Healthcare Resource Utilization Disruptions During the COVID-19 Era and Methodological Considerations: A Review

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Introduction

The COVID-19 pandemic led to widespread disruptions in healthcare resource utilization (HCRU) across all settings and disease areas globally. These disruptions complicate longitudinal analyses that span the COVID-19 era and may introduce potential bias to traditional HCRU analyses. Traditional HCRU analysis methods may be insufficient to adjust for these disruptions, especially when comparing care utilization over time.

Aim

This study reviewed published articles of studies based on data that spanned the COVID-19 era, quantifying the relative change in HCRU from before the pandemic across different disease areas and summarizing applicable methods to account for this data shift

Methods

Search strategy and screening

- A systematic search for relevant articles on observational studies published in 1/1/2020 – 6/20/2024 was conducted in PubMed

- Keywords in the title or abstract used as search terms included: *COVID, pandemic, impact, effect, bias, reduction, disruption,* and HCRU types

- (Level 1) Titles, abstracts, and (Level 2) full texts of all articles extracted based on the search terms were screened against inclusion and exclusion criteria

  Inclusion criteria
  > Article was published in English
  > Study assessed the impact of the COVID-19 pandemic on HCRU using data from before and during the pandemic
  > Study incorporated either traditional methods or advanced modeling (e.g., counterfactual estimation)

  Exclusion criteria
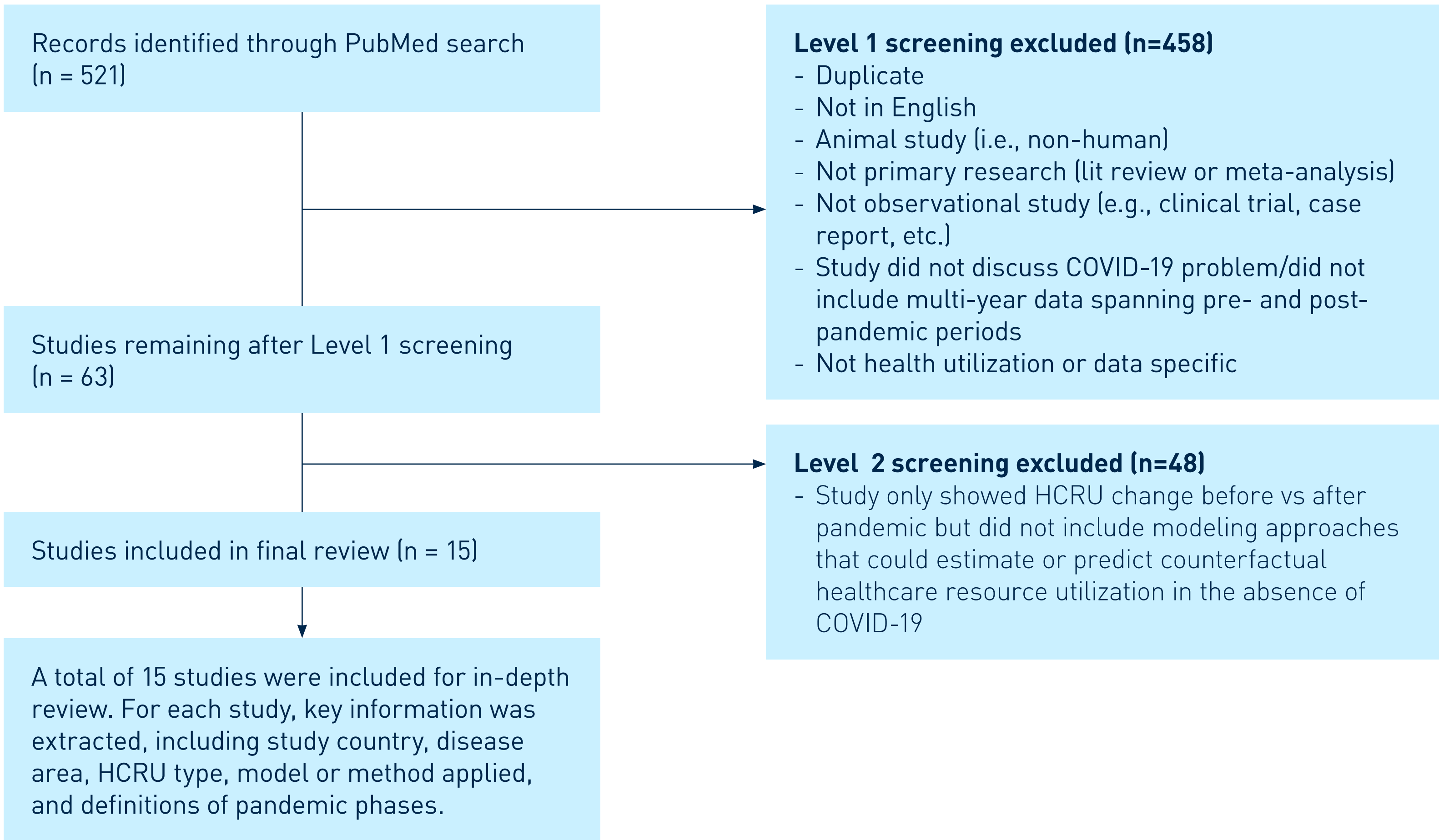 > Animal study, review/meta-analysis
  > Duplicate

Analytic approach

- HCRU data from the final set of articles were extracted and analyzed by type:
  > Outpatient visits, in-person[1]
  > Inpatient visits
  > Emergency department (ED) visits

- To standardize outcomes across studies, we reported *percent change* as a measure of the relative change in HCRU. This percent change was either extracted directly from the articles or derived using the following formulas:
  > Based on incident rate ratios (IRR):[2]

  $$\% \; Change = (IRR - 1) * 100$$

  > Based on change in number of visits:

  $$\% \; Change = \frac{N_{2020} - N_{2019}}{N_{2019}} * 100$$

- Where multiple studies reported percent change in HCRU for the same disease or disease area within the same timeframe, we computed and reported the median (range)

1. In one study (Moin 2023), outpatient visits include both in-person and virtual encounters, whereas in the other studies, outpatient visits refer to in-person visits only.
2. Principles of Epidemiology | Lesson 3 - Section 5

Results

Figure 1: PRISMA Flow Diagram of Literature Search and Screening Process

Records identified through PubMed search (n = 521)

Level 1 screening excluded (n=458)
- Duplicate
- Not in English
- Animal study (i.e., non-human)
- Not primary research (lit review or meta-analysis)
- Not observational study (e.g., clinical trial, case report, etc.)
- Study did not discuss COVID-19 problem/did not include multi-year data spanning pre- and post-pandemic periods
- Not health utilization or data specific

Studies remaining after Level 1 screening (n = 63)

Level 2 screening excluded (n=48)
- Study only showed HCRU change before vs after pandemic but did not include modeling approaches that could estimate or predict counterfactual healthcare resource utilization in the absence of COVID-19

Studies included in final review (n = 15)

A total of 15 studies were included for in-depth review. For each study, key information was extracted, including study country, disease area, HCRU type, model or method applied, and definitions of pandemic phases.

A total of 15 studies meeting eligibility were included in the review, spanning a range of disease areas, including cancer (n=3), cardiovascular conditions (n=5), chronic diseases (n=5), mental health (n=6), others (n=3), as well as the general population (n=2)[1] (Figure 2)

Component diseases that comprise the disease areas are as follows (Table 1):

Table 1. Component Diseases by Disease Area

Disease Area	Component Diseases	# of Studies
Cancer	Breast cancer	2
	Chronic lymphocytic leukemia (CLL)	1
	Lung cancer	1
	Stomach, Colorectal, Cervical, Prostate, and Other	1
	Pancreatic cancer	1
Cardiovascular conditions	Angina	2
	Atherosclerotic cardiovascular disease (ASCVD)	1
	Congestive heart failure (CHF)	4
	High cholesterol	1
	Hypertension	1
	Myocardial infarction	1
	Stroke	1
	Transient ischaemic attack	1
	Venous thromboembolism	1
	Non-specific	1
Chronic diseases	Asthma	3
	Chronic obstructive pulmonary disease	3
	Diabetes	4
	Epilepsy	2
	Non-specific	1
Mental health conditions	Assault-related injuries, deliberate self-harm	2
	Dysthymia	1
	Eating disorders	2
	Major depressive disorder (MDD)	4
	Mood and anxiety disorders	2
	Obsessive-compulsive disorder	1
	Psychiatry	1
	Substance abuse	2
General population	Latino undocumented immigrants	1
	General Japanese population	1
	Children (<18 years)	1
Other	Dental	1
	Multiple sclerosis (MS)	1
	Psoriasis	1
	Wet age-related macular degeneration (AMD)	1

1. Figures are not mutually exclusive; individual studies may report findings across multiple disease areas.

- Studies generally employed one of two statistical approaches to assess changes in HCRU during the pandemic relative to the period before:

  1. Pre vs post analysis
     > Descriptive or comparative analyses using traditional regression methods to evaluate HCRU during versus before the pandemic

  2. Interrupted time-series analysis (+/- ARIMA and time splines)
     > A counterfactual analytic approach used to estimate expected HCRU levels based on pre-pandemic trends. Changes in HCRU were then quantified by comparing expected levels to observed values, capturing both the immediate impact and longer-term trends since the onset of the pandemic

- Add-on adjustments:
  > Autoregressive Integrated Moving Average (ARIMA) to account for autocorrelation and seasonality
  > Time splines to model shifts and nonlinear trends across pandemic phases
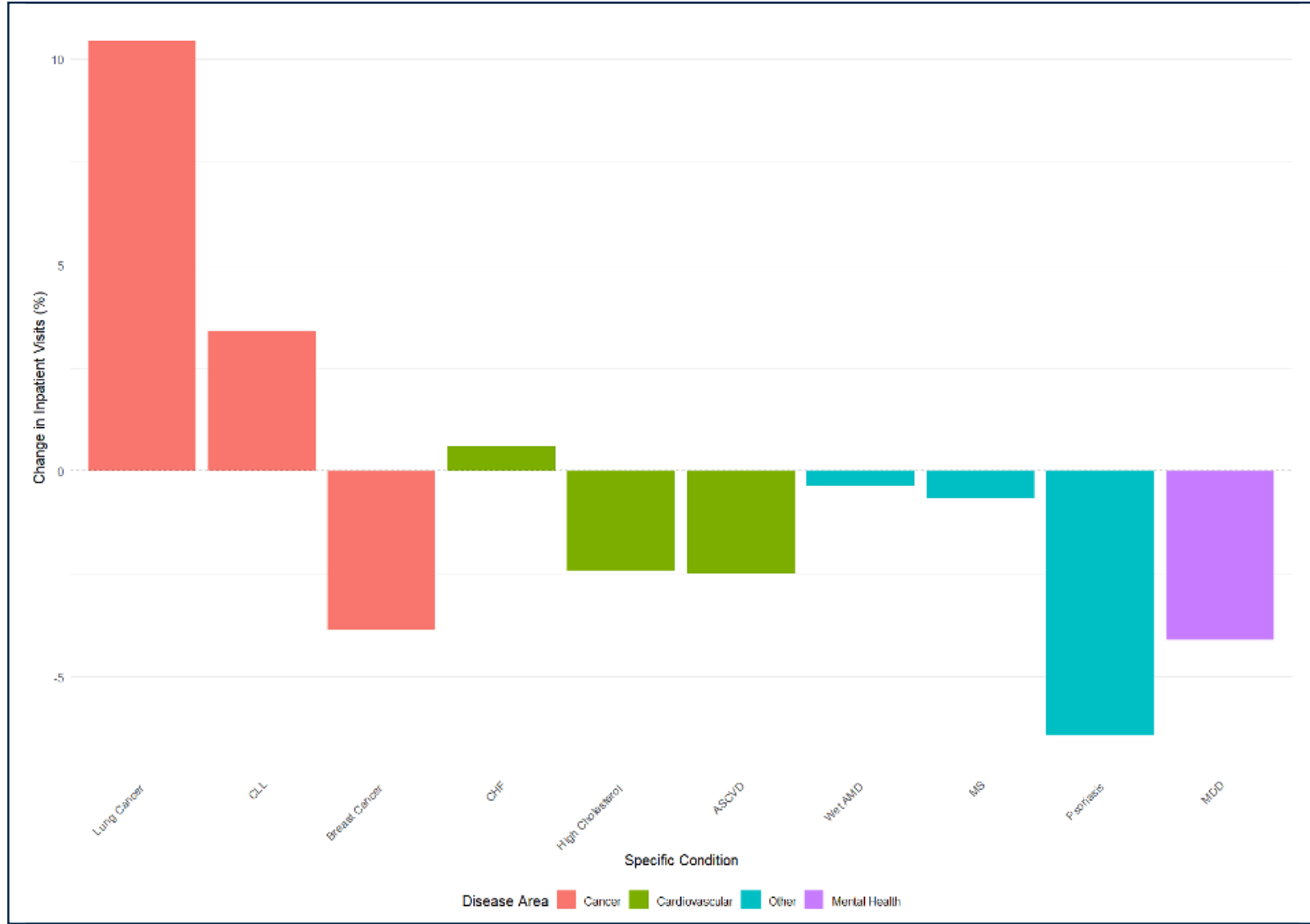
Pre vs Post Analysis

Outpatient Visits
Figure 2a. Percent change in Outpatient Visits by Disease Area During the First Year of COVID Compared to the Previous Year
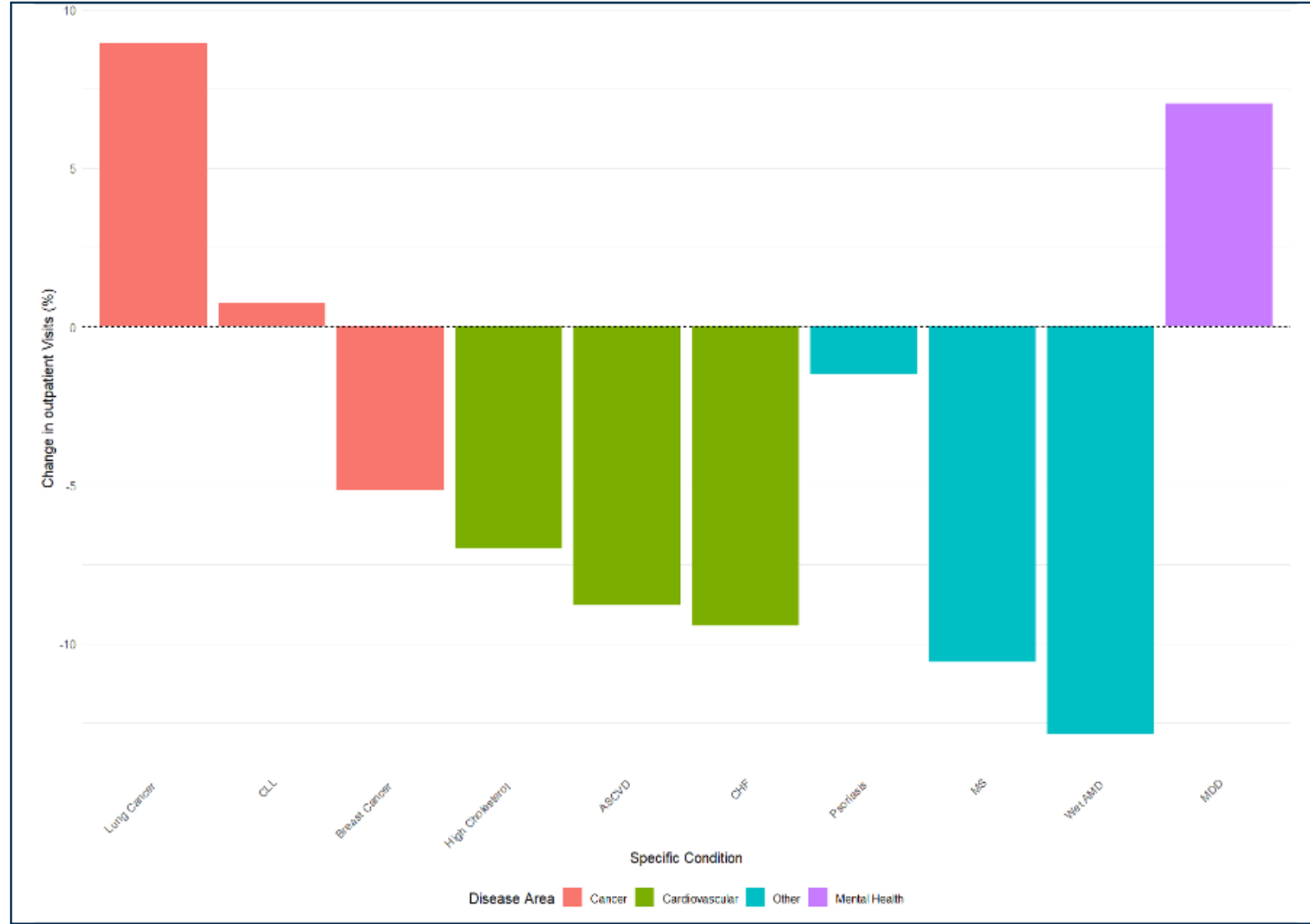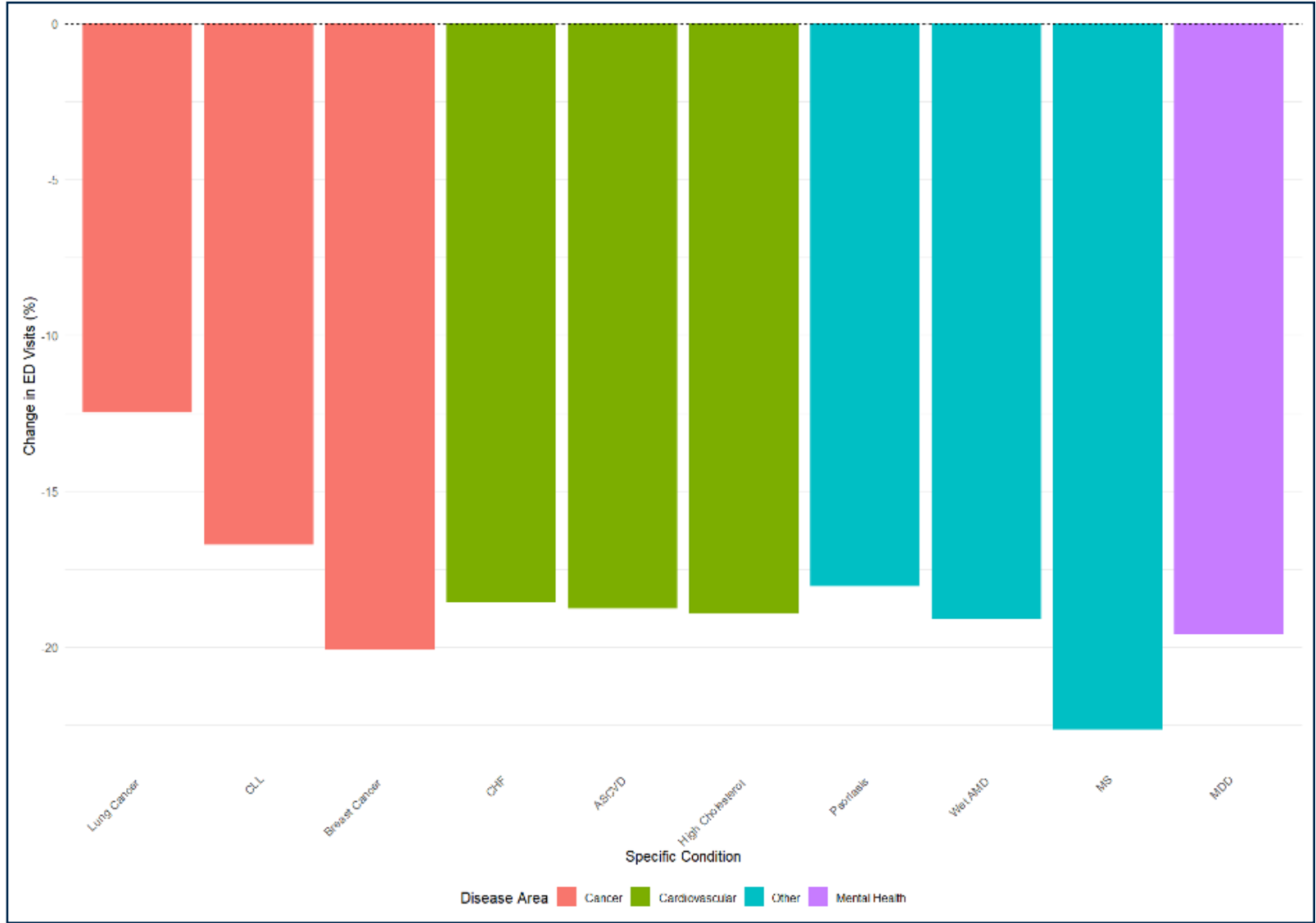
Inpatient Visits
Figure 2b. Percent change in Inpatient Visits by Disease Area During the First Year of COVID Compared to the Previous Year
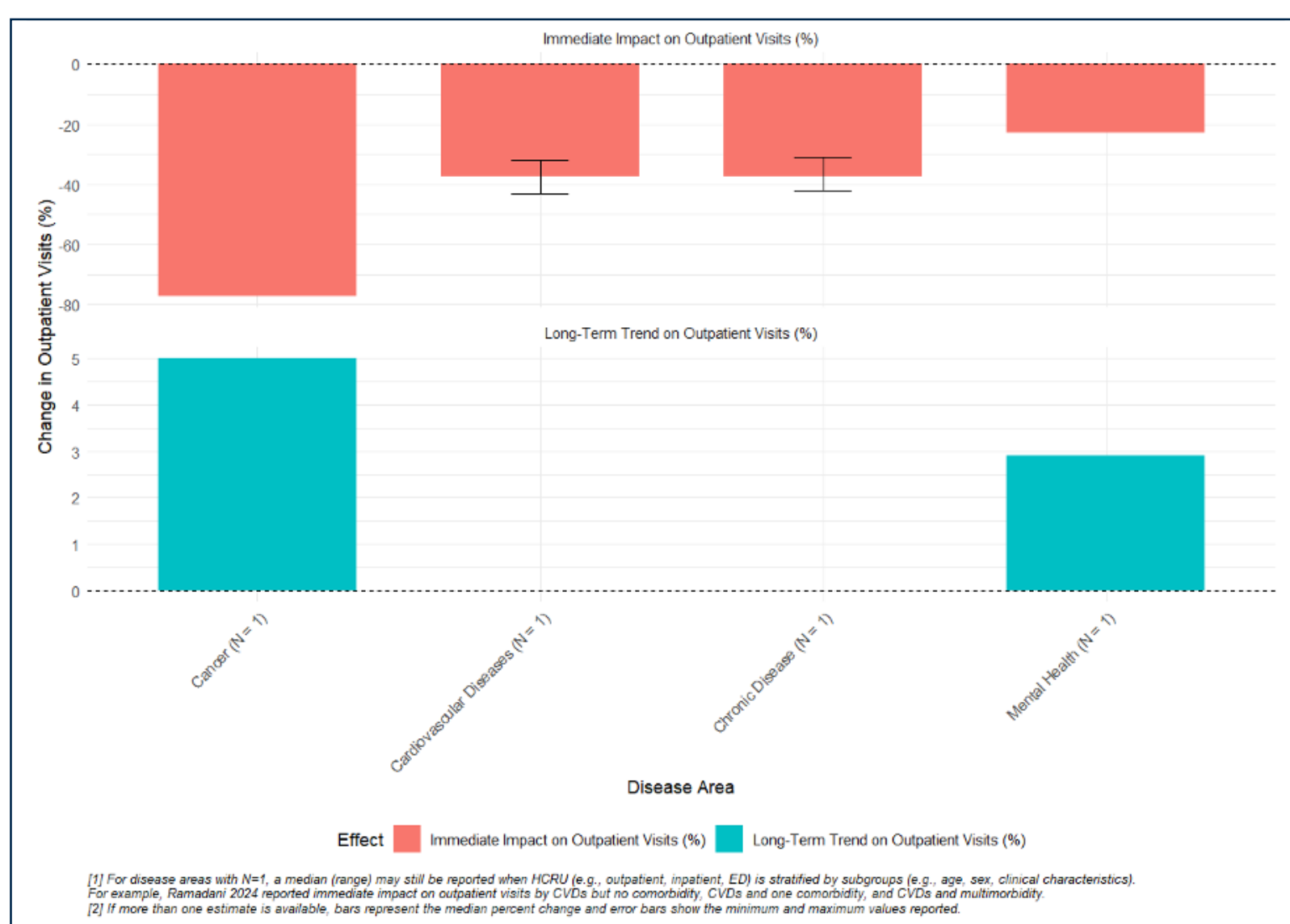
ED Visits
Figure 2c. Percent change in ED Visits by Disease Area During the First Year of COVID Compared to the Previous Year
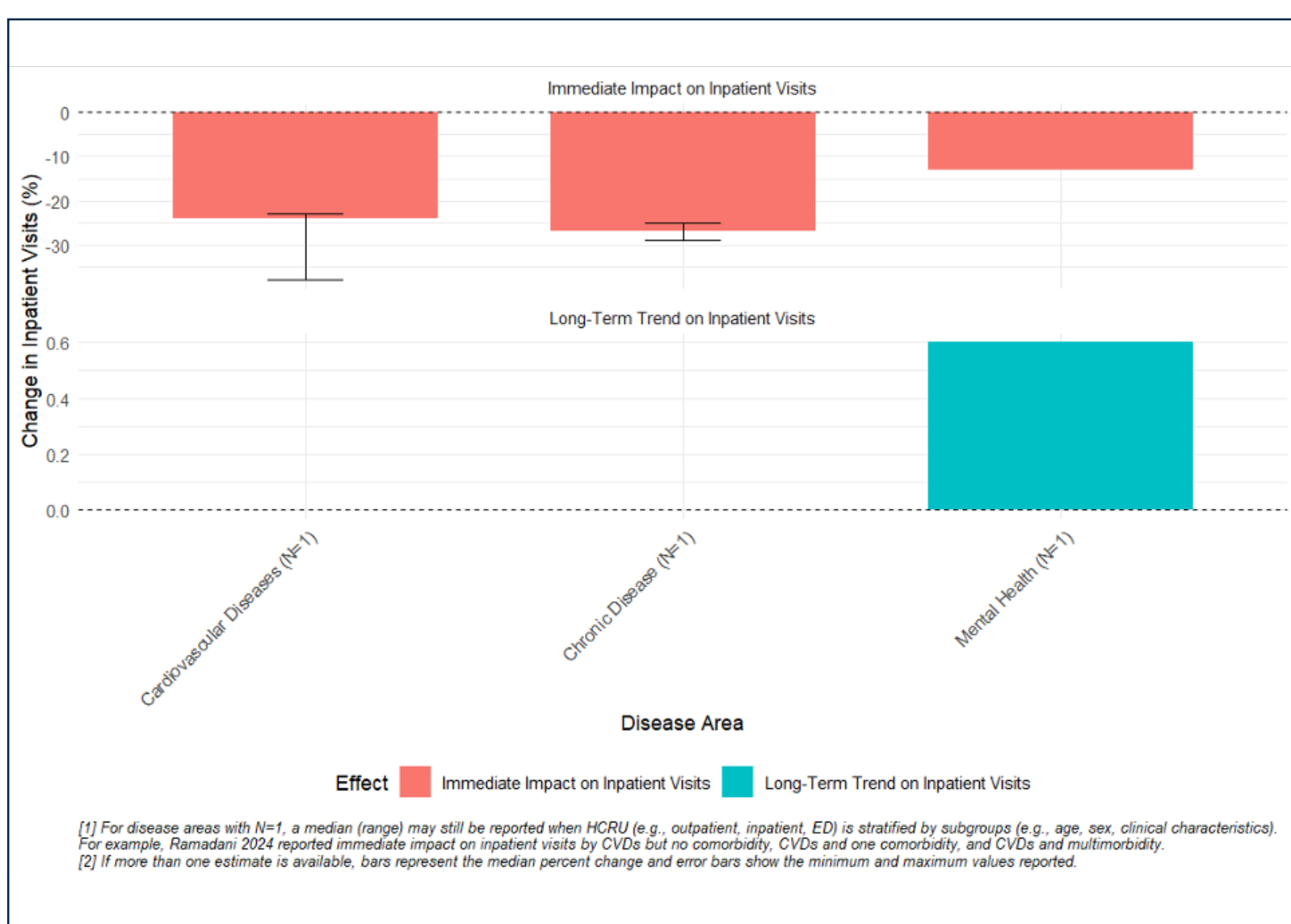
Interrupted Time-Series Analysis

Outpatient Visits
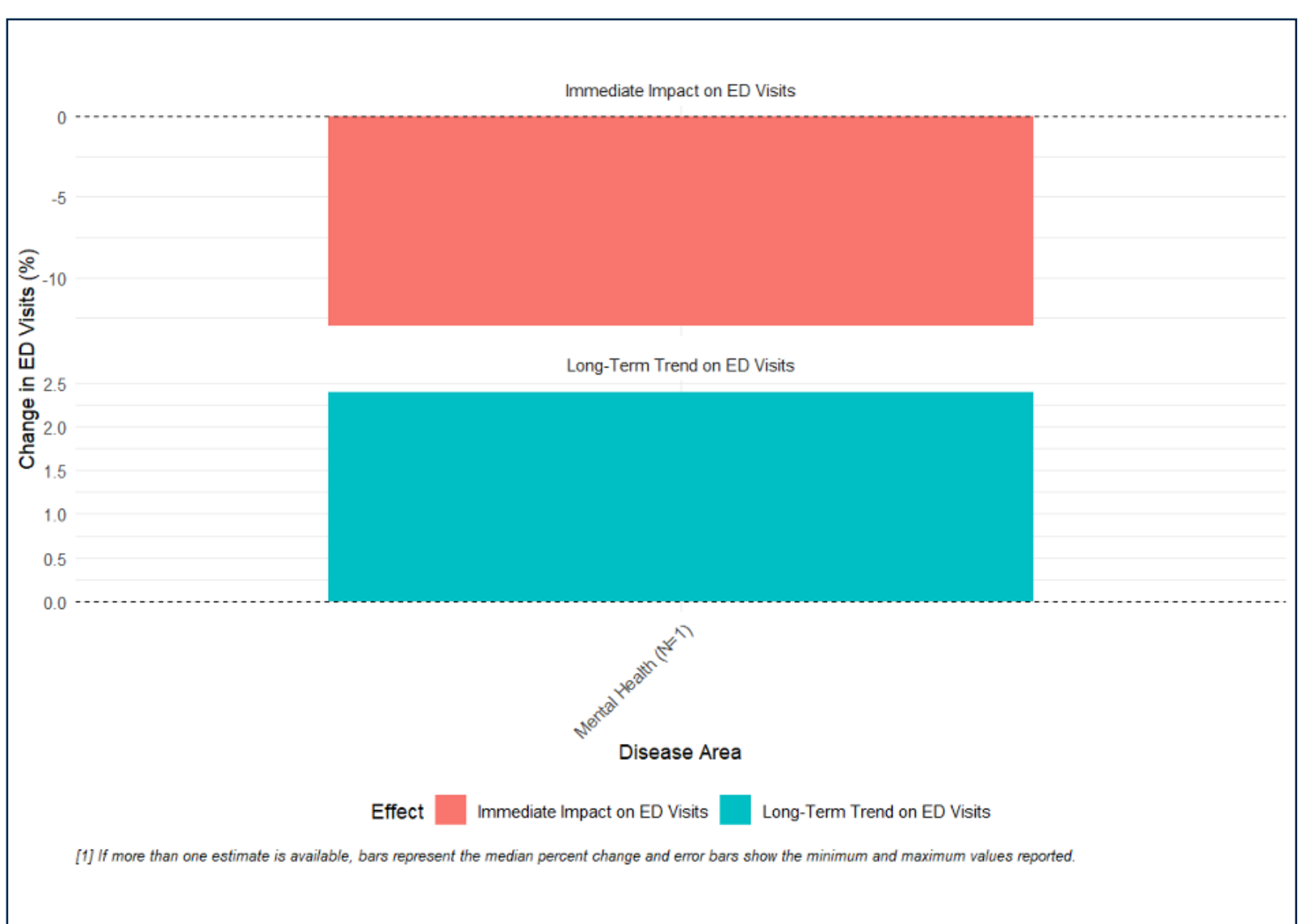Figure 3a. Immediate and Long-Term Effects on Outpatient visits by Disease Area during the Pandemic

Inpatient Visits
Figure 3b. Immediate and Long-Term Effects on Inpatient visits by Disease Area during the Pandemic

ED Visits
Figure 3c. Immediate and Long-Term Effects on ED visits by Disease Area during the Pandemic

Conclusion

- This review highlights the substantial and varied impact of COVID-19 on HCRU across diseases, HCRU type, and different phases of the pandemic
  > Acute declines in inpatient and ED care were most notable early in the pandemic, particularly for chronic diseases and cardiovascular conditions, whereas cancer care showed greater stability and a full rebound by 2023

- Mental health services experienced a sharp drop in outpatient visits, whereas general and deferrable care saw slower and less complete recovery, likely due to patient preferences and lower urgency

- A one-size-fits-all approach to accounting for COVID-era disruptions is insufficient; rather, careful consideration of the disease in question, underlying HCRU type both before and during pandemic, timing and amount of COVID-era data, and treatment (or comparison) groups involved is necessary to determine suitable approach

- While traditional methods may be suitable for certain diseases with HCRU that remained stable during the pandemic, the variety of more sophisticated models available, such as interrupted time-series, to study COVID-era HCRU interruptions could be adapted to best leverage data from this time-period in HCRU analyses

- Inadequately accounting for the magnitude of the COVID-19 disruptions on HCRU and their relative impact on treatment arms may lead to bias in HCRU assessments. This is especially true for studies that evaluate change in HCRU before and after an intervention that span the pandemic.