.

Table 38: Changes in counts of medicines dispensed under the Pharmaceutical Benefits Scheme and Repatriation Pharmaceutical Benefits Scheme following the introduction of strict COVID-19 public health measures in March 2020, by state/territory, short-run analysis.

Posterior inference	Average number of dispensations per month				Cumulative number of dispensations over follow up			
	Count	SD	95% CI		Count	SD	95% CI	
NSW								
Actual	5,800,000				41,000,000			
Prediction	6,300,000	699,603	5,000,000	7,800,000	44,000,000	4,897,222	35,000,000	55,000,000
Absolute effect	-515,889	699,603	-2,000,000	761,615	-3,611,223	4,897,222	-14,000,000	5,331,306
Relative effect (%)	-8%	11%	-32%	12%	-8%	11%	-32%	12%
VIC								
Actual	4,400,000				31,000,000			
Prediction	4,400,000	257,866	3,900,000	4,900,000	31,000,000	1,805,059	27,000,000	34,000,000
Absolute effect	10,910	257,866	-482,433	538,132	76,367	1,805,059	-3,377,033	3,766,922
Relative effect (%)	0.3%	6%	-11%	12%	0.3%	6%	-11%	12%
QLD								
Actual	3,700,000				26,000,000			
Prediction	3,600,000	258,981	3,200,000	4,200,000	26,000,000	1,812,870	22,000,000	29,000,000
Absolute effect	101,902	258,981	-425,279	592,130	713,315	1,812,870	-2,976,955	4,144,912
Relative effect (%)	3%	7%	-12%	16%	3%	7%	-12%	16%
SA								
Actual	1,500,000				10,000,000			
Prediction	1,600,000	182,946	1259364	2,000,000	11,000,000	1,280,622	8,815,551	14,000,000
Absolute effect	-129,294	182,946	-514687	196,414	-905,057	1,280,622	-3,602,809	1,374,898
Relative effect (%)	-8%	12%	-32%	12%	-8%	12%	-32%	12%
WA								
Actual	1,600,000				11,000,000			
Prediction	1,500,000	164,254	1,148,605	1,800,000	10,000,000	1,149,775	8,040,236	12,000,000
Absolute effect	141,866	164,254	-152,521	480,855	993,060	1,149,775	-1,067,647	3,365,983
Relative effect (%)	10%	11%	-10%	32%	10%	11%	-10%	32%

Posterior inference	Average number of dispensations per month				Cumulative number of dispensations over follow up			
	Count	SD	95% CI		Count	SD	95% CI	
TAS								
Actual	495,792				3,470,544			
Prediction	519,119	86,102	344,310	682,812	3,633,831	602,712	2,410,167	4,779,685
Absolute effect	-23,327	86,102	-187,020	151,482	-163,287	602,712	-1,309,141	1,060,377
Relative effect (%)	-4%	17%	-36%	29%	-4%	17%	-36%	29%
NT								
Actual	66,257				463,797			
Prediction	62,006	5,830	50,455	73,508	434,040	40,812	353,184	514,554
Absolute effect	4,251	5,830	-7,251	15,802	29,757	40,812	-50,757	110,613
Relative effect (%)	7%	9%	-12%	25%	7%	9%	-12%	25%
ACT								
Actual	211,740				1,482,180			
Prediction	224,501	34,815	159,637	293,403	1,571,510	243,705	1,117,457	2,053,823
Absolute effect	-12,761	34,815	-81,663	52,103	-89,330	243,705	-571,643	364,723
Relative effect (%)	-6%	16%	-36%	23%	-6%	16%	-36%	23%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval

Table 39: Changes in counts of medicines dispensed under the Pharmaceutical Benefits Scheme and Repatriation Pharmaceutical Benefits Scheme following the introduction of strict COVID-19 public health measures in March 2020, by state/territory, long-run analysis.

Posterior inference	Average number of dispensations per month				Cumulative number of dispensations over follow up			
	Count	SD	95% CI		Count	SD	95% CI	
NSW								
Actual	5,800,000				160,000,000			
Prediction	5,800,000	135,604	5,500,000	6,000,000	160,000,000	3,796,902	150,000,000	170,000,000
Absolute effect	44,018	135,604	-236,907	303,704	1,232,491	3,796,902	-6,633,405	8,503,701
Relative effect (%)	0.8%	2%	-4%	5%	0.8%	2%	-4%	5%
VIC								
Actual	4,400,000				120,000,000			
Prediction	4,300,000	70,000	4,200,000	4,400,000	120,000,000	2,000,000	120,000,000	120,000,000
Absolute effect	129,515	70,000	-8,135	265,469	3,626,407	2,000,000	-227,773	7,433,123
Relative effect (%)	3%	2%	-0.2%	6%	3%	2%	-0.2%	6%
QLD								
Actual	3,800,000				110,000,000			
Prediction	3,700,000	65,619	3,500,000	3,800,000	100,000,000	1,837,321	99,000,000	110,000,000
Absolute effect	174,434	65,619	50,857	304,463	4,884,148	1,837,321	1,424,009	8,524,975
Relative effect (%)	5%	2%	1%	8%	5%	2%	1%	8%
SA								
Actual	1,500,000				41,000,000			
Prediction	1,500,000	31,628	1,400,000	1,600,000	42,000,000	885,572	40,000,000	43,000,000
Absolute effect	-13,267	31,628	-76,353	52,220	-371,475	885,572	-2,137,891	1,462,153
Relative effect (%)	-0.9%	2%	-5%	4%	-0.9%	2%	-5%	4%
WA								
Actual	1,700,000				47,000,000			
Prediction	1,600,000	38,915	1,500,000	1,600,000	44,000,000	1,089,621	42,000,000	46,000,000
Absolute effect	113,394	38,915	39,309	189,667	3,175,034	1,089,621	1,100,659	5,310,666
Relative effect (%)	7%	3%	3%	12%	7%	3%	3%	12%

Posterior inference	Average number of dispensations per month				Cumulative number of dispensations over follow up			
	Count	SD	95% CI		Count	SD	95% CI	
TAS								
Actual	520,000				15,000,000			
Prediction	490,000	13,680	460,000	510,000	14,000,000	383,033	13,000,000	14,000,000
Absolute effect	33,137	13,680	6,422	59,759	927,825	383,033	179,808	1,673,261
Relative effect (%)	7%	3%	1%	12%	7%	3%	1%	12%
NT								
Actual	70,501				1,974,030			
Prediction	65,613	1,878	61,896	69,221	1,837,165	52,572	1,733,074	1,938,185
Absolute effect	4,888	1,878	1,280	8,606	136,865	52,572	35,845	240,956
Relative effect (%)	7%	3%	2%	13%	7%	3%	2%	13%
ACT								
Actual	222,511				6,230,297			
Prediction	207,496	4,494	198769	215,720	5,809,892	125,827	5,565,531	6,040,155
Absolute effect	15,014	4,494	6791	23,742	420,405	125,827	190,142	664,766
Relative effect (%)	7%	2%	3%	11%	7%	2%	3%	11%

Footnote: Follow-up period ends at the end of June 2022. SD: standard deviation; CI: confidence interval.

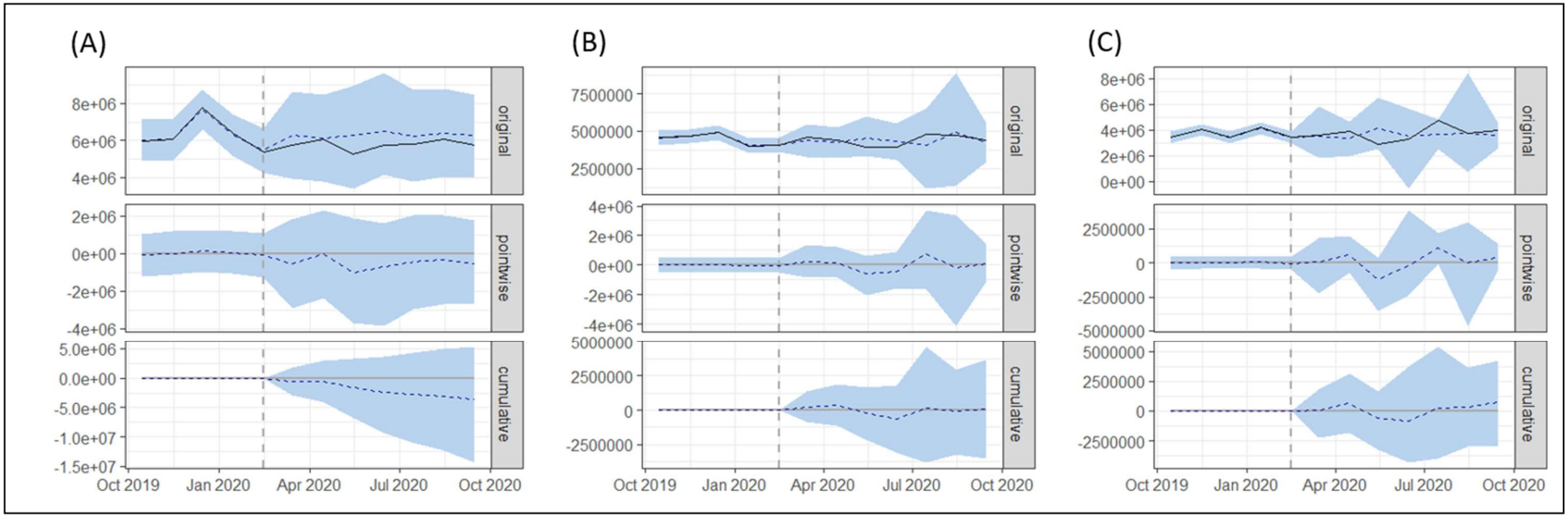

Figure 38: Changes in counts of medicines dispensed under the Pharmaceutical Benefits Scheme and Repatriation Pharmaceutical Benefits Scheme following the introduction of strict COVID-19 public health measures in March 2020, in (A) New South Wales, (B) Victoria, (C) Queensland, (D) South Australia, (E) Western Australia, (F) Tasmania, (G) Northern Territory, (H) Australian Capital Territory, short-run analysis.

Top panel displays monthly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures in March 2020.

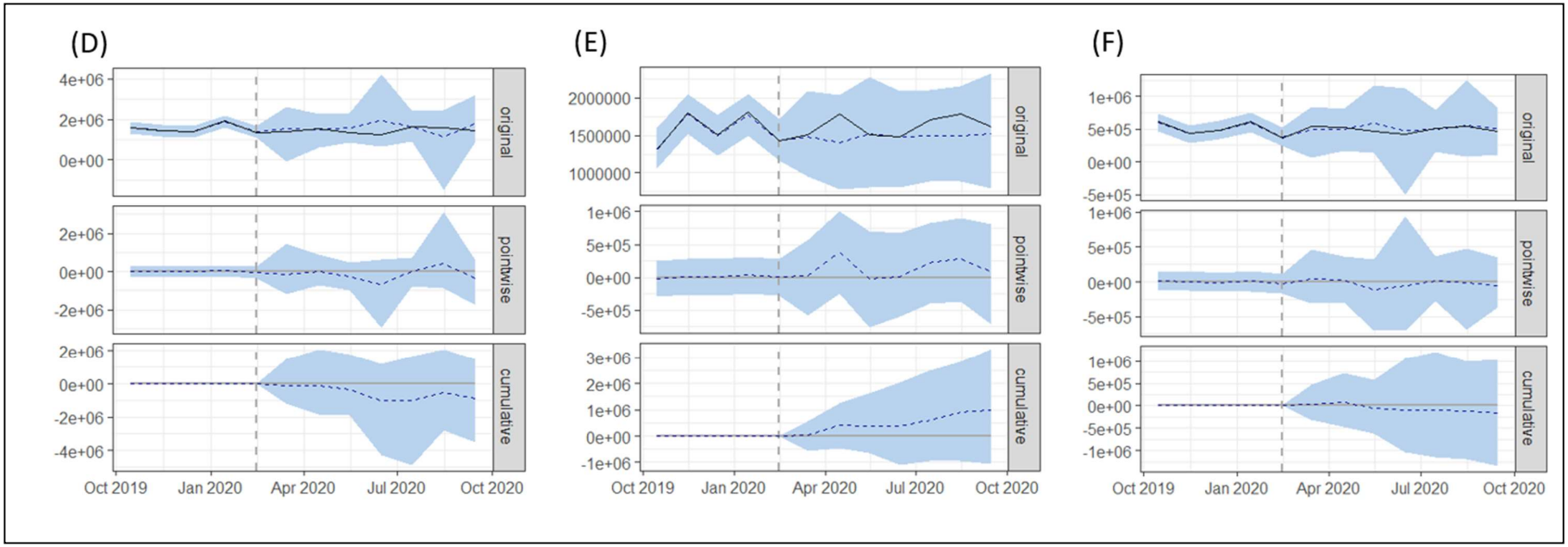

Figure 38 cont.: Changes in counts of medicines dispensed under the Pharmaceutical Benefits Scheme and Repatriation Pharmaceutical Benefits Scheme following the introduction of strict COVID-19 public health measures in March 2020, in (A) New South Wales, (B) Victoria, (C) Queensland, (D) South Australia, (E) Western Australia, (F) Tasmania, (G) Northern Territory, (H) Australian Capital Territory, short-run analysis.

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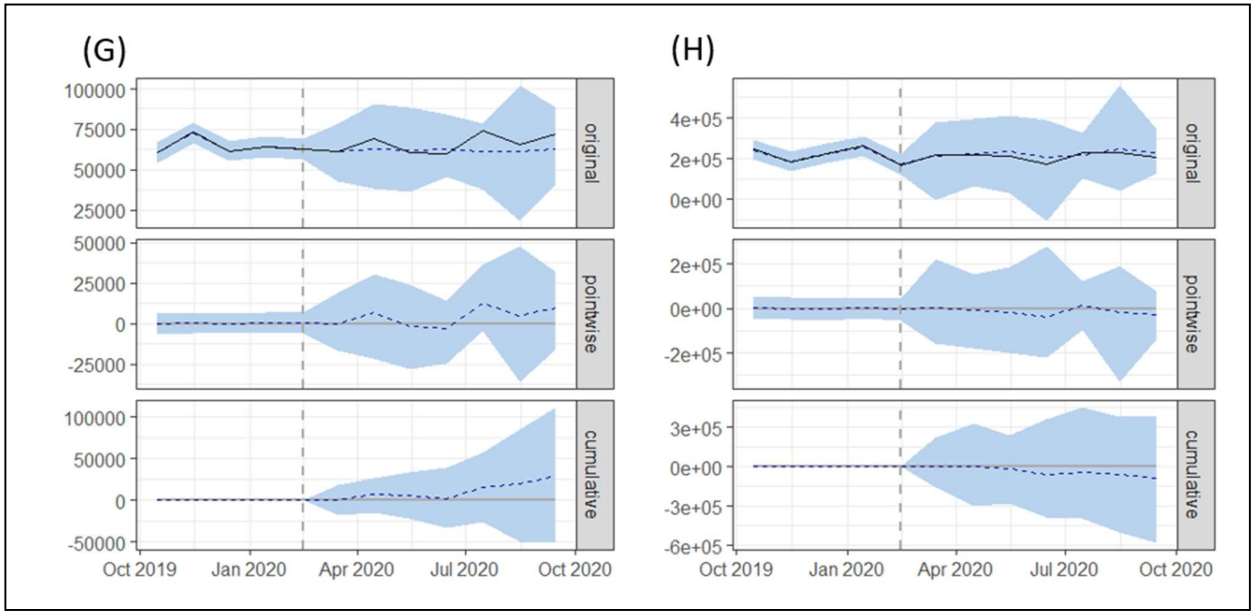

Figure 38 cont.: Changes in counts of medicines dispensed under the Pharmaceutical Benefits Scheme and Repatriation Pharmaceutical Benefits Scheme following the introduction of strict COVID-19 public health measures in March 2020, in (A) New South Wales, (B) Victoria, (C) Queensland, (D) South Australia, (E) Western Australia, (F) Tasmania, (G) Northern Territory, (H) Australian Capital Territory, short-run analysis.

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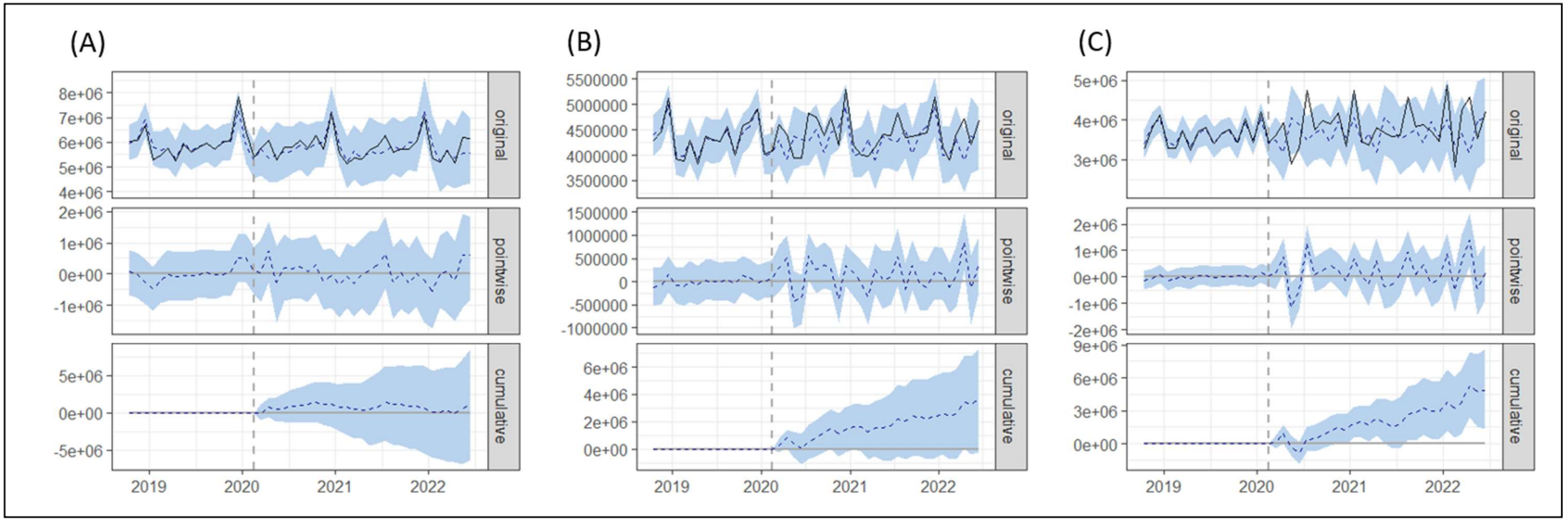

Figure 39: Changes in counts of medicines dispensed under the Pharmaceutical Benefits Scheme and Repatriation Pharmaceutical Benefits Scheme following the introduction of strict COVID-19 public health measures in March 2020, in (A) New South Wales, (B) Victoria, (C) Queensland, (D) South Australia, (E) Western Australia, (F) Tasmania, (G) Northern Territory, (H) Australian Capital Territory, long-run analysis.

Top panel displays monthly counts observed from October 2014 to June 2022 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures in March 2020.

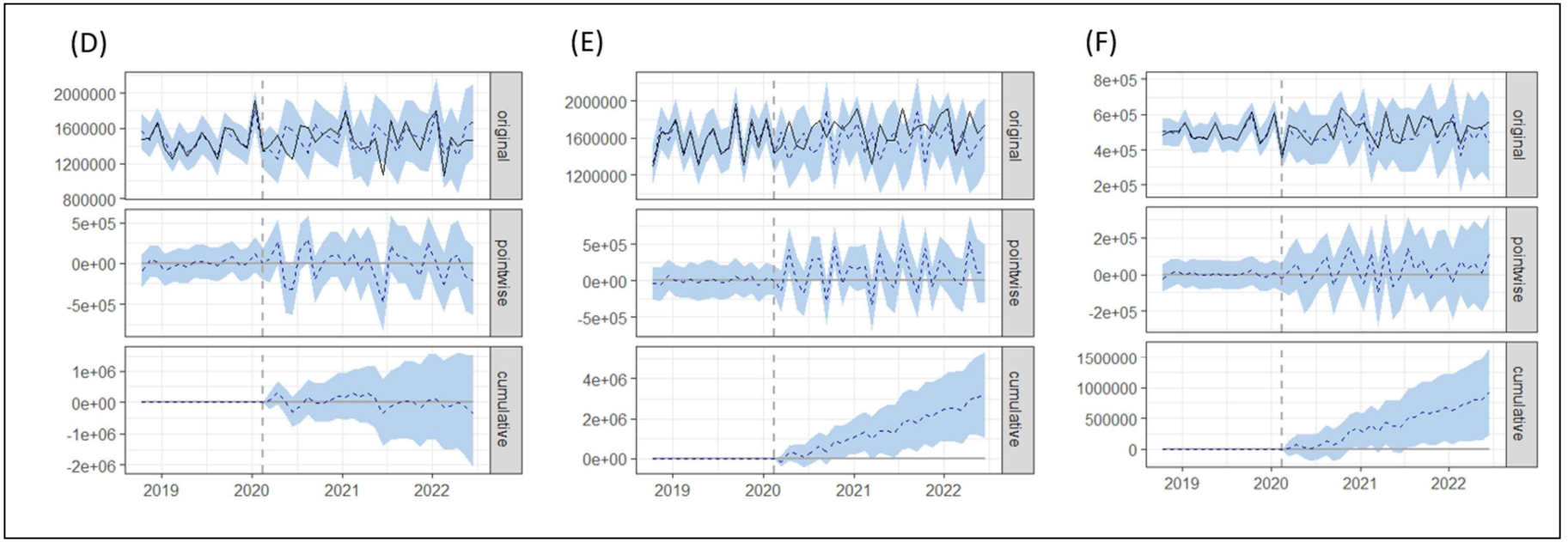

Figure 39 cont.: Changes in counts of medicines dispensed under the Pharmaceutical Benefits Scheme and Repatriation Pharmaceutical Benefits Scheme following the introduction of strict COVID-19 public health measures in March 2020, in (A) New South Wales, (B) Victoria, (C) Queensland, (D) South Australia, (E) Western Australia, (F) Tasmania, (G) Northern Territory, (H) Australian Capital Territory, long-run analysis.

Top panel displays monthly counts observed from October 2014 to June 2022 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures in March 2020.

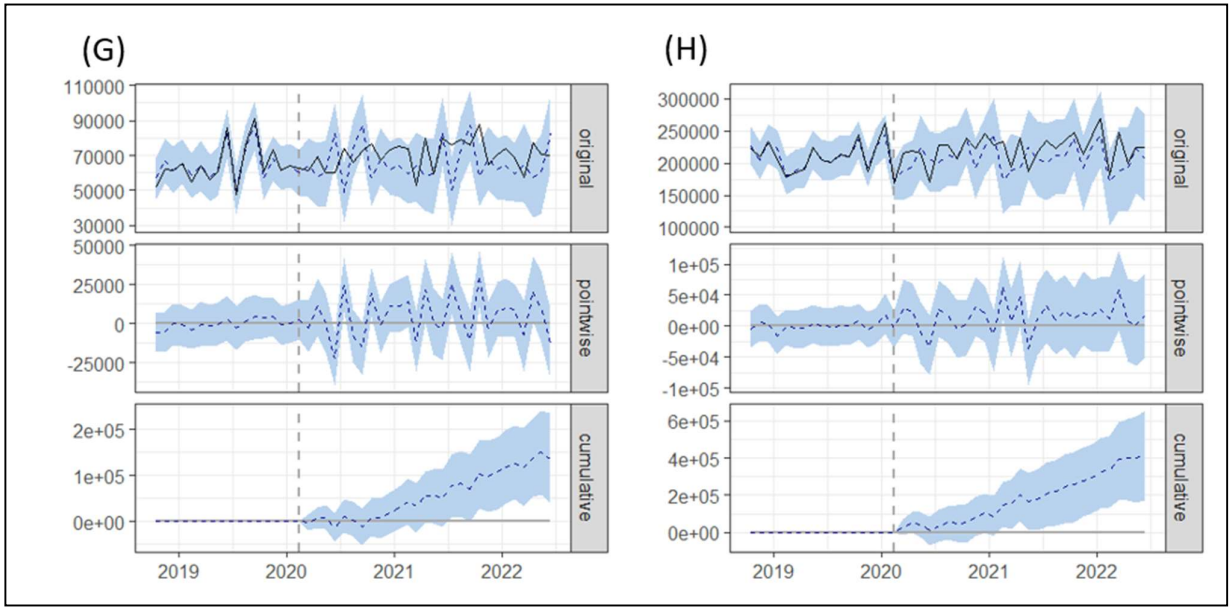

Figure 39 cont.: Changes in counts of medicines dispensed under the Pharmaceutical Benefits Scheme and Repatriation Pharmaceutical Benefits Scheme following the introduction of strict COVID-19 public health measures in March 2020, in (A) New South Wales, (B) Victoria, (C) Queensland, (D) South Australia, (E) Western Australia, (F) Tasmania, (G) Northern Territory, (H) Australian Capital Territory, long-run analysis.

Top panel displays monthly counts observed from October 2014 to June 2022 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures in March 2020.

Dispensations, by type of medication

Within Western Australia, dispensing patterns differed between medications targeting different body systems during the pandemic. In the short-run analysis with six months of follow-up, substantial but non-significant increases in monthly dispensations were recorded for cardiovascular system medications (9% monthly increase, 95%CI -13%, 30%), nervous system medications (10% increase, -9%, 30%) and medications for the alimentary tract and metabolism (10% increase, -12%, 31%) (Table 40). A non-significant decrease of 3% in monthly dispensations was recorded for anti-infectives for systemic use (-21%, 16%). The largest change was observed for conditions targeting the respiratory system. There were an additional 16,000 dispensations of these medications per month in Western Australia following the introduction of COVID-19 public health measures, equivalent to a 23% increase in dispensations (0.1%, 47%). Figure 40, panel E indicates that this increase was predominantly driven by a substantial increase in dispensations from approximately April – June 2020, after which dispensations were marginally higher than pre-pandemic levels.

Significant changes in prescribing each of the five most common medications were recorded in the long-run analysis. These changes were increases for cardiovascular medications (9% increase, 4%, 13%), nervous system medications (5% increase, 0.0%, 11%), alimentary tract and metabolism medications (12% increase, 7%, 17%), and respiratory system medications (10% increase, 5%, 14%) (Table 41). Anti-infectives for systemic use differed dramatically as these dispensations decreased by 12% (-17%, -7%). The largest absolute change was in cardiovascular system medications, showing an increase of 40,000 dispensations per month across the follow-up. In each case, these changes appeared relatively steady through the follow-up period (Figure 41) except for respiratory system medications (panel E), which had an immediate increase after introducing public health measures, followed by a steady monthly increase.

Table 40: Changes in counts of medicines dispensed under the Pharmaceutical Benefits Scheme and Repatriation Pharmaceutical Benefits Scheme following the introduction of strict COVID-19 public health measures in March 2020, by type of medication, short-run analysis.

Posterior inference	Average number of dispensations per month				Cumulative number of dispensations over follow up			
	Count	SD	95% CI		Count	SD	95% CI	
Cardiovascular								
Actual	493,319				3,453,230			
Prediction	452,736	49,660	359,008	550,910	3,169,151	347,618	2,513,059	3,856,367
Absolute effect	40,583	49,660	-57,591	134,310	284,079	347,618	-403,137	940,171
Relative effect (%)	9%	11%	-13%	30%	9%	11%	-13%	30%
Nervous system								
Actual	385,456				2,698,192			
Prediction	348,999	35,994	279,066	416,759	2,442,996	251,957	1,953,461	2,917,314
Absolute effect	36,457	35,994	-31,303	106,390	255,196	251,957	-219,122	744,731
Relative effect (%)	10%	10%	-9%	30%	10%	10%	-9%	30%
Alimentary tract and metabolism								
Actual	255,102				1,785,712			
Prediction	233,052	25,919	182,701	282,856	1,631,363	181,431	1,278,905	1,979,992
Absolute effect	22,050	25,919	-27,754	72,401	154,349	181,431	-194,280	506,807
Relative effect (%)	10%	11%	-12%	31%	10%	11%	-12%	31%
Anti-infectives for systemic use								
Actual	79,432				556,026			
Prediction	81,834	7,467	66,698	96,814	572,839	52,267	466,886	677,700
Absolute effect	-2,402	7,467	-17,382	12,734	-16,813	52,267	-121674	89,140
Relative effect (%)	-3%	9%	-21%	16%	-3%	9%	-21%	16%
Respiratory system								
Actual	87,840				614,882			
Prediction	71,348	8,404	54,149	87,802	499,437	58,831	379,042	614,613
Absolute effect	16,492	8,404	38	33,691	115,445	58,831	269	235,840
Relative effect (%)	23%	12%	0.1%	47%	23%	12%	0.1%	47%

Footnote: Follow-up period ends at the end of September 2020. SD: standard deviation; CI: confidence interval

Table 41: Changes in counts of medicines dispensed under the Pharmaceutical Benefits Scheme and Repatriation Pharmaceutical Benefits Scheme following the introduction of strict COVID-19 public health measures in March 2020, by type of medication, long-run analysis.

Posterior inference	Average number of dispensations per month				Cumulative number of dispensations over follow up			
	Count	SD	95% CI		Count	SD	95% CI	
Cardiovascular								
Actual	520,000				14,000,000			
Prediction	470,000	11,380	450,000	500,000	13,000,000	318,651	13,000,000	14,000,000
Absolute effect	40,575	11,380	17,754	62,474	1,136,112	318,651	497,123	1,749,276
Relative effect (%)	9%	2%	4%	13%	9%	2%	4%	13%
Nervous system								
Actual	390,000				11,000,000			
Prediction	370,000	9,978	351,286	390,000	10,000,000	279,374	9,836,008	11,000,000
Absolute effect	20,031	9,978	27	40,600	560,871	279,374	764	1,136,806
Relative effect (%)	5%	3%	0.0%	11%	5%	3%	0.0%	11%
Alimentary tract and metabolism								
Actual	270,090				7,562,519			
Prediction	241,884	5,679	230,041	252,544	6,772,751	159,013	6,441,161	7,071,241
Absolute effect	28,206	5,679	17,546	40,048	789,768	159,013	491,278	1,121,358
Relative effect (%)	12%	2%	7%	17%	12%	2%	7%	17%
Anti-infectives for systemic use								
Actual	79,017				2,212,477			
Prediction	89,651	2,192	85,232	93,813	2,510,222	61,371	2,386,490	2,626,756
Absolute effect	-10,634	2,192	-14,796	-6,215	-297,745	61,371	-414,279	-174,013
Relative effect (%)	-12%	2%	-17%	-7%	-12%	2%	-17%	-7%
Respiratory system								
Actual	83,340				2,333,526			
Prediction	76,093	1,843	72699	79657	2,130,596	51,603	2035560	2230401
Absolute effect	7,248	1,843	3683	10,642	202,930	51,603	103125	297,966
Relative effect (%)	10%	2%	5%	14%	10%	2%	5%	14%

Footnote: Follow-up period ends at the end of June 2022. SD: standard deviation; CI: confidence interval

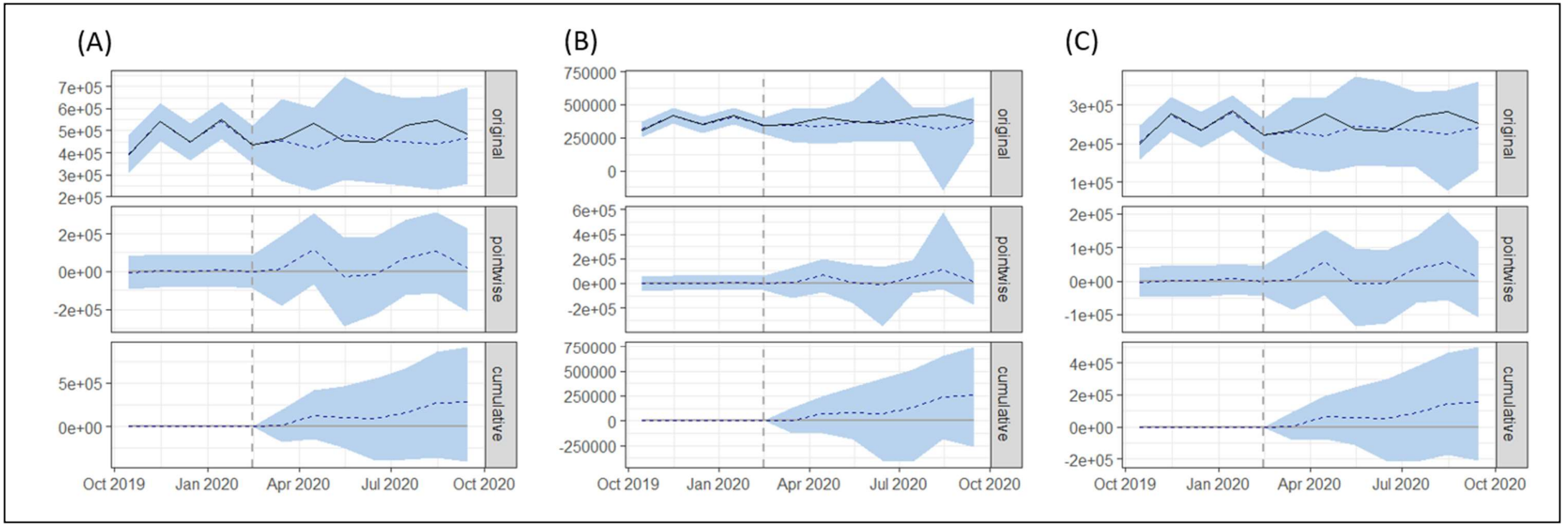

Figure 40: Changes in counts of medicines dispensed under the Pharmaceutical Benefits Scheme and Repatriation Pharmaceutical Benefits Scheme following the introduction of strict COVID-19 public health measures in March 2020, medications for (A) Cardiovascular system, (B) Nervous system, (C) alimentary tract and metabolism, (D) Anti-infectives for systematic use, (E) Respiratory system, short-run analysis.

Top panel displays monthly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures in March 2020.

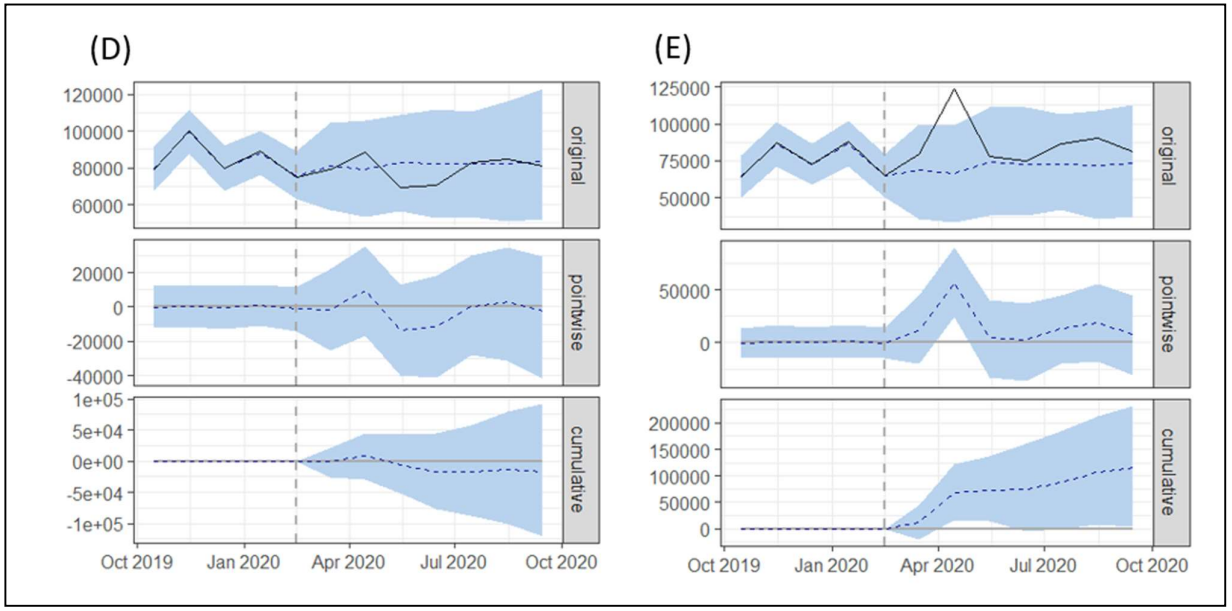

Figure 40 cont.: Changes in counts of medicines dispensed under the Pharmaceutical Benefits Scheme and Repatriation Pharmaceutical Benefits Scheme following the introduction of strict COVID-19 public health measures in March 2020, medications for (A) Cardiovascular system, (B) Nervous system, (C) alimentary tract and metabolism, (D) Anti-infectives for systematic use, (E) Respiratory system, short-run analysis.

Top panel displays monthly counts observed from October 2019 to end September 2020 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures in March 2020.

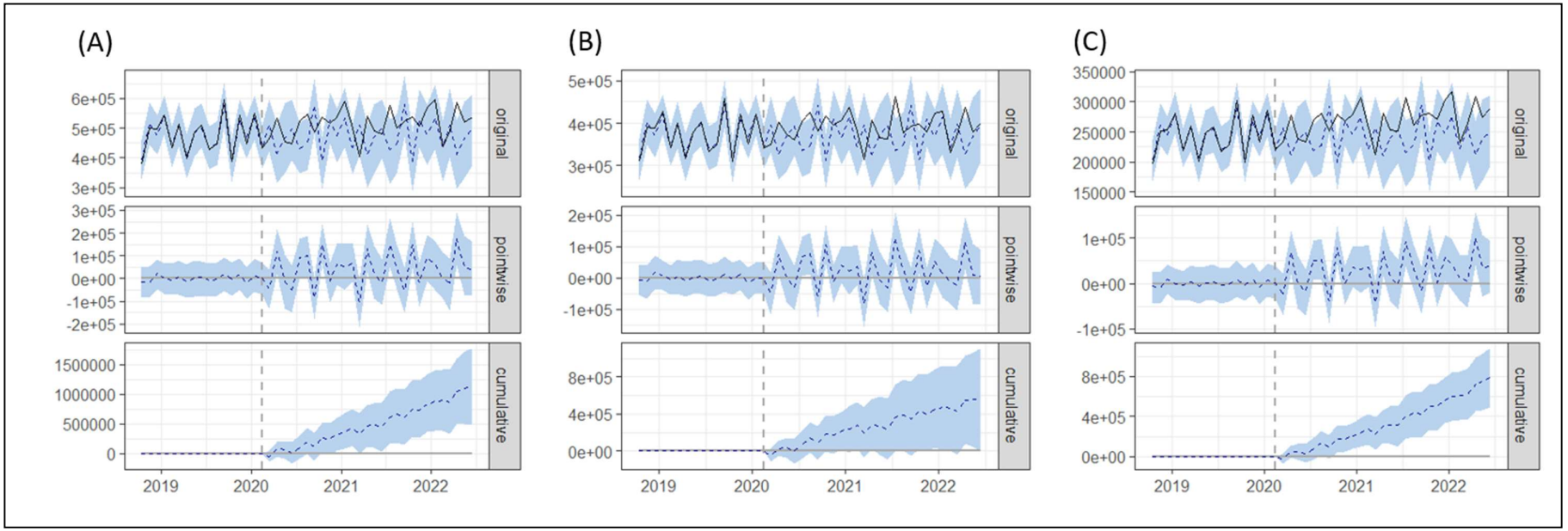

Figure 41: Changes in counts of medicines dispensed under the Pharmaceutical Benefits Scheme and Repatriation Pharmaceutical Benefits Scheme following the introduction of strict COVID-19 public health measures in March 2020, medications for (A) Cardiovascular system, (B) Nervous system, (C) alimentary tract and metabolism, (D) Anti-infectives for systematic use, (E) Respiratory system, long-run analysis.

Top panel displays monthly counts observed from October 2014 to June 2022 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures in March 2020.

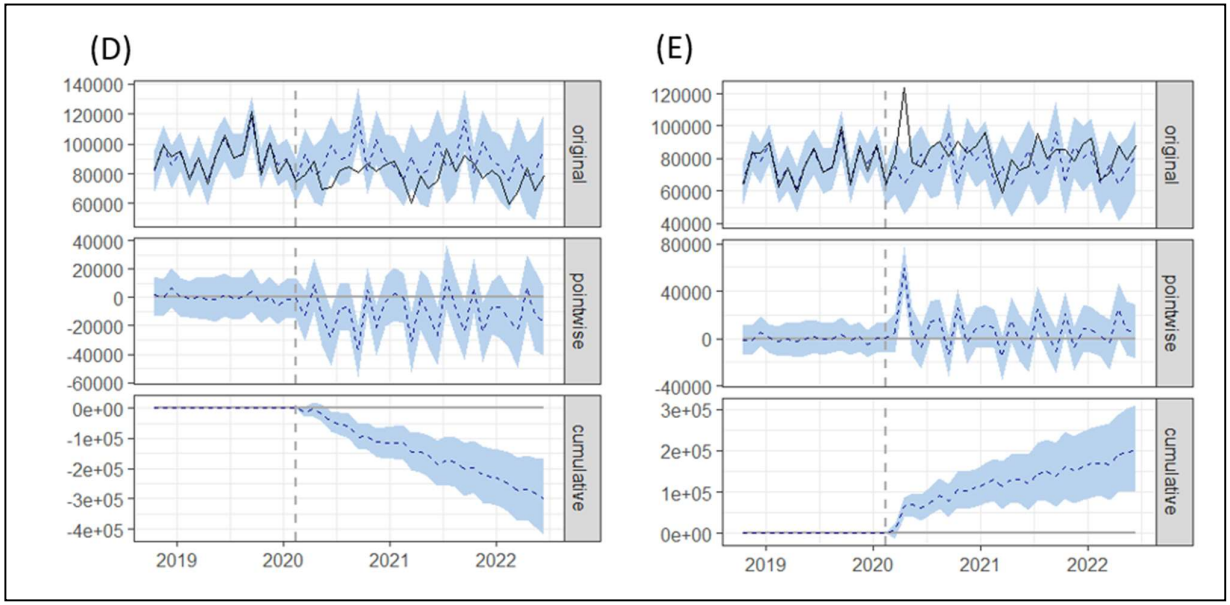

Figure 41 cont.: Changes in counts of medicines dispensed under the Pharmaceutical Benefits Scheme and Repatriation Pharmaceutical Benefits Scheme following the introduction of strict COVID-19 public health measures in March 2020, medications for (A) Cardiovascular system, (B) Nervous system, (C) alimentary tract and metabolism, (D) Anti-infectives for systematic use, (E) Respiratory system, long-run analysis.

Top panel displays monthly counts observed from October 2014 to June 2022 (solid line) and the expected counts based on the prior 5 years' data (dashed line). Shaded areas represent 95% confidence intervals. Middle panel displays the monthly difference between observed and expected counts and bottom panel displays the cumulative difference between observed and expected counts over time. Dashed vertical line represents the introduction of the strictest COVID-19 public health measures in March 2020.

Section Summary

Monthly medication dispensations funded via the PBS/RPBS remained the same in all states/territories for six months after the introduction of COVID-19 control measures. Some states/territories reported increases, and others decreases in dispensations relative to pre-pandemic levels, with Western Australia recording the largest increase. However, these changes were not statistically significant in any jurisdiction during the six-month follow-up.

Across a longer two-year follow-up, Western Australia recorded the second-largest increase in dispensations relative to the pre-pandemic period, behind the Northern Territory. Most states/territories recorded significant increases in dispensing through this period, except for New South Wales and South Australia, which recorded no significant change. These increases generally appeared as a sustained level of prescribing marginally above expected levels throughout the follow-up period. Western Australia was like most other jurisdictions in this respect.

Within Western Australia, during the six months following the introduction of COVID-19 public health measures, the dispensation of respiratory system medications recorded a large and significant increase. There was no significant change for the other five most common broad medication groups, although most recorded a net increase. The increase in respiratory system medication dispensations during this period occurs alongside a decrease in hospital admissions for respiratory disorders described earlier. The increase in respiratory system medications may have been partly driven by patients with respiratory conditions increasing their use of preventative medications to prevent exacerbation of their condition coinciding with potential COVID-19 infection.

Across a two-year follow-up, however, each of these medication types recorded a significant change. The category of anti-infectives for systemic use recorded a significant reduction, while all other categories (cardiovascular, nervous system, alimentary tract and metabolism, and respiratory system medications) increased. These changes generally appeared as levels of use steadily above pre-pandemic levels which persisted through follow-up.

Conclusion

Following the introduction of public health measures in Western Australia in response to the COVID-19 pandemic, there were substantial changes in the use of some health services. The largest change was observed for emergency department presentations, which recorded a large decrease early in the pandemic. A similar, but slightly smaller, decrease was observed for hospital admissions. The diagnoses of new cancers did not change for the population overall, nor did monthly deaths. The monthly numbers of outpatient Medicare-funded services and the counts of medications subsidised via the PBS remained the same through the six months following the introduction of pandemic control measures.

These patterns were generally similar across demographic characteristics, except for a slight difference in those aged 19-44 in how ED presentations and hospitalisations were affected in comparison to other age groups, a significant decrease in cancer diagnoses in women, which was not observed in men, and one-month increase in deaths in women, which then returned to pre-pandemic levels. The cause of the temporary increase in deaths among women is unclear. However, the decrease in cancer diagnoses in women was partly driven by a reduction in breast cancer diagnoses, likely caused by the cessation of screening programs. There was also a reduction in lung cancer diagnoses. These findings may point to patient cohorts who require further investigation to determine whether apparent delays in diagnosis have led to differences in patient management and outcomes since the pandemic.

Changes in health service use through the pandemic differed greatly between diagnostic categories. Some diagnostic categories (for example, neoplasms and conditions originating in the perinatal period, along with dialysis and chemotherapy admissions) did not record decreases in ED presentations or hospital admissions following the introduction of public health measures, possibly because of the long lead time between the onset of these conditions and the need for health services. Other categories (such as, respiratory conditions and infectious/parasitic conditions) reported substantially larger reductions in ED and hospital use, likely due to reductions in the transmission of infectious diseases resulting from pandemic control measures. Alongside reductions in hospitalisation for respiratory conditions, there was a substantial increase in dispensations of respiratory system medications, while other common medication classes did not change. No change was recorded in any category of outpatient service through the 6-month follow-up period.

Across a two-year follow-up, the increase in respiratory system medications persisted. At the same time, increases in other medication types were also recorded across the longer follow-up period, apart from anti-infectives for systemic use, which remained below pre-pandemic levels. This general increase in dispensations through the two-year follow-up period was similar in Western Australia as for most other states. In contrast, Western Australia was one of the only states (alongside Tasmania) that did not record a significant increase in the use of Medicare-funded out-of-hospital services. This insignificant change in service volumes was observed across most broad types of service in Western Australia. Data availability limitations mean that the longer two-year follow-up could not be assessed for hospitalisations, emergency department presentations, death records and cancer diagnoses.

These findings highlight potential patient cohorts who may require further investigation or monitoring to understand the potential impacts of changes in health service use throughout the pandemic.

References

1. Department of Health and Aged Care. COVID-19 Temporary MBS Telehealth Services [Internet]. Canberra: Australian Government; 2022 [cited 26 Jun 2023]. Available from: http://www.mbsonline.gov.au/internet/mbsonline/publishing.nsf/Content/Factsheet-TempBB.
2. Australian Institute of Health and Welfare. COVID-19 disruptions led to lowest number of public elective surgeries performed in over a decade [Internet]. Canberra: AIHW; 2022 [cited 26 June 2023]. Available from: https://www.aihw.gov.au/news-media/media-releases/2021/december/covid-19-disruptions-led-to-lowest-number-of-publi.
3. Carlson SJ, Tomkinson S, Blyth CC, Attwell K. COVID-19 vaccine knowledge, attitudes, and experiences of health care workers in Perth, Western Australia: A qualitative study. PLoS One. 2022; 17(12):e0279557. doi:10.1371/journal.pone.0279557.
4. Sutherland K, Chessman J, Zhao J, et al. Impact of COVID-19 on healthcare activity in NSW, Australia. Public Health Res Pract. 2020; 30(4) [cited Dec 9]; doi:10.17061/phrp3042030.
5. Lange SJ, Ritchey MD, Goodman AB, et al. Potential Indirect Effects of the COVID-19 Pandemic on Use of Emergency Departments for Acute Life-Threatening Conditions - United States, January-May 2020. MMWR Morb Mortal Wkly Rep. 2020; 69(25):795-800. [cited Jun 26]; doi:10.15585/mmwr.mm6925e2.
6. Rausa E, Kelly ME, Manfredi R, Riva I, Lucianetti A. Impact of COVID-19 on attendances to a major emergency department: an Italian perspective. Intern Med J. 2020; 50(9):1159-1160. [cited Sep]; doi:10.1111/imj.14972.
7. Mafham M, Spata E, Goldacre R, et al. COVID-19 pandemic and admission rates for and management of acute coronary syndromes in England. The Lancet. 2020; 396(10248):381-389. doi:10.1016/S0140-6736(20)31356-8.
8. Page A, Ambrose S, Glover J, Hetzel D. Atlas of Avoidable Hospitalisations in Australia: ambulatory care-sensitive conditions Adelaide: The University of Adelaide,; 2007.
9. Greene G, Griffiths R, Han J, et al. Impact of the SARS-CoV-2 pandemic on female breast, colorectal and non-small cell lung cancer incidence, stage and healthcare pathway to diagnosis during 2020 in Wales, UK, using a national cancer clinical record system. Br J Cancer. 2022; 127(3):558-568. [cited Aug]; doi:10.1038/s41416-022-01830-6.
10. Ijzerman M, Emery J. Is delayed cancer diagnosis a consequence of COVID-19? [Internet]. 2020 [cited 30 September 2020]. Available from: https://pursuit.unimelb.edu.au/articles/is-a-delayed-cancer-diagnosis-a-consequence-of-covid-19.
11. Services Australia. Medicare Item Reports [Internet]. Canberra: Australian Government; 2022 [cited 28 Sep 2022]. Available from: http://medicarestatistics.humanservices.gov.au/statistics/mbs_item.jsp.
12. Services Australia. Pharmaceutical Benefits Schedule Item Reports [Internet]. Canberra: Australian Government; 2022 [cited 28 Sep 2022]. Available from: http://medicarestatistics.humanservices.gov.au/statistics/pbs_item.jsp.
13. National Centre for Classification in Health. International Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification Sydney:1998.
14. Statistics ABo. Australian Statistical Geography Standard (ASGS): Volume 5 - Remoteness Structure, July 2016 [Internet]. Canberra: ABS; 2018 [cited 17/08/2022]. Available from: https://www.abs.gov.au/ausstats/abs@.nsf/mf/1270.0.55.005?OpenDocument.
15. Australian Bureau of Statistics. Socio-Economic Indexes for Areas [Internet]. Canberra: ABS; 2022 [cited 17/08/2022]. Available from: https://www.abs.gov.au/websitedbs/censushome.nsf/home/seifa.
16. Australian Institute of Health and Welfare. Medicines in the health system [Internet]. Canberra: AIHW; 2022 [cited 22 Mar 2023]. Available from: https://www.aihw.gov.au/reports/medicines/medicines-in-the-health-system.
17. Edwards B, Barnes R, Rehill P, et al. Variation in policy response to COVID-19 across Australian states and territories Oxford: University of Oxford; 2022.
18. Storen R, Corrigan N. COVID-19: a chronology of state and territory government announcements (up until 30 June 2020) Canberra: Parliament of Australia; 2020.

19. McNeill H. A timeline of WA's COVID-19 response: Was our success luck, good management, or a bit of both? WAtoday. 2020. Available from: https://www.watoday.com.au/national/western-australia/a-timeline-of-wa-s-covid-19-response-was-our-success-luck-good-management-or-a-bit-of-both-20200827-p55q03.html.
20. Australian Government. March 2020 news archive [Internet]. Canberra: Australian Govenment; 2021 [cited 30 June 2023]. Available from: https://www.australia.gov.au/news-and-updates/march-2020-news-archive.
21. Brodersen K, Gallusser F, Koehler J, Remy N, Scott S. Inferring causal impact using Bayesian structural time-series models. Annals of Applied Statistics. 2015; 9:247-274.
22. Australian Bureau of Statistics. IRSD [Internet]. Canberra: ABS; 2018 [Available from: https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/2033.0.55.001~2016~Main%20Features~IRSD~19.
23. Australian Bureau of Statistics. Australian Statistical Geography Standard [Internet]. Canberra: ABS; 2018 [cited 03 Dec 2021]. Available from: https://www.abs.gov.au/ausstats/abs@.nsf/mf/1270.0.55.005.
24. Australian Institute of Health and Welfare. Cancer in Australia Canberra: AIHW; 2021.
25. YJ Y, M G, FM A-Z. Global impact of COVID-19 pandemic on road trafc collisions. World J Emerg Surg. 2021; 16(51) doi:https://doi.org/10.1186/s13017-021-00395-8.
26. Welfare AIoHa. Cancer screening and COVID-19 in Australia [Internet]. Canberra: AIHW; 2020 [cited 02 June 2023]. Available from: https://www.aihw.gov.au/reports/cancer-screening/cancer-screening-and-covid-19-in-australia/contents/how-has-covid-19-affected-australias-cancer-screening-programs.
27. Department of Health and Aged Care. COVID-19 Temporary MBS Telehealth Services [Internet]. Canberra: Australian Government; 2022 [cited 02 June 2023]. Available from: http://www.mbsonline.gov.au/internet/mbsonline/publishing.nsf/Content/Factsheet-TempBB.