IMPACT OF COVID-19 ON AUSTRALIA

COS30045 DATA VISUALISATIONPROCESS BOOKSWINBURNE UNIVERSITY OF TECHNOLOGYJUNE 7, 2024

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Executive Summary

The process book documents our progress in developing an interactive platform for the project called ‘Impact of COVID-19 on Australia’. It outlines our working stages from data gathering and processing, initial design prototyping to implementing visualisations in a web browser.

The developed website’s primary objective is to leverage interactive data visualisations to effectively communicate complex statistics to a broad audience, including healthcare professionals, policymakers, and the public. To evaluate the effectiveness of the created data visualisations, our team conducted usability testing, where participants were asked to complete some tasks using our figures. This is essential in identifying common issues that users experience in reality and finding out potential causes to improve in a later stage.

In short, the process book not only acts as a concise documentation of our working process but also reflects our experience and knowledge acquired throughout the learning journey in Data Visualisation.

1. Introduction

1.1. Background and Motivation

Covid-19 is a severe global pandemic caused by the SARS-Cov-2 virus (World Health Organization, 2024). It affects lives, economies, and the functioning of healthcare systems worldwide. In response to this unprecedented healthcare crisis, our team aims to develop a website that informs the public about the virus's impact by investigating healthcare spending and trends across local government areas of Australia.

The motivation behind creating this webpage is to aggregate data related to COVID-19 visually engagingly. Our team aims at making data more accessible and interpretable to a broader audience. The utilise of up-to-date data sources in combination with interactive visualisations successfully represents healthcare expenditure, fatality rate, and vaccination coverage across Australia. In short, the platform seeks to encourage informed discussions and data-driven decision-making on pandemic response strategies.

1.2. Visualisation Purpose

The key objective of the visualisations provided on the website is to paint a clear picture of the ongoing spreading effects of the COVID-19 pandemic across Australia. By visually representing the data, web users find it easier and more engaging to find out about the changes in health aspects that are affected by the coronavirus over time.

There are three visualisations in total:

- **Healthcare Expenditure Visualisation**: This chart illustrates the financial impacts of COVID-19, showing how much Australia has spent over the years. The economic burden is highlighted by showcasing the expenditure before, and during the pandemic.
- **Fatality Rate Map**: By mapping deaths caused by Wuhan flu, this visualisation depicts a geographical view of the severity of the pandemic across different Australian states and

territories. This offers insights into regional disparities in healthcare outcomes among regions.

- **Vaccination Progress Visualisation**: This visualisation reports the number of vaccinations administered over the years, which is pivotal for assessing the effectiveness of health response, resource allocation and the progress towards enhanced public immunity.

In addition to providing insights into health trends, our team hopes to raise awareness about healthcare disparities and encourage discussions about improving health outcomes for all Australians. Deep understanding and analysis of the data and trends facilitate the creation of a healthier future for communities.

In brief, through these visualisations, we seek to empower individuals with knowledge and encourage informed decision-making to promote better health outcomes across Australia.

2. Data

2.1. Health spending

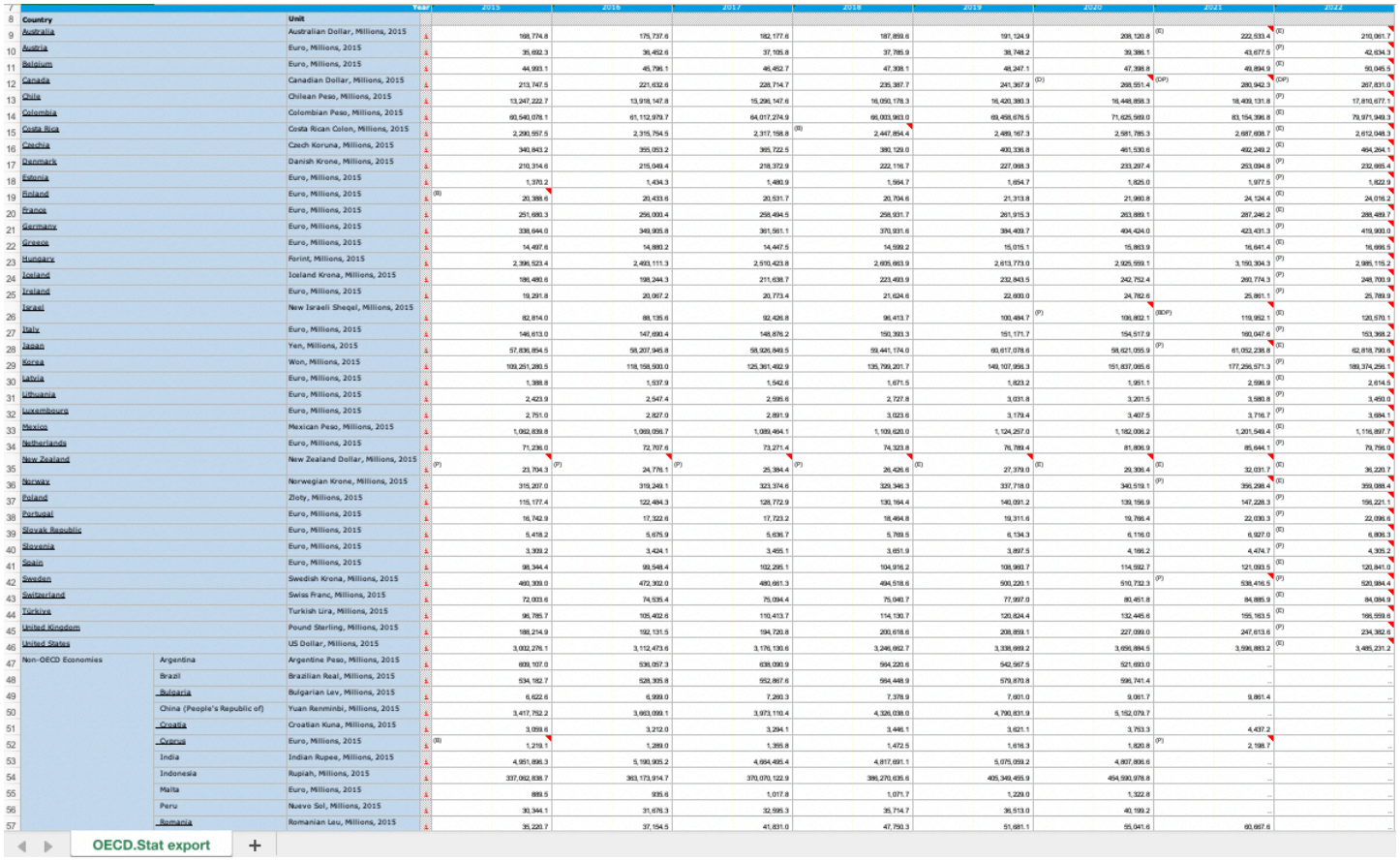
2.1.1 Data Source

- Data source link: Health expenditure and financing
- Data provider: OECD (the Organisation for Economic Cooperation and Development) hosts an online library, which provides a rich repository of statistics across numerous domains of both member and non-member countries. The data is retrieved from OECD Health Statistics. 'Health expenditure and financing' statistical data demonstrates how different countries finance their healthcare systems.

2.1.2 Data Processing

Data download

The initial data format is downloaded in the .xls file. Using sorting functions in Microsoft Excel, the data is filtered to include only data from OCED member countries from 2019 to 2022. As the analysis focuses on how health spending is influenced by COVID-19, the period for visualisation only spans from 2019 until 2022. The given timeline is sufficient to define how health expenditure of countries, especially Australia changes as a response before, during and after the pandemic.



Country		Unit	2015	2016	2017	2018	2019	2020	2021	2022
Australia		Australian Dollar, Millions, 2015	198,774.8	175,737.6	182,177.6	187,859.6	191,124.9	208,120.8	222,933.4 (E)	210,061.7 (E)
Austria		Euro, Millions, 2015	35,692.3	36,452.6	37,105.8	37,785.9	38,748.2	39,386.1	43,677.5 (P)	42,634.3 (P)
Belgium		Euro, Millions, 2015	44,993.1	45,795.1	46,452.7	47,308.1	48,247.1	47,398.8	49,894.9 (E)	50,045.9 (E)
Canada		Canadian Dollar, Millions, 2015	213,747.5	221,632.6	228,714.7	235,387.7	241,367.9 (D)	268,551.4 (DP)	280,942.3 (DP)	267,831.0 (DP)
Chile		Chilean Peso, Millions, 2015	13,247,222.7	13,918,147.8	15,296,147.6	16,090,178.3	16,420,380.3	16,448,858.3	18,409,131.8 (P)	17,810,677.1 (P)
Colombia		Colombian Peso, Millions, 2015	60,540,078.1	61,112,979.7	64,017,274.9	66,003,963.0	69,498,676.5	71,625,569.0	83,154,396.8 (E)	79,971,949.3 (E)
Costa Rica		Costa Rican Colon, Millions, 2015	2,290,557.5	2,315,754.5	2,317,198.8 (B)	2,447,854.4	2,489,167.3	2,581,785.3	2,687,938.7 (E)	2,612,948.3 (E)
Czechia		Czech Koruna, Millions, 2015	340,843.2	355,053.2	365,722.5	380,129.0	400,336.8	461,530.6	492,249.2 (E)	464,264.1 (E)
Denmark		Danish Krone, Millions, 2015	210,314.6	215,049.4	218,372.9	222,116.7	227,998.3	233,297.4	253,094.8 (P)	232,995.4 (P)
Estonia		Euro, Millions, 2015	1,370.3	1,434.3	1,480.9	1,594.7	1,654.7	1,626.0	1,977.5 (P)	1,822.9 (P)
Finland		Euro, Millions, 2015	20,388.6 (B)	20,433.6	20,531.7	20,704.6	21,313.8	21,960.8	24,124.4 (E)	24,016.2 (E)
France		Euro, Millions, 2015	251,680.3	256,000.4	258,494.5	258,931.7	261,915.3	263,889.1	287,246.2 (E)	288,489.7 (E)
Germany		Euro, Millions, 2015	338,644.0	349,905.8	361,561.1	370,931.6	384,409.7	404,424.0	423,431.3 (P)	419,993.0 (P)
Greece		Euro, Millions, 2015	14,497.6	14,880.2	14,447.5	14,599.2	15,015.1	15,863.9	16,641.4 (E)	16,699.5 (E)
Hungary		Forint, Millions, 2015	2,396,523.4	2,493,111.3	2,510,423.8	2,605,883.9	2,613,773.0	2,925,559.1	3,150,304.3 (P)	2,995,115.2 (P)
Iceland		Iceland Krona, Millions, 2015	186,480.6	198,244.3	211,638.7	223,493.9	232,843.5	242,752.4	260,774.3 (P)	248,700.9 (P)
Ireland		Euro, Millions, 2015	19,291.8	20,067.2	20,773.4	21,624.6	22,600.0	24,782.6	25,861.1 (P)	25,789.9 (P)
Israel		New Israeli Shequl, Millions, 2015	82,814.0	88,135.6	92,426.8	96,413.7	100,484.7 (P)	106,892.1	119,952.1 (BDP)	120,570.1 (E)
Italy		Euro, Millions, 2015	146,613.0	147,690.4	148,876.2	150,393.3	151,171.7	154,517.9	160,947.6 (P)	153,368.2 (P)
Japan		Yen, Millions, 2015	57,836,854.5	58,207,945.8	58,926,849.5	59,441,174.0	60,617,078.6	58,621,055.9	61,052,238.8 (P)	62,818,780.6 (E)
Korea		Won, Millions, 2015	109,251,280.5	118,158,500.0	125,361,492.9	135,799,201.7	149,107,956.3	151,837,095.6	177,256,571.3 (P)	169,374,256.1 (P)
Latvia		Euro, Millions, 2015	1,388.8	1,537.9	1,542.6	1,671.5	1,823.2	1,951.1	2,596.9 (E)	2,614.5 (E)
Lithuania		Euro, Millions, 2015	2,423.9	2,547.4	2,595.6	2,727.8	3,031.8	3,201.5	3,590.8 (P)	3,493.0 (P)
Luxembourg		Euro, Millions, 2015	2,751.0	2,827.0	2,891.9	3,023.6	3,179.4	3,407.5	3,716.7 (P)	3,684.1 (P)
Mexico		Mexican Peso, Millions, 2015	1,092,839.8	1,069,056.7	1,089,464.1	1,109,620.0	1,124,257.0	1,182,096.2	1,201,549.4 (E)	1,116,897.7 (E)
Netherlands		Euro, Millions, 2015	71,236.0	72,707.6	73,271.4	74,323.8	76,789.4	81,899.9	85,644.1 (P)	79,756.0 (P)
New Zealand		New Zealand Dollar, Millions, 2015	23,704.3 (P)	24,776.1 (P)	25,394.4 (P)	26,426.6 (E)	27,379.0 (E)	29,306.4 (E)	32,031.7 (E)	30,220.7 (E)
Norway		Norwegian Krone, Millions, 2015	315,207.0	319,249.1	323,374.6	329,346.3	337,718.0	340,519.1	356,298.4 (P)	359,088.4 (E)
Poland		Zloty, Millions, 2015	115,177.4	122,484.3	128,772.9	130,164.4	140,091.2	139,199.9	147,228.3 (P)	156,221.1 (P)
Portugal		Euro, Millions, 2015	16,742.9	17,322.6	17,723.2	18,484.8	19,311.6	19,788.4	22,030.3 (P)	22,096.6 (P)
Slovak Republic		Euro, Millions, 2015	5,418.2	5,675.9	5,636.7	5,769.5	6,134.3	6,116.0	6,927.0 (E)	6,806.3 (E)
Slovenia		Euro, Millions, 2015	3,309.2	3,424.1	3,495.1	3,651.9	3,897.5	4,166.2	4,474.7 (P)	4,305.2 (P)
Spain		Euro, Millions, 2015	98,344.4	99,548.4	102,295.1	104,916.2	108,993.7	114,592.7	121,093.5 (E)	120,841.0 (E)
Sweden		Swedish Krona, Millions, 2015	469,309.0	472,302.0	480,661.3	494,518.6	500,220.1	510,732.3	536,416.5 (P)	520,984.4 (P)
Switzerland		Swiss Franc, Millions, 2015	72,003.6	74,535.4	75,094.4	75,040.7	77,997.0	80,451.8	84,885.9 (E)	84,094.9 (E)
Türkiye		Turkish Lira, Millions, 2015	96,785.7	105,462.6	110,413.7	114,130.7	120,824.4	132,446.6	155,163.5 (E)	166,559.6 (E)
United Kingdom		Pound Sterling, Millions, 2015	186,214.9	192,131.5	194,720.8	200,618.6	208,859.1	227,099.0	247,613.6 (P)	234,382.6 (P)
United States		US Dollar, Millions, 2015	3,002,276.1	3,112,473.6	3,176,130.6	3,246,992.7	3,338,999.2	3,698,884.5	3,996,883.2 (E)	3,485,231.2 (E)
Non-OECD Economies	Argentina	Argentine Peso, Millions, 2015	609,107.0	536,057.3	638,090.9	564,220.6	542,567.5	521,693.0	..	..
	Brazil	Brazilian Real, Millions, 2015	534,182.7	528,305.8	552,867.6	564,448.9	579,870.8	596,741.4	..	..
	Bulgaria	Bulgarian Lev, Millions, 2015	6,622.6	6,999.0	7,260.3	7,378.9	7,601.0	9,061.7	9,861.4	..
	China (People's Republic of)	Yuan Renminbi, Millions, 2015	3,417,752.2	3,663,099.1	3,973,110.4	4,326,038.0	4,790,831.9	5,152,079.7	..	..
	Croatia	Croatian Kuna, Millions, 2015	3,059.6	3,212.0	3,294.1	3,446.1	3,621.1	3,753.3	4,437.2	..
	Cyprus	Euro, Millions, 2015	1,219.1 (B)	1,289.0	1,355.8	1,472.5	1,616.3	1,820.8 (P)	2,198.7	..
	India	Indian Rupee, Millions, 2015	4,951,896.3	5,190,905.2	4,694,495.4	4,817,691.1	5,075,059.2	4,807,936.6	..	..
	Indonesia	Rupiah, Millions, 2015	337,992,836.7	363,173,914.7	370,070,122.9	386,270,635.6	405,349,455.9	454,590,978.8	..	..
	Malta	Euro, Millions, 2015	889.5	935.6	1,017.8	1,071.7	1,229.0	1,322.8	..	..
	Peru	Nuevo Sol, Millions, 2015	30,344.1	31,676.3	32,595.3	35,714.7	36,513.0	40,199.2	..	..
	Romania	Romanian Leu, Millions, 2015	35,220.7	37,154.5	41,831.0	47,750.3	51,681.1	55,041.6	60,667.6	..

OECD.Stat export +

Figure 1. OECD Health Expenditure Source Data

Data Processing using Microsoft Excel

The data records the health expenditure for each country using its own currency. Therefore, it is challenging to compare the statistics. A new column called ‘Currency’ is created in replacement of the ‘Unit’ column to list the currency of OECD countries. This will be further used to convert to a common currency, which is ‘USD Dollar’.

	Country	Currency	2019	2020	2021	2022
2	Australia	AUD	191,124.9	208,120.8	222,533.4	210,061.7
3	Austria	EUR	38,748.2	39,386.1	43,677.5	42,634.3
4	Belgium	EUR	48,247.1	47,398.8	49,894.9	50,045.5
5	Canada	CAD	241,367.9	268,551.4	280,942.3	267,831.0
6	Chile	CLP	16,420,380.3	16,448,858.3	18,409,131.8	17,810,677.1
7	Colombia	COP	69,458,676.5	71,625,569.0	83,154,396.8	79,971,949.3
8	Costa Rica	CRC	2,489,167.3	2,581,785.3	2,687,608.7	2,612,048.3
9	Czechia	CZK	400,336.8	461,530.6	492,249.2	464,264.1
10	Denmark	DKK	227,068.3	233,297.4	253,094.8	232,665.4
11	Estonia	EUR	1,654.7	1,825.0	1,977.5	1,822.9
12	Finland	EUR	21,313.8	21,960.8	24,124.4	24,016.2
13	France	EUR	261,915.3	263,889.1	287,246.2	288,489.7
14	Germany	EUR	384,409.7	404,424.0	423,431.3	419,900.0
15	Greece	EUR	15,015.1	15,863.9	16,641.4	16,666.5
16	Hungary	HUF	2,613,773.0	2,925,559.1	3,150,304.3	2,985,115.2
17	Iceland	ISK	232,843.5	242,752.4	260,774.3	248,700.9
18	Ireland	EUR	22,600.0	24,782.6	25,861.1	25,789.9
19	Israel	ILS	100,484.7	106,802.1	119,952.1	120,570.1
20	Italy	EUR	151,171.7	154,517.9	160,047.6	153,368.2
21	Japan	JPY	60,617,078.6	58,621,055.9	61,052,238.8	62,818,790.6
22	Korea	KRW	149,107,956.3	151,837,065.6	177,256,571.3	189,374,256.1
23	Latvia	EUR	1,823.2	1,951.1	2,596.9	2,614.5
24	Lithuania	EUR	3,031.8	3,201.5	3,580.8	3,450.0
25	Luxembourg	EUR	3,179.4	3,407.5	3,716.7	3,684.1
26	Mexico	MXN	1,124,257.0	1,182,006.2	1,201,549.4	1,116,897.7
27	Netherlands	EUR	76,789.4	81,806.9	85,644.1	79,756.0
28	New Zealand	NZD	27,379.0	29,306.4	32,031.7	36,220.7
29	Norway	NOK	337,718.0	340,519.1	356,298.4	359,088.4
30	Poland	PLN	140,091.2	139,156.9	147,228.3	156,221.1
31	Portugal	EUR	19,311.6	19,766.4	22,030.3	22,096.6
32	Slovak Republic	EUR	6,134.3	6,116.0	6,927.0	6,806.3
33	Slovenia	EUR	3,897.5	4,166.2	4,474.7	4,305.2
34	Spain	EUR	108,960.7	114,592.7	121,093.5	120,841.0
35	Sweden	SEK	500,220.1	510,732.3	538,416.5	520,984.4
36	Switzerland	CHF	77,997.0	80,451.8	84,885.9	84,084.9
37	Türkiye	TRY	120,824.4	132,445.6	155,163.5	166,559.6
38	United Kingdom	GBP	208,859.1	227,099.0	247,613.6	234,382.6
39	United States	USD	3,338,669.2	3,656,884.5	3,596,883.2	3,485,231.2

Figure 2. Dataset with the added 'Currency' column

Then, the curated dataset is exported to the '.json' format for further processing and visualisation creation utilising the Javascript library, which is D3.js.

Data Refinement in JavaScript

To convert the raw health expenditure data to a unified currency (USD), the health spending dataset is used in combination with the currency conversion rates dataset, which will be discussed in detail in the following session. Overall, this data refinement is pivotal to accurately compare annual statistics across countries as the created visualisations offer valuable insights into contextualising Australia's statistics in a global framework.

```
script > JS expenditure.js > BarLineChart
13
14  /*
15  1. Setup and loading data
16  */
17
18  // Ensure the DOM is fully loaded before running the D3 code
19  document.addEventListener("DOMContentLoaded", function() {
20    // Load data for the 1st chart
21    d3.json("script/conversionRates2015.json").then(function(rates) {
22        // Convert the currency
23        d3.json("dataset/healthExpenditure.json").then(function(data) {
24            const convertedData = data.map(country => {
25                const rate = rates[country.Currency]; // convert health expenditure data to local currency
26                ['2019', '2020', '2021', '2022'].forEach(year => {
27                    country[year] = (parseFloat(country[year]) / rate).toFixed(2); // Convert the string to a number and apply the rate
28                });
29                return country;
30            });
31
32            // calculate ranks
33            const rankings = calculateRankings(convertedData);
34
35            // Extract expenditure data for Australia
36            const australiaData = ['2019', '2020', '2021', '2022'].map(year => {
37                const entry = rankings[year].find(e => e.country === 'Australia');
38                return { year, expenditure: entry.expenditure, rank: entry.rank };
39            });
40
41            BarLineChart(australiaData);
42
43            console.log(australiaData);
44
45        }).catch(error => {
46            console.error('Error fetching or processing data:', error);
47        });
48    });
49  });
50
```

Figure 3. Code snippet to convert currency

The above code snippet supports the conversion of the original health spending dataset from various currencies to a shared currency, which is USD and the ranking calculation. The process is divided into four main steps:

1. **Data Loading**: It begins with loading two following key datasets:
    - *conversionRates2015.json*: it encompasses currency conversion rates that map each country's currency to the equivalent value in USD.
    - *healthExpenditure.json*: it includes raw data health expenditure data for 38 OECD countries in their respective national currencies.
2. **Currency Conversion**: Each country's expenditure record is fetched from the healthExpenditure.json file and converted into USD by applying the conversion rate specified in the conversionRates2015.json. More specifically, the original health spending is divided by the respective rate for each country's currency.

3. **Ranking Calculation**: Once the data is converted, a ranking function is applied to evaluate each nation's expenditure in comparison to others.
4. **Data Integration in Visualisations**: The processed data, which mainly focuses on Australia is used to generate a bar and line combo chart, which is further discussed in the following section of the process book.

2.2. Currency Conversion Rates

2.2.1 Data Source

Data source link: Purchasing power parities (PPP)

Conversion rates are downloaded from the OECD Data platform. As discussed earlier, the use of diverse currencies does not facilitate the comparison among countries in terms of health spending from 2019 to 2022. Hence, the currency conversion rates are pivotal in exchanging to a common USD dollar currency.

Instead of using the exchange rates, our team decided to utilise the purchasing power parities (PPP) due to the following characteristics:

- **True Cost Reflection**: PPPs are currency conversion rates that equalise the purchasing power of various currencies by removing disparities in price levels between nations (OECD, 2023). They account for the difference in costs of living and actual purchasing power in each country. The use of Purchasing Power Parities demonstrates higher accuracy in how much medical goods and services can be acquired in each location for the same amount of money.
- **Stability**: PPP rates remain stable over time (Wikipedia Contributors, 2019). However, exchange rates are susceptible to sudden shifts due to transformations in the economy or politics (Lowry, 2024), which may lead to misleading comparisons.

2.2.2 Data Processing

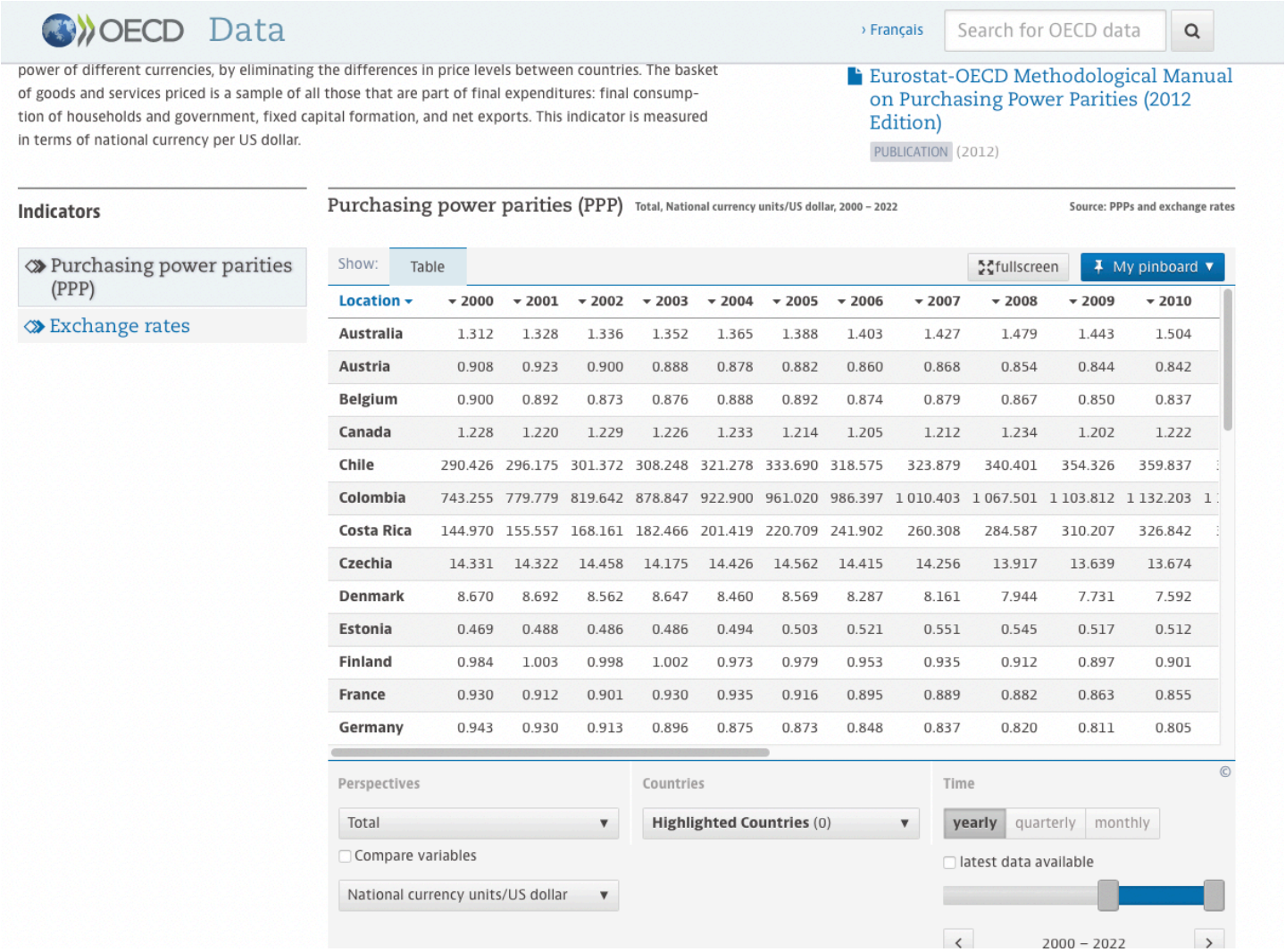


Figure 4. Purchasing power parities raw data on OECD Data webpage

The rates are first accessed via the OECD Data website. The webpage provides filtering functionality underneath the table of statistics. As the value of the currency in the original health expenditure data is indicated to be in 2015, the conversion rates are taken in this corresponding year for alignment. The main target countries for analysis are OECD countries; therefore, the rates for 38 countries in total are essential.

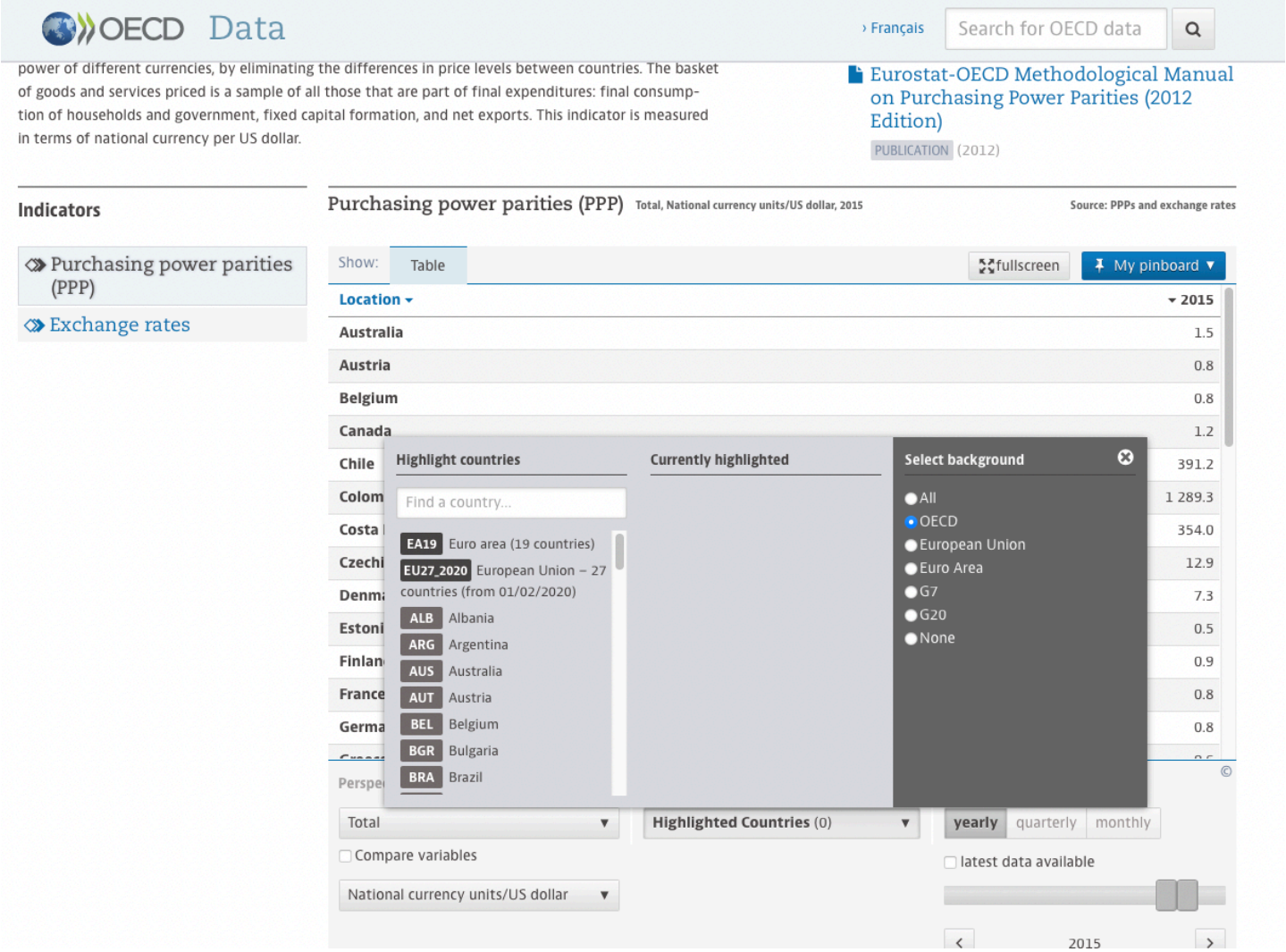


Figure 5. Filter currency conversion rates

Upon the filtered data, it is downloaded and converted to a '.json' file to be used for the currency conversion function.

2.3. COVID-19 Death Cases

2.3.1 Data Source

The primary data for this project is sourced from the Australian Bureau of Statistics (ABS). The Australian Bureau of Statistics (ABS) is the national agency responsible for collecting and providing statistical information about Australia. Established in 1905, the ABS helps support decisions made by the government, businesses, and researchers by offering reliable and accurate data on various topics such as economics, health and population.

The specific dataset used is "COVID-19 Mortality in Australia: Deaths Registered until 31 January 2024". This dataset provides detailed information on the number of deaths due to COVID-19 across different states in Australia from 2021 to 2024.

Link to the data source: ABS COVID-19 Mortality Data

The data is presented in a tabular format and includes the following attributes:

- State: The region in Australia where the deaths were registered.
- Year: The year in which the deaths were registered (2021, 2022, 2023, 2024).
- Number of Deaths: The number of deaths registered each year.
- Total: The cumulative number of deaths over the entire period.

As the visualisation depicts the number of COVID-19-related deaths by states over the years, other attributes available in the dataset, such as standardized death rates, are not included in this visualisation.

2.3.2 Data Processing:

Here is the initial dataset before cleaning up and processing:

COVID-19 deaths by state of registration, 2020-24

Download

	2020	2021	2022	2023	2024	Total
Number of deaths						
NSW	63	630	3,733	1,567	76	6,069
Vic	805	706	2,986	1,184	54	5,735
Qld	4	3	1,691	766	24	2,488
SA	4	3	845	371	9	1,232
WA	11	0	639	441	19	1,110
Tas	17	0	200	117	6	340
NT	0	1	52	15	1	69
ACT	2	12	155	64	0	233
Aus	906	1,355	10,301	4,525	189	17,276
Standardised death rates						
NSW	0.7	6.0	31.3	12.6	7.0	13.1
Vic	10.7	8.2	32.1	12.4	6.7	15.9
Qld	np	np	24.3	10.6	3.9	9.2
SA	np	np	27.7	11.7	np	10.3
WA	np	—	17.8	11.7	np	8.0
Tas	np	—	22.3	12.3	np	9.7
NT	—	np	37.2	np	np	12.3
ACT	np	np	30.7	12.4	—	12.0
Aus	3.1	4.1	28.3	12.0	5.8	12.2

Figure 6. Australia's Raw Mortality Dataset

Data Cleanup and Processing Steps

1. **Data Collection:**

- Access the ABS website and search for the dataset "COVID-19 Mortality in Australia: Deaths Registered until 31 January 2024".
- Download the dataset as a CSV file.

2. Initial Data Format:

- The dataset is initially presented as shown in the image:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	COVID-19 deaths by state of registration, 2020-24																					
2		2020	2021	2022	2023	2024	Total															
3	Number of deaths																					
4	NSW	63	630	3,733	1,567	76	6,069															
5	Vic	805	706	2,986	1,184	54	5,735															
6	Qld	4	3	1,691	766	24	2,488															
7	SA	4	3	845	371	9	1,232															
8	WA	11	0	639	441	19	1,110															
9	Tas	17	0	200	117	6	340															
10	NT	0	1	52	15	1	69															
11	ACT	2	12	155	64	0	233															
12	Aus	906	1,355	10,301	4,525	189	17,276															
13	Standardised death rates																					
14	NSW	0.7	6	31.3	12.6	7	13.1															
15	Vic	10.7	8.2	32.1	12.4	6.7	15.9															
16	Qld	np	np	24.3	10.6	3.9	9.2															
17	SA	np	np	27.7	11.7	np	10.3															
18	WA	np	â€”	17.8	11.7	np	8															
19	Tas	np	â€”	22.3	12.3	np	9.7															
20	NT	â€”	np	37.2	np	np	12.3															
21	ACT	np	np	30.7	12.4	â€”	12															
22	Aus	3.1	4.1	28.3	12	5.8	12.2															
23																						
24	a. Includes COVID-19 death registrations only. Numbers will differ to disease surveillance systems.																					
25	b. Includes all COVID-19 deaths (both doctor and coroner certified) that occurred and were registered by 31 January 2024.																					
26	c. All deaths due to COVID-19 in this report have been coded to ICD-10 code U07.1 COVID-19, virus identified; U07.2 COVID-19, virus not identified as the underlying cause of death; or U10.9 Multisystem inflammatory syndrome associated with COVID-19.																					
27	d. Data is provisional and subject to change.																					
28	e. Refer to the methodology for more information regarding the data in this graph.																					
29	f. Standardised death rates have been annualised.																					
30																						
31	Source: Australian Bureau of Statistics, COVID-19 Mortality in Australia: Deaths registered until 31 January 2024 27/02/2024																					
32																						
33																						

Figure 7. Raw Mortality Dataset (view in Microsoft Excel)

3. Removing Unnecessary Data:

- Exclude data from the year 2020 as our focus is on the period from 2021 to 2024.
- Remove the columns related to standardized death rates, as they are not required for this visualization.

	A	B	C	D	E	F
1	Number of deaths	2021	2022	2023	2024	
2	NSW	630	3733	1567	76	
3	Vic	706	2986	1184	54	
4	Qld	3	1691	766	24	
5	SA	3	845	371	9	
6	WA	0	639	441	19	
7	Tas	0	200	117	6	
8	NT	1	52	15	1	
9	ACT	12	155	64	0	
10						

Figure 8. Refined Australian Mortality Dataset

4. Calculating Totals for Australia:

- Use the SUM function to calculate the total number of deaths in Australia for each year from 2021 to 2024:

  “=SUM(B2:B9)”

	A	B	C	D	E	F
1	Number of deaths	2021	2022	2023	2024	
2	NSW	630	3,733	1,567	76	
3	Vic	706	2,986	1,184	54	
4	Qld	3	1,691	766	24	
5	SA	3	845	371	9	
6	WA	0	639	441	19	
7	Tas	0	200	117	6	
8	NT	1	52	15	1	
9	ACT	12	155	64	0	
10	Aus	1,355				
11						

Figure 9. Calculating the totals for Australia's statistics

- Apply this function across all relevant columns (B to E) for the row labelled "Aus". Use the "Fill Right" feature to copy the formula across these columns.

- To calculate the total number of deaths for each state over the period from 2021 to 2024, use the following formula for each state's row:

  “=SUM(B2:E2)”

	A	B	C	D	E	F
1	Number of deaths	2021	2022	2023	2024	Total
2	NSW	630	3,733	1,567	76	6006
3	Vic	706	2,986	1,184	54	
4	Qld	3	1,691	766	24	
5	SA	3	845	371	9	
6	WA	0	639	441	19	
7	Tas	0	200	117	6	
8	NT	1	52	15	1	
9	ACT	12	155	64	0	
10	Aus	1,355	10,301	4,525	189	
11						

Figure 10. Calculate Annual Total Deaths for each State

- Apply this formula down the column for each state by using the "Fill Down" feature.

5. **Formatting Data for Use in D3.js:**

- Ensure the numerical data is in a format readable by D3.js. Select the data range (B2) and change the format to "General" to ensure compatibility.
- Save the processed data as "deaths.csv" for use in the visualization.

Final Processed Dataset

After processing, the final dataset is displayed as follows:

	A	B	C	D	E	F	G
1	Number of deaths	2021	2022	2023	2024	Total	
2	NSW	630	3733	1567	76	6006	
3	Vic	706	2986	1184	54	4930	
4	Qld	3	1691	766	24	2484	
5	SA	3	845	371	9	1228	
6	WA	0	639	441	19	1099	
7	Tas	0	200	117	6	323	
8	NT	1	52	15	1	69	
9	ACT	12	155	64	0	231	
10	Aus	1355	10301	4525	189	16370	
11							

Figure 11. Final Mortality Dataset

This structured approach to data handling ensures that the visualization is both accurate and meaningful, helping users understand the impact of COVID-19 across Australia and the effectiveness of vaccination efforts.

2.4. COVID-19 Vaccination Doses

2.4.1 Data Source

The visualisation utilises data that is acquired from the Australian Government Department of Health and Aged Care. The Department of Health and Aged Care is the national body responsible for managing and providing public health services, information, and policies in Australia. It supports health-related decisions made by the government, healthcare providers, and researchers by offering reliable and accurate data on various health topics, including the COVID-19 vaccination rollout.

The specific dataset used is the "COVID-19 Vaccination Rollout Update." This dataset provides detailed information on the number of COVID-19 vaccination doses administered across different states in Australia from 2021 to 2024.

Link to the data source: Australian Government Department of Health and Aged Care

The data is presented in a tabular format and includes the following attributes:

- State: The region in Australia where the vaccinations were administered.
- Year: The year in which the vaccinations were administered (2021, 2022, 2023, 2024).
- Total Doses Administered: The cumulative number of vaccine doses administered.
- Doses Administered: The number of doses given.

The main focus is placed on the total number of COVID-19 vaccination doses administered by states and years. Other attributes available in the dataset, such as first, second, and booster doses, are excluded from this visualization.

2.4.2 Data Processing

Data Collection:

- Access the Australian Government Department of Health and Aged Care website and navigate to the "COVID-19-Vaccination Vaccination Data".
- Since the data is provided in separate yearly reports, collect data from each year individually (e.g., for 2021, use data from September 2021).

Figure 12. Vaccination Datasource

Initial Data Format:

- Download the dataset for each year. The dataset initially includes various attributes, but for this project, only the total vaccination doses by state are needed.

	A	B	C	D
1	Measure Name	Value		
2	National - Total vaccine doses administered	20,855,353		
3	National - Daily increase - Total vaccine doses recorded	213,595		
4	National - Number of people 16 and over with 1 dose	12,938,761		
5	National - Number of people 16 and over fully vaccinated	7,879,487		
6	National - Population 16 and over	20,619,959		
7	ACT - Administration state - Total vaccine doses administered	490,820		
8	NSW - Administration state - Total vaccine doses administered	7,469,406		
9	NT - Administration state - Total vaccine doses administered	220,682		
10	QLD - Administration state - Total vaccine doses administered	3,667,531		
11	SA - Administration state - Total vaccine doses administered	1,330,093		
12	TAS - Administration state - Total vaccine doses administered	475,347		
13	VIC - Administration state - Total vaccine doses administered	5,330,721		
14	WA - Administration state - Total vaccine doses administered	1,870,753		
15	ACT - Administration state - Daily increase doses recorded	4,430		
16	NSW - Administration state - Daily increase doses recorded	94,698		
17	NT - Administration state - Daily increase doses recorded	962		
18	QLD - Administration state - Daily increase doses recorded	31,068		
19	SA - Administration state - Daily increase doses recorded	9,352		
20	TAS - Administration state - Daily increase doses recorded	4,050		
21	VIC - Administration state - Daily increase doses recorded	51,561		
22	WA - Administration state - Daily increase doses recorded	17,474		
23	National - Administration state - Total doses administered state and territory facilities	8,794,903		
24	ACT - Administration state - Total doses administered state and territory facilities	225,878		
25	NSW - Administration state - Total doses administered state and territory facilities	2,755,186		
26	NT - Administration state - Total doses administered state and territory facilities	132,430		
27	QLD - Administration state - Total doses administered state and territory facilities	1,430,604		
28	SA - Administration state - Total doses administered state and territory facilities	584,054		
29	TAS - Administration state - Total doses administered state and territory facilities	253,889		
30	VIC - Administration state - Total doses administered state and territory facilities	2,525,987		
31	WA - Administration state - Total doses administered state and territory facilities	886,875		
32	National - Administration state - Daily increase doses administered state and territory facilities	124,958		
33	ACT - Administration state - Daily increase doses administered state and territory facilities	2,357		
34	NSW - Administration state - Daily increase doses administered state and territory facilities	56,625		
35	NT - Administration state - Daily increase doses administered state and territory facilities	828		
36	QLD - Administration state - Daily increase doses administered state and territory facilities	19,767		
37	SA - Administration state - Daily increase doses administered state and territory facilities	5,116		
38	TAS - Administration state - Daily increase doses administered state and territory facilities	2,398		

Figure 13. Initial Vaccination Data Format

Data Cleaning:

- Insert a new column on the left of the data by selecting "Home" and then "Insert Columns in Cells" (see image of raw data).

	A	B	C	D
1		Measure Name	Value	
2		National - Total vaccine doses administered	20,855,353	
3		National - Daily increase - Total vaccine doses recorded	213,595	
4		National - Number of people 16 and over with 1 dose	12,938,761	
5		National - Number of people 16 and over fully vaccinated	7,879,487	
6		National - Population 16 and over	20,619,959	
7		ACT - Administration state - Total vaccine doses administered	490,820	
8		NSW - Administration state - Total vaccine doses administered	7,469,406	
9		NT - Administration state - Total vaccine doses administered	220,682	
10		QLD - Administration state - Total vaccine doses administered	3,667,531	
11		SA - Administration state - Total vaccine doses administered	1,330,093	
12		TAS - Administration state - Total vaccine doses administered	475,347	
13		VIC - Administration state - Total vaccine doses administered	5,330,721	
14		WA - Administration state - Total vaccine doses administered	1,870,753	
15		ACT - Administration state - Daily increase doses recorded	4,430	
16		NSW - Administration state - Daily increase doses recorded	94,698	
17		NT - Administration state - Daily increase doses recorded	962	
18		QLD - Administration state - Daily increase doses recorded	31,068	
19		SA - Administration state - Daily increase doses recorded	9,352	
20		TAS - Administration state - Daily increase doses recorded	4,050	
21		VIC - Administration state - Daily increase doses recorded	51,561	
22		WA - Administration state - Daily increase doses recorded	17,474	
23		National - Administration state - Total doses administered state and territory facilities	8,794,903	
24		ACT - Administration state - Total doses administered state and territory facilities	225,878	
25		NSW - Administration state - Total doses administered state and territory facilities	2,755,186	
26		NT - Administration state - Total doses administered state and territory facilities	132,430	
27		QLD - Administration state - Total doses administered state and territory facilities	1,430,604	
28		SA - Administration state - Total doses administered state and territory facilities	584,054	
29		TAS - Administration state - Total doses administered state and territory facilities	253,889	
30		VIC - Administration state - Total doses administered state and territory facilities	2,525,987	
31		WA - Administration state - Total doses administered state and territory facilities	886,875	
32		National - Administration state - Daily increase doses administered state and territory facilities	124,958	
33		ACT - Administration state - Daily increase doses administered state and territory facilities	2,357	
34		NSW - Administration state - Daily increase doses administered state and territory facilities	56,625	

Figure 14. Inserting new column

- To identify the relevant rows, use the formula:

“=IF(ISNUMBER(SEARCH("Total vaccine doses administered", B2)), 1, 2)”

- This formula marks rows containing "Total vaccine doses administered" with a 1 and other rows with a 2.

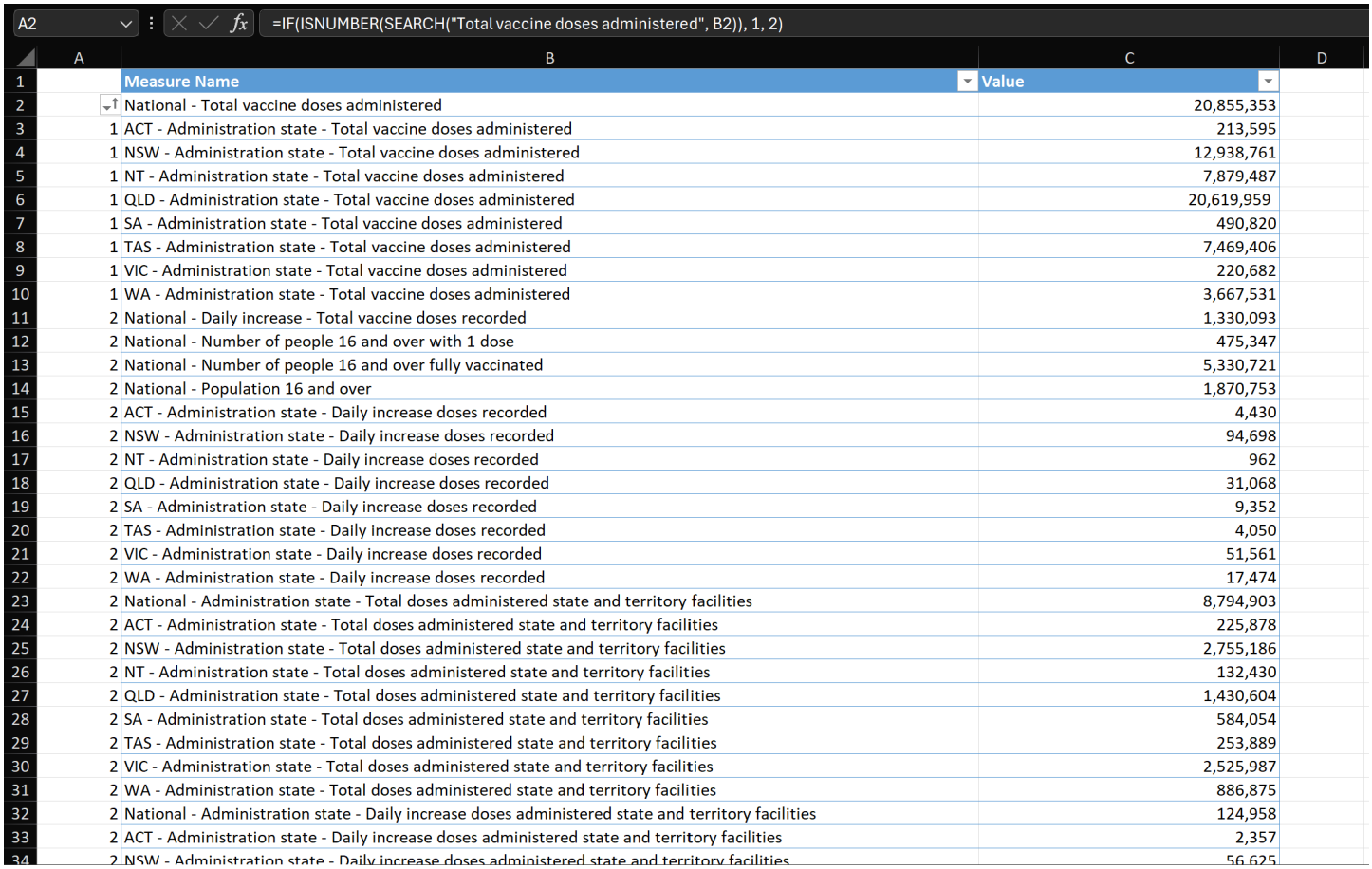
A2 =IF(ISNUMBER(SEARCH("Total vaccine doses administered", B2)), 1, 2)

	A	Measure Name	Value
2	1	National - Total vaccine doses administered	20,855,353
3	2	National - Daily increase - Total vaccine doses recorded	213,595
4	2	National - Number of people 16 and over with 1 dose	12,938,761
5	2	National - Number of people 16 and over fully vaccinated	7,879,487
6	2	National - Population 16 and over	20,619,959
7	1	ACT - Administration state - Total vaccine doses administered	490,820
8	1	NSW - Administration state - Total vaccine doses administered	7,469,406
9	1	NT - Administration state - Total vaccine doses administered	220,682
10	1	QLD - Administration state - Total vaccine doses administered	3,667,531
11	1	SA - Administration state - Total vaccine doses administered	1,330,093
12	1	TAS - Administration state - Total vaccine doses administered	475,347
13	1	VIC - Administration state - Total vaccine doses administered	5,330,721
14	1	WA - Administration state - Total vaccine doses administered	1,870,753
15	2	ACT - Administration state - Daily increase doses recorded	4,430
16	2	NSW - Administration state - Daily increase doses recorded	94,698
17	2	NT - Administration state - Daily increase doses recorded	962
18	2	QLD - Administration state - Daily increase doses recorded	31,068
19	2	SA - Administration state - Daily increase doses recorded	9,352
20	2	TAS - Administration state - Daily increase doses recorded	4,050
21	2	VIC - Administration state - Daily increase doses recorded	51,561
22	2	WA - Administration state - Daily increase doses recorded	17,474
23	2	National - Administration state - Total doses administered state and territory facilities	8,794,903
24	2	ACT - Administration state - Total doses administered state and territory facilities	225,878
25	2	NSW - Administration state - Total doses administered state and territory facilities	2,755,186
26	2	NT - Administration state - Total doses administered state and territory facilities	132,430
27	2	QLD - Administration state - Total doses administered state and territory facilities	1,430,604
28	2	SA - Administration state - Total doses administered state and territory facilities	584,054
29	2	TAS - Administration state - Total doses administered state and territory facilities	253,889
30	2	VIC - Administration state - Total doses administered state and territory facilities	2,525,987
31	2	WA - Administration state - Total doses administered state and territory facilities	886,875
32	2	National - Administration state - Daily increase doses administered state and territory facilities	124,958
33	2	ACT - Administration state - Daily increase doses administered state and territory facilities	2,357
34	2	NSW - Administration state - Daily increase doses administered state and territory facilities	56,625

Figure 15. Identification of Relevant Rows using the Formula

Sorting Data:

- Select column A and sort the data from smallest to largest. This will bring all the rows with total vaccine doses administered to the top.



	A	Measure Name	Value
2		National - Total vaccine doses administered	20,855,353
3	1	ACT - Administration state - Total vaccine doses administered	213,595
4	1	NSW - Administration state - Total vaccine doses administered	12,938,761
5	1	NT - Administration state - Total vaccine doses administered	7,879,487
6	1	QLD - Administration state - Total vaccine doses administered	20,619,959
7	1	SA - Administration state - Total vaccine doses administered	490,820
8	1	TAS - Administration state - Total vaccine doses administered	7,469,406
9	1	VIC - Administration state - Total vaccine doses administered	220,682
10	1	WA - Administration state - Total vaccine doses administered	3,667,531
11	2	National - Daily increase - Total vaccine doses recorded	1,330,093
12	2	National - Number of people 16 and over with 1 dose	475,347
13	2	National - Number of people 16 and over fully vaccinated	5,330,721
14	2	National - Population 16 and over	1,870,753
15	2	ACT - Administration state - Daily increase doses recorded	4,430
16	2	NSW - Administration state - Daily increase doses recorded	94,698
17	2	NT - Administration state - Daily increase doses recorded	962
18	2	QLD - Administration state - Daily increase doses recorded	31,068
19	2	SA - Administration state - Daily increase doses recorded	9,352
20	2	TAS - Administration state - Daily increase doses recorded	4,050
21	2	VIC - Administration state - Daily increase doses recorded	51,561
22	2	WA - Administration state - Daily increase doses recorded	17,474
23	2	National - Administration state - Total doses administered state and territory facilities	8,794,903
24	2	ACT - Administration state - Total doses administered state and territory facilities	225,878
25	2	NSW - Administration state - Total doses administered state and territory facilities	2,755,186
26	2	NT - Administration state - Total doses administered state and territory facilities	132,430
27	2	QLD - Administration state - Total doses administered state and territory facilities	1,430,604
28	2	SA - Administration state - Total doses administered state and territory facilities	584,054
29	2	TAS - Administration state - Total doses administered state and territory facilities	253,889
30	2	VIC - Administration state - Total doses administered state and territory facilities	2,525,987
31	2	WA - Administration state - Total doses administered state and territory facilities	886,875
32	2	National - Administration state - Daily increase doses administered state and territory facilities	124,958
33	2	ACT - Administration state - Daily increase doses administered state and territory facilities	2,357
34	2	NSW - Administration state - Daily increase doses administered state and territory facilities	56,625

Figure 16. Sorting Data

Extracting Relevant Data:

- Copy the sorted data containing the total vaccine doses administered for each state to a new Excel sheet.

	A	B	C
1	States	2021	
2	NSW	7469406	
3	VIC	5330721	
4	QLD	3667531	
5	SA	1330093	
6	WA	1870753	
7	TAS	475347	
8	NT	220682	
9	ACT	490820	
10			

Figure 17. Extracting Data

Combining Data for Each Year:

- Repeat steps 1-5 for each year (2021, 2022, 2023, 2024) and combine the data into a single Excel sheet.

	A	B	C	D	E	F
1	States	2021	2022	2023	2024	
2	NSW	7469406	13758731	20015383	22000000	
3	VIC	5330721	11340028	16799543	18500000	
4	QLD	3667531	8269435	12175475	13300000	
5	SA	1330093	2893768	4498728	5000000	
6	WA	1870753	4120530	7026840	7600000	
7	TAS	475347	940782	1466816	1700000	
8	NT	220682	421788	624810	654100	
9	ACT	490820	1041938	1941889	2300000	
10	Aus					
11						
12						
13						

Figure 18. Yearly State Vaccination

1. **Calculating Totals:**

- For each year, calculate the total vaccine doses administered across all states using the formula:

“=SUM(B2:B9)”

	A	B	C	D	E	F
1	States	2021	2022	2023	2024	
2	NSW	7469406	13758731	20015383	22000000	
3	VIC	5330721	11340028	16799543	18500000	
4	QLD	3667531	8269435	12175475	13300000	
5	SA	1330093	2893768	4498728	5000000	
6	WA	1870753	4120530	7026840	7600000	
7	TAS	475347	940782	1466816	1700000	
8	NT	220682	421788	624810	654100	
9	ACT	490820	1041938	1941889	2300000	
10	Aus	20855353				
11						
12						

Figure 19. Calculating Totals

- Use the "Fill" feature to copy this formula across columns for each year.

	A	B	C	D	E	F
1	States	2021	2022	2023	2024	
2	NSW	7469406	13758731	20015383	22000000	
3	VIC	5330721	11340028	16799543	18500000	
4	QLD	3667531	8269435	12175475	13300000	
5	SA	1330093	2893768	4498728	5000000	
6	WA	1870753	4120530	7026840	7600000	
7	TAS	475347	940782	1466816	1700000	
8	NT	220682	421788	624810	654100	
9	ACT	490820	1041938	1941889	2300000	
10	Aus	20855353	42787000	64549484	71054100	
11						
12						

Figure 20. Data Filling

2. Formatting Data:

- Select all data by pressing “Ctrl + A” and change the data type to "General".
- Save the processed data as "vaccination.csv" for use in the visualization.

Final Processed Dataset

E10 =SUM(E2:E9)

	A	B	C	D	E	F
1	States	2021	2022	2023	2024	
2	NSW	7469406	13758731	20015383	22000000	
3	VIC	5330721	11340028	16799543	18500000	
4	QLD	3667531	8269435	12175475	13300000	
5	SA	1330093	2893768	4498728	5000000	
6	WA	1870753	4120530	7026840	7600000	
7	TAS	475347	940782	1466816	1700000	
8	NT	220682	421788	624810	654100	
9	ACT	490820	1041938	1941889	2300000	
10	Aus	20855353	42787000	64549484	71054100	
11						
12						
13						

Figure 21. Processed Vaccination Dataset

3. Visualisation Design

3.1. Overall trends in Health spending over the years

3.1.1 Initial Design 1: Bar and Line Combo Chart

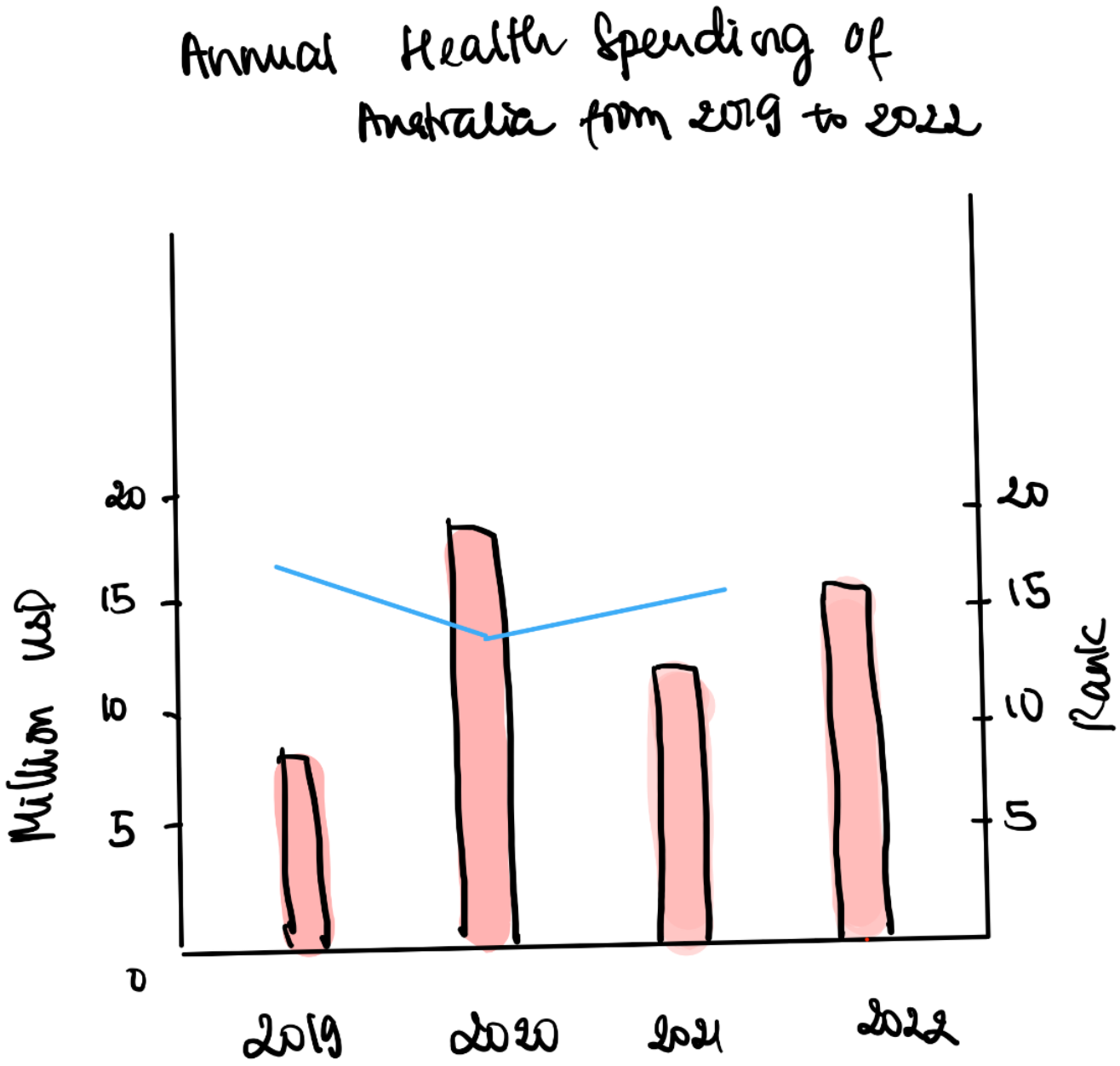


Figure 22. Initial Design 1

The first initial design depicts a straightforward representation of Australia's annual health expenditure from 2019 to 2022 using a bar and line combo chart. The drafted visualisation employs two data types:

- **Quantitative data:** Australia's health spending is represented using bar charts, which provide a clear depiction of the amount being spent on health over four years. The statistics are measured in USD dollars.
- **Ordinal data:** The focused country's annual rankings are displayed on the lines. The data type indicates Australia's health spending rank among 38 OECD countries, which visually contextualises its healthcare expenses in an international frame.

The simultaneous representation of two data types necessitates the dual-axis design. The left y-axis quantifies the health spending, while the right y-axis depicts the ordinal rankings. Combining bar and line charts in a single visualisation provides an integrated insight into Australia's spending and its relative standing among different countries.

3.1.2 Initial Design 2: Bar and Line Combo Chart

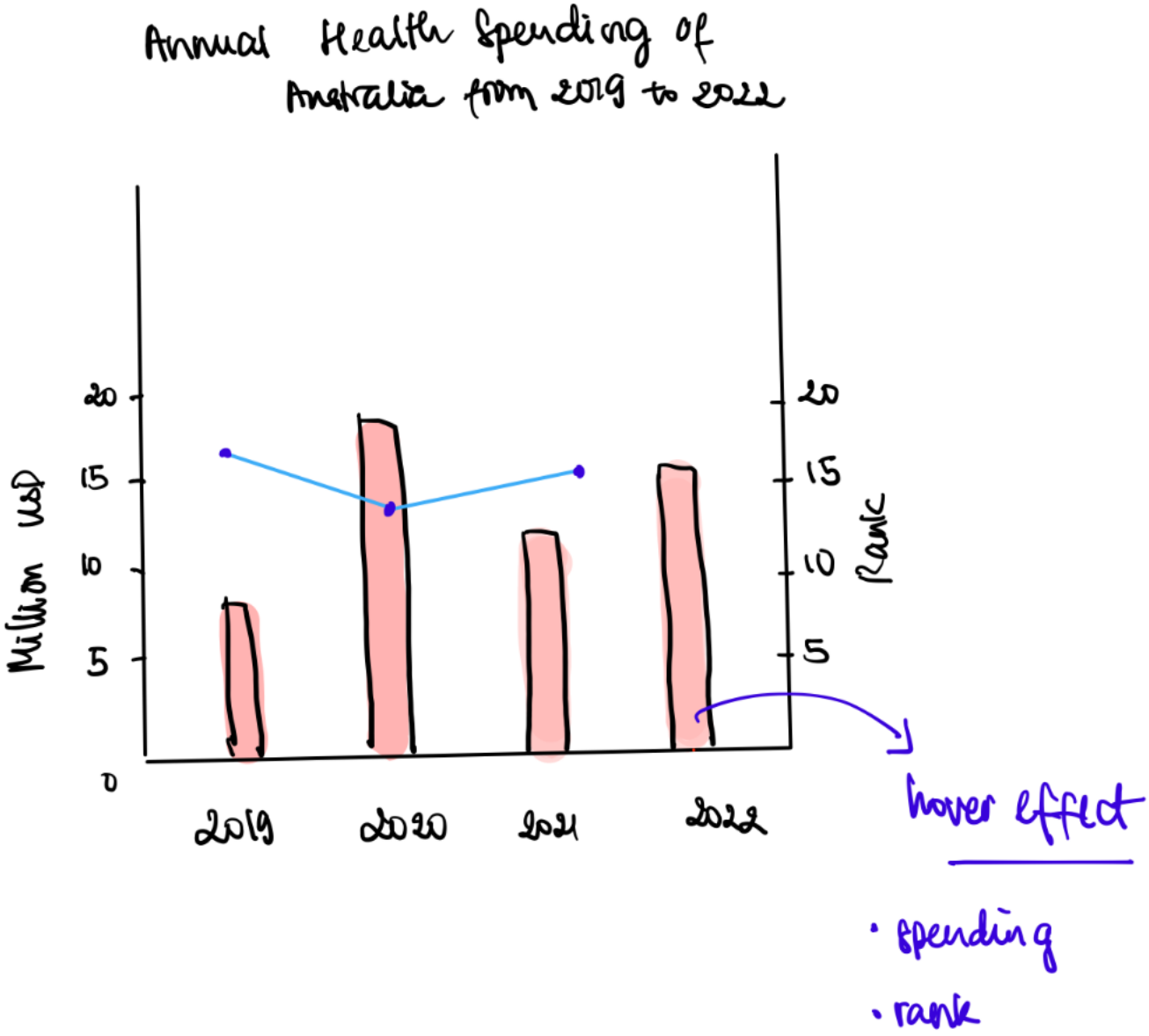


Figure 23. Initial Design 2

The second prototype has been improved from the original sketch mainly in terms of interactivity. Instead of merely showing the lines, data pinpoints are depicted identifying Australia's position among other countries year by year. Consequently, this provision adds precision to the visual narrative. Moreover, hover effects are noted for later implementation to annotate annual statistics for both health spending and ranking in the hovered year. The chart offers a dynamic solution for data exploration by enhancing its interactivity.

In short, these proposed enhancements boost the chart's utility. Interactivity assists in the interpretation of complex datasets; thereby, improving the audience's experience (Munzner, 2014). In other words, interactive elements not only make data more interpretable but also enhance user satisfaction.

3.1.3 Draft: Bar and Line Combo Chart

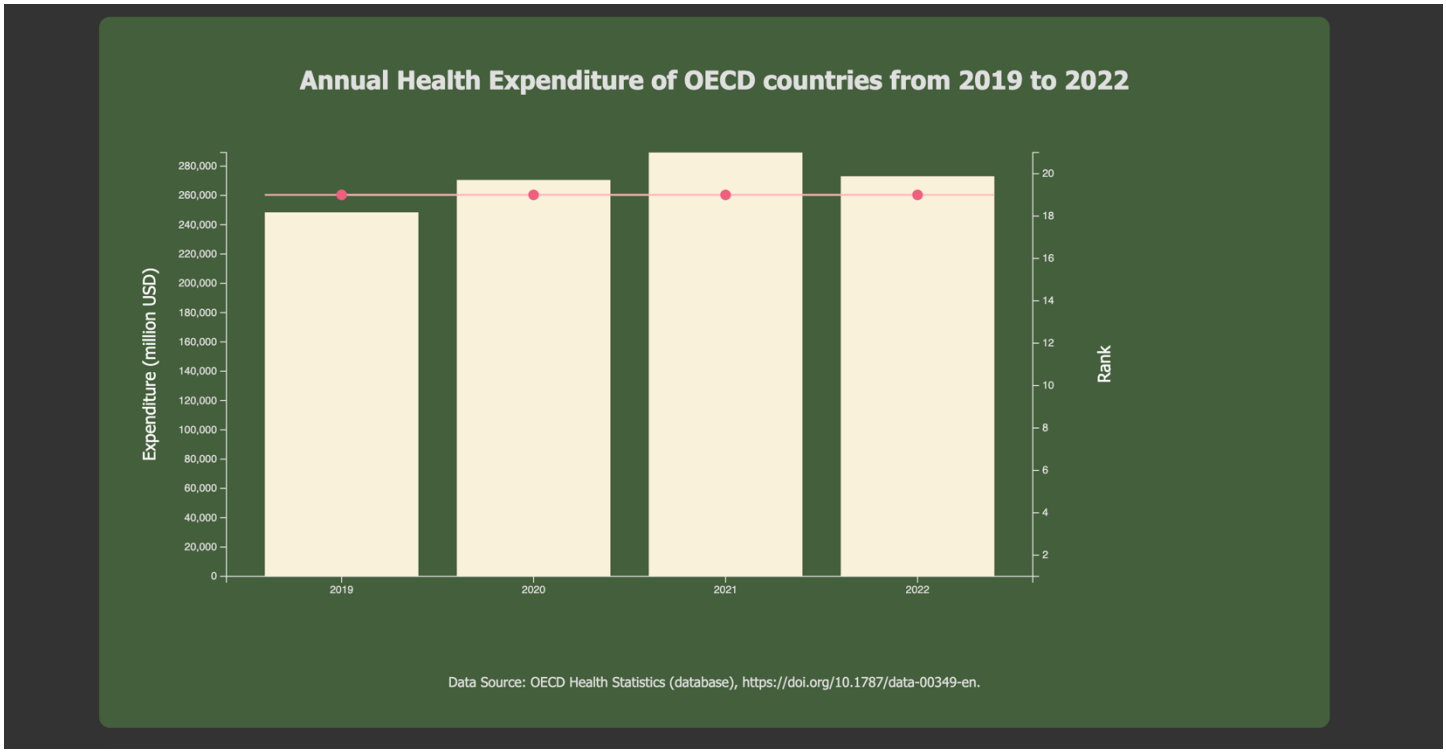


Figure 24. Visualisation Draft

This draft acts as the transition from prototype to initial web development. It aims at minimising visual distraction by featuring basic styling and colouring. This draft demonstrates the integration of the hand-drawn design within a web application, affirming the visualisation's implementation as intended.

As it is the draft version, there are a few points noted for improvements:

- **Chart Perceivability**: This version is inspired by a minimalistic design that showcases basic colour usage. It may be deficient in terms of visually appealing to viewers. Even though the utilised colour palette is colourblind-friendly, the figure elements need to be clearly

and nicely delineated to enhance the perceivable data presentation by adding colour contrast or increasing the font size.

- **Interactivity**: Serving as a functional starting point, this draft has not fully implemented all the proposed features. The chart has not fully implemented all interactive aspects. It lacks hover effects; hence, at the current stage, readers cannot view the statistical details of a specific year when moving the mouse over.
- **Data Representation**: As this phase is typical in testing the effectiveness and adjusting the elements visually, the ranking line might not be fully accurate at this stage and needs further work at a later stage. Moreover, the combination of numbers in the thousands, which are presented on the right y-axis and the noted units of expenditure in millions of USD is quite misleading.

3.1.4 Final Design: Bar and Line Combo Chart

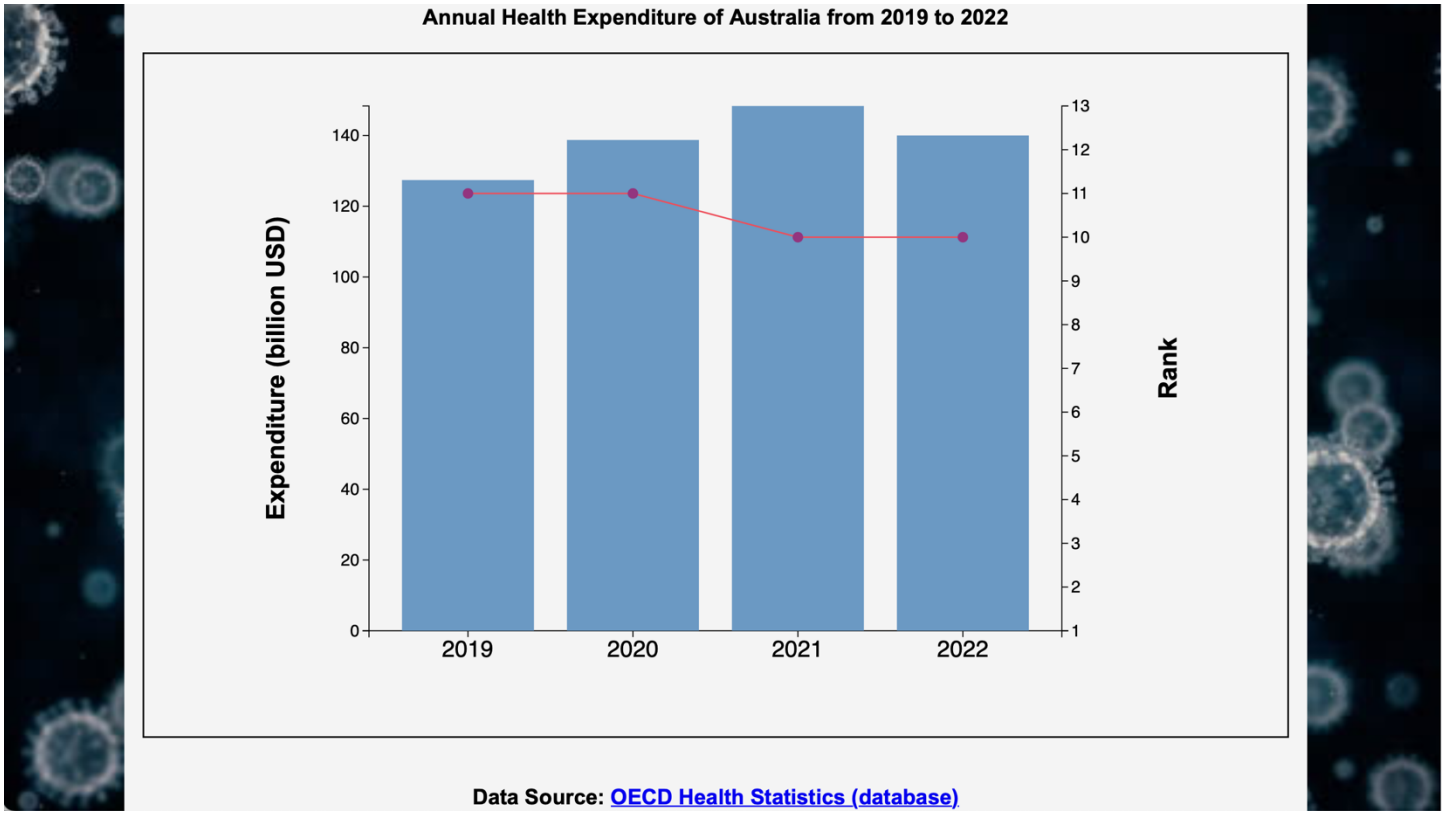


Figure 25. Visualisation's Final Design

The final implementation of the 'Annual Health Expenditure of Australia from 2019 to 2022' effectively communicate Australia's health spending trends and ranking among OECD countries over four years via comprehensible data visualisation. The elements that facilitate the effectiveness and utility of the developed figure are discussed in more detail as follows.

a. Data Refinement and Representation

- **Health Expenditure:**
    - Data type: Quantitative data
    - Data representation: The bar chart depicts Australia's annual health spending in billions of USD. The statistics are mapped on the primary vertical axis, which is on the left-hand side. It provides a clear visual indicator of the expenditure scale. More specifically, the height of each bar directly correlates with the spending amount: the more expense Australia spent on healthcare, the higher the bar for that year is. The straightforward bar presentation facilitates an immediate visual assessment of year-to-year changes in response to the COVID-19 pandemic.

- **Ranking:**
    - Data type: Ordinal data
    - Data representation: The line chart overlays the bar chart, representing Australia's rank among OECD countries on the secondary y-axis, which is located on the right-hand side. The expenditure on healthcare is contextualised within a global background by including the ordinal ranking. The combination of bar and line charts effectively provides insights into whether yearly changes are aligned with not only the improvements in rankings or not but also with the general worldwide spending patterns.

b. Interactivity

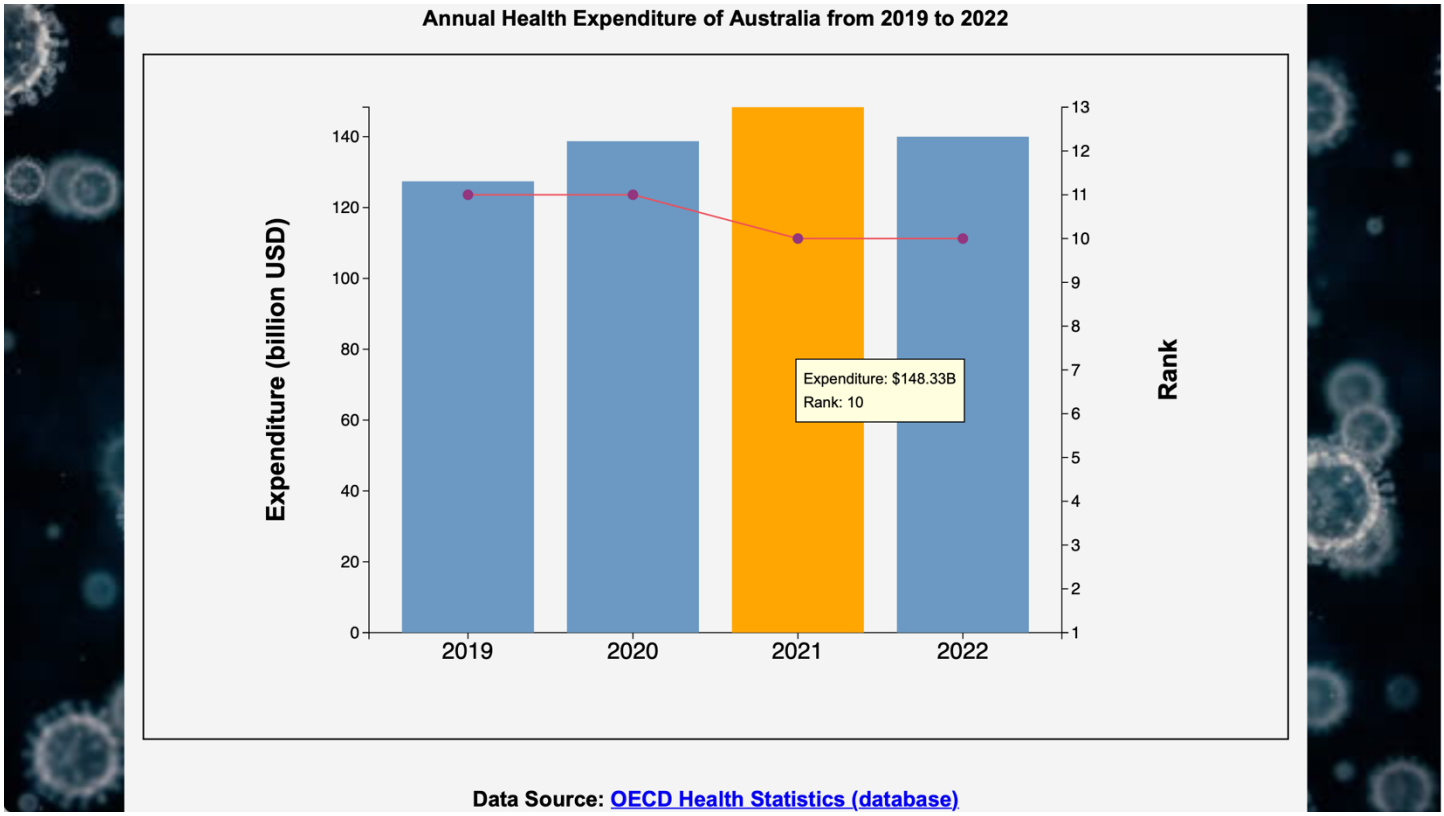


Figure 26. Hover Effect

The complete implementation of hover effects in the final version enhances user and chart interaction. As a viewer hovers over a specific bar, the detailed spending and rank for that year will be annotated. This delivery of on-demand information is pivotal to maintaining a clear design and accommodating users' need for precise data review. Thanks to the tooltips, readers do not need to estimate values when necessary, which improves data accessibility.

Furthermore, the colour alteration upon hovering enhances interactivity by drawing viewers' attention to the selected element. The bar on the hovered is changed to yellow, which differentiates itself from others. The rationale behind colour modification is that colours can influence the extent of attention, which is directly proportional to data processing in people's cognitive systems (Dzulkifli & Mustafar, 2013). In short, this feature facilitates comprehending and managing multiple data points being displayed simultaneously.

Overall, hover effects encourage users to explore data in a thorough and engaging way. At first glance, users can easily compare health spending in Australia over the years. When it comes to

deeper information retention, the tooltips support analytical outcomes without the need to perform mental calculations.

c. Colour Palette

The selected colour palette is perceivable to people with visual impairments. It is verified by using a colour vision deficiency tool developed by David Nichols. Colouring for colour blindness acts as a colour vision deficiency simulator, where the colour palette is displayed under different views of colour blindness types: **prot**anopia, **deut**eranopia, or **trit**anopia.

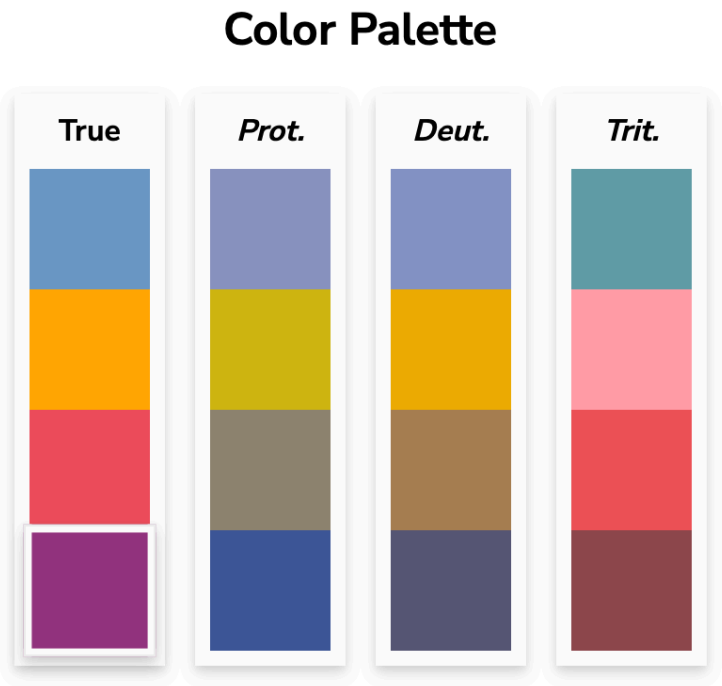


Figure 27. Colour Palette

The colour palette in use for this chart is displayed in the outer left-hand side column as 'True' and the remaining columns are adaptations for different colour blindness forms. The design guarantees that regardless of visual capabilities, all users can interact with a coherent visualisation.

The primary colour of the bars is blue, which indicates healthcare-related figures. Blue, especially in softer tones, are preferred in most health-related contexts (Military Health System, n.d.). Additionally, soft blue is visually comfortable for the eyes while still being visible on a plain background. The remaining colours are chosen mainly to guide readers' focus as the use of warm colours such as yellow and red has a greater effect on attention than cool-tone colours (Dzulkifli & Mustafar, 2013). The second colour in the palette is used to highlight bars when being hovered over. Naturally, yellow attracts users due to its vividness and contrast with the blue bars, which effectively help users focus on specific data points to uncover more detailed statistics. Following that, the combination of pink and purple hues to represent and connect ranking data points apparently stands out from the blue background bars and yellow hover effect. Consequently, the data pinpoints along with a linking line are noticeable, which reduces the probability of missing the comparative context of the health spending data.

To sum up, the careful selection of the colour palette supports effective information delivery to a broader range of audience.

d. Data-ink ratio

The data-ink principle, which is proposed by Edward Tufte, is effectively applied into the visualisation:

- **Minimal Non-data ink**: The figure uses solid colour fills for bars and a simple line connecting the ranking data points. This visual representation aims to provide a straightforward and uncluttered design, which helps users focus on the data without being distracted by unnecessary graphical elements such as decorations, and grid backgrounds.
- Tooltips and Highlighting: The hover effect of changing the colour of hovered elements enhances data visibility without extra data ink being used. This feature properly adheres to Tufte's principle of maximising the amount of ink used to display data. The tooltips upon hovering provide detailed financial and rank records, which ensures the visibility of data-related information.

e. Improvements from the draft

Compared to the initial implementation, the acknowledged issues are addressed:

- **Enhanced Visual Appeal**: As discussed earlier, the final design uses a colourblind-friendly palette, which ensures that the visualisation is accessible to a wider audience.
- **Data Refinements**: The unit of measurement, previously expressed in thousand millions, is adjusted to billions. Along with that is the abbreviation of axis labels. As a result, large data figures have become more comprehensible and manageable. The final design has effectively provided critical insights into how COVID-19 has impacted health spending in Australia in relation to other OECD countries.
- **Interactive Elements**: The implementation of hover effects significantly enriches the user experience by allowing deeper data interpretation and exploration. Viewers can now see specific records for expenditure and rankings for each year on hover.

3.2. Covid-19 Vaccination and Death Rates

3.2.1 Objectives

This figure provides an interactive visualisation of COVID-19 mortality and vaccination statistics in different regions of Australia from 2021 to 2024. Using this visualisation, users can evaluate the effectiveness of government health policies targeted at reducing the severe impact of COVID-19.

3.2.2 Initial Design 1: Choropleth and Bar chart

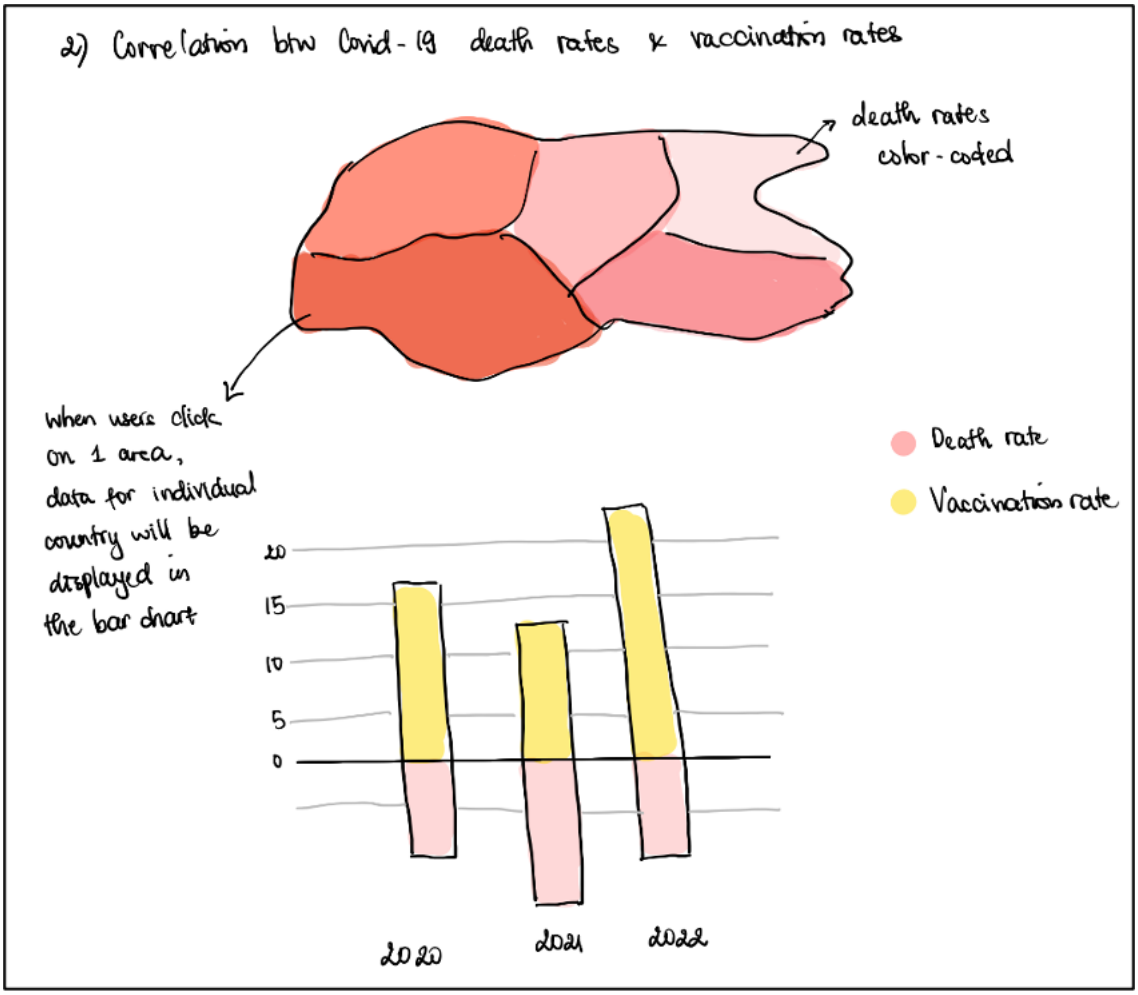


Figure 28. Initial Design 1

a. First Chart: Choropleth Map

The choropleth map illustrates the regional distribution of COVID-19 deaths among Australian states. It uses a colour gradient to illustrate different death rates, with deeper hues signifying larger percentages. This colour coding enables users to rapidly assess the effect of the pandemic in different locations. By clicking on a specific section of the map, users may see a comprehensive representation of the relevant state's statistics in an accompanying bar chart, improving interactive exploration and offering quick, localised insights.

b. Second chart: Bar Chart

Adjacent to the choropleth map, a bar chart compares vaccination and mortality rates in each state. The primary bars show vaccination rates as percentages in yellow, representing the proportion of the population that has been vaccinated. Secondary bars in pink directly underneath these reflect death rates, giving a strong visual contrast that allows consumers to compare immunisation efforts with mortality results. This arrangement not only allows for a clear comparison study, but also highlights the effectiveness of immunisations in reducing mortality rates across states.

c. Data Representation

The data representation in this project focuses on providing comparable metrics for COVID-19 cases and vaccination doses administered across Australian states.

COVID-19 Cases are represented as raw numbers for each state. This metric shows the total number of confirmed COVID-19 cases, providing a clear indicator of the pandemic's impact in different regions.

Vaccination Doses Administered are also represented as raw numbers for each state. This metric indicates the cumulative number of COVID-19 vaccine doses administered over time, offering insight into the progress and scale of vaccination campaigns.

The use of raw numbers for both metrics allows for detailed analysis and comparison between states and over time, illustrating the effectiveness of vaccination efforts in reducing the number of COVID-19 cases.

d. Description of Elements

Choropleth Map:

- The choropleth map efficiently reports COVID-19 death cases among Australian states by using a colour gradient. Lighter tones imply lower death rates, whilst darker shades indicate higher mortality. This visualisation enables users to rapidly identify and focus on places with significant repercussions by maintaining a clear geographical distribution of the pandemic's impacts. Consequently, regions requiring urgent health interventions or resource allocations are quickly detected.

Bar Chart:

- The bar chart that accompanies the choropleth map presents comparison statistics for each state, with two sets of bars representing vaccination and mortality rates, respectively. Vaccination rates are presented in yellow, indicating the proportion of the vaccinated population, whilst mortality rates are shown in red, creating a dramatic visual contrast that emphasises the effects of health initiatives. This colour-coded, dual-bar layout allows for easy visual comparison, demonstrating how effective immunisation efforts correspond with decreased fatality rates.
- Furthermore, the chronical data representation allows users, especially the government and policymakers, to track the progress and effectiveness of vaccination programmes in response to the pandemic.

Interaction with Bar Chart:

- When a user clicks on a state on the choropleth map, the corresponding state's data is highlighted in the bar chart. This bar chart dynamically updates to display detailed vaccination and death rate data for the selected state.

- This interaction allows users to thoroughly investigate data of specific states. As a result, readers are better informed about the local impacts of COVID-19 and the effectiveness of vaccination campaigns.

e. Tufte's Principles:

Data-Ink Ratio

Following Tufte's principle of maximizing the data-ink ratio, the design minimizes non-essential elements. Every part of the visualization is used to convey important information, reducing chart junk. According to Tufte (2001), "Above all else show the data" (p. 92). This approach ensures that the maximum amount of ink is used for meaningful data representation.

- The choropleth map and bar charts are minimalist approaches, with an emphasis on clarity and simplicity of comprehension. The map uses a graded colour range from light to dark red to represent variances in COVID-19 fatality rates, making these discrepancies visually distinct and readily obvious. This colour technique successfully emphasises the intensity of the impact in different states.
- The bar charts use straightforward bars coloured dark red (maroon) to represent mortality instances and dark blue for vaccination doses. This colour coding is purposely simplistic to maintain a high data-ink ratio, which reduces extraneous graphical features and directs the viewer's attention to the most important information. Such design decisions encourage a clutter-free viewing experience, allowing viewers to swiftly comprehend key data points and trends without distraction.

Graphical Excellence

The visualizations aim for graphical excellence by presenting complex data in an accessible manner. Tufte (2001) defines graphical excellence as "the well-designed presentation of interesting data—a matter of substance, of statistics, and of design" (p. 51).

The combination of a choropleth map and bar charts provides both a geographical and a quantitative view of the data. Thereby, users can gain insights at multiple levels of detail. This

dual approach inspects the relationship between vaccination rates and death rates, which is essential to assess the effectiveness of vaccination efforts. This integration allows for a comprehensive view that supports deeper analysis and interpretation, embodying Tufte's principles of graphical excellence.

Layering and Separation:

The design uses layering to separate different types of information while maintaining clarity. Tufte (2006) emphasizes the importance of layering and separation to manage complexity and prevent visual overload: "Good design can help viewers find the narratives in the data" (p. 105).

- **Separation of Geographical and Quantitative Data:** The choropleth map shows geographical data with states colour-coded based on death rates, while the bar charts provide detailed quantitative data on death cases and vaccination doses. This separation ensures that each type of data is presented in the most effective way, without causing confusion. Layering also helps in maintaining a clean and organized visual structure, making it easier for users to navigate and understand the data. The dynamic interaction, where clicking on a state updates the bar charts to reflect that state's data over multiple years, further enhances the layering effect, allowing users to explore detailed information on demand.

3.2.3 Draft: Choropleth and Bar chart

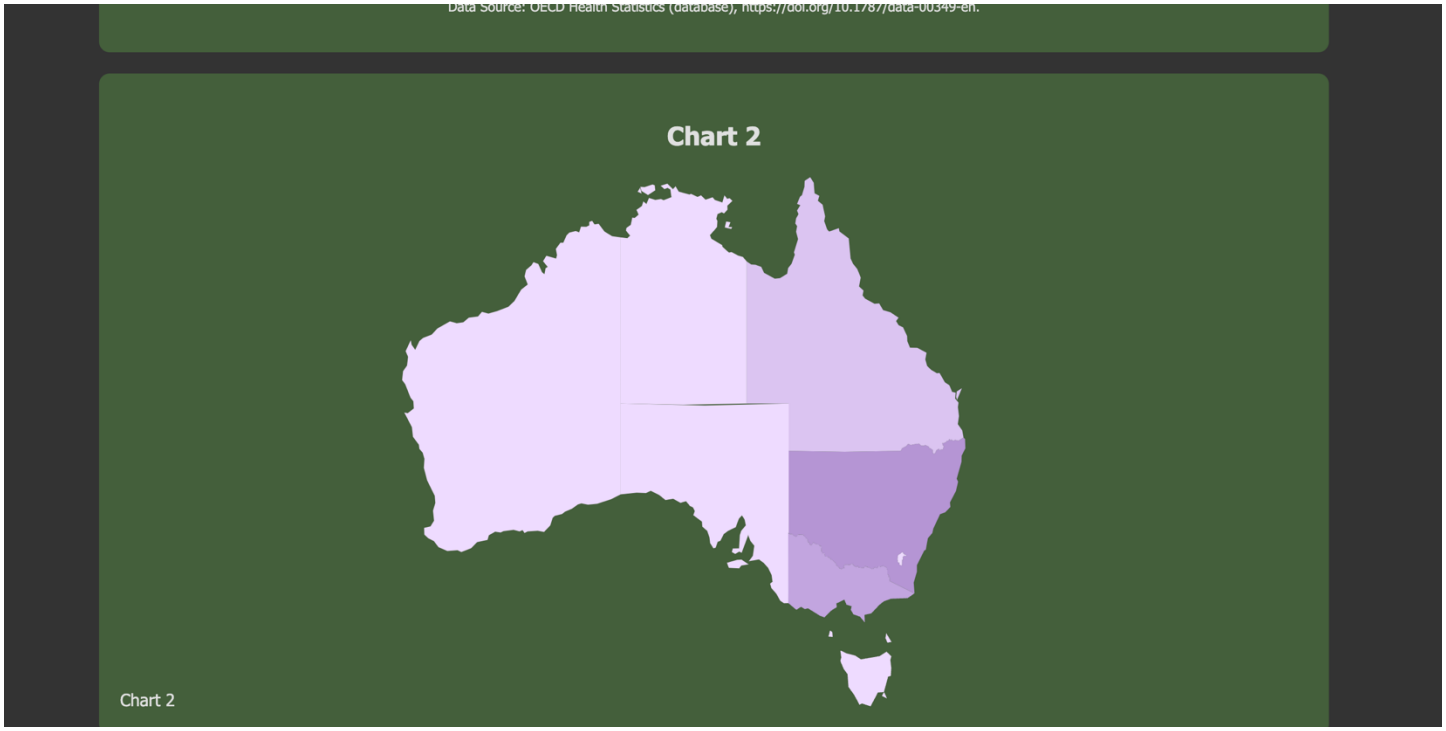


Figure 29. Choropleth Map Draft

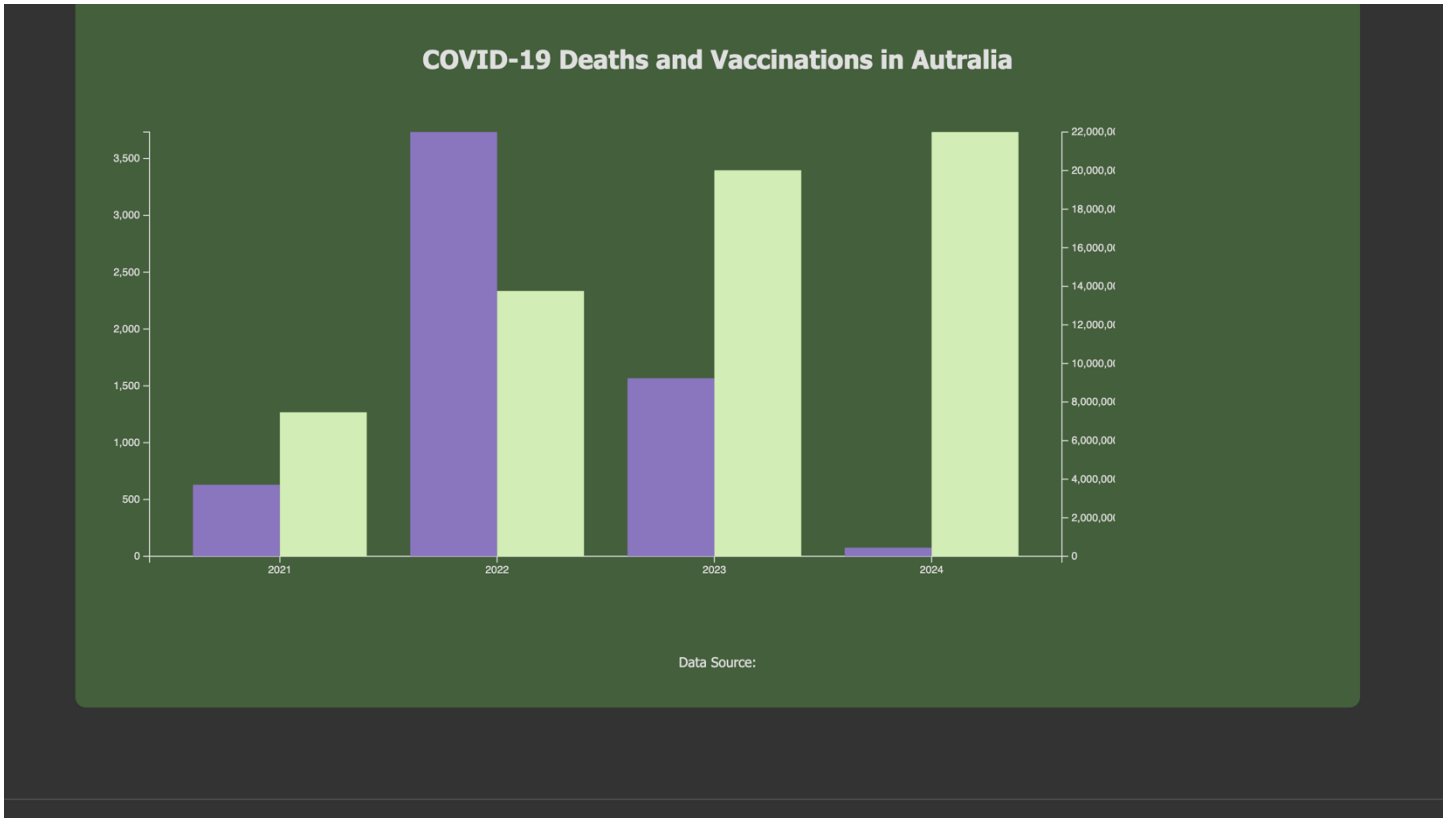


Figure 30. Bar Chart Draft

This draft serves as an intermediary step toward the final product of our visualization, testing the integration and functionality of key components. It demonstrates the distribution of COVID-

19 deaths across the map of Australia and the corresponding vaccination data through a combined bar chart.

Several key points have been accomplished in this draft:

Map Implementation:

- **Geographical Boundaries:** The choropleth map clearly depicts Australian states with precise boundaries and a colour gradient ranging from light to dark purple to show varied death rates. This visualisation style enables viewers to readily distinguish between states with greater or lower mortality rates, providing an immediate grasp of the pandemic's impact across regions.

- **Colour Gradient for Death Rates:** The map correctly applies colour gradients to represent death rates, ranging from light to dark purple. This visual cue allows users to quickly identify which states have higher or lower death rates, enhancing immediate comprehension of the data's geographical distribution.

- **Enhanced Interactive Functionality:** The map's interactivity allows visitors to click on a specific state to obtain extensive information about COVID-19 fatalities and vaccine doses in that state. This feature is crucial since it allows for a personalised and deeper investigation of data, offering insights into how various areas are managing the pandemic.

- **Dynamic Data Integration:** The approach effectively incorporates dynamic updating of the bar charts in response to user interactions with the map. This synchronisation between the map and bar charts guarantees that users receive the most relevant data in a visually appealing way, therefore improving the usability and usefulness of the visualisation tool.

- **Smooth Visual Transitions:** Implementing seamless visual transitions while transitioning between different states on the map not only increases the aesthetic appeal of the

visualisation but also contributes to decreasing the cognitive demand on users, making the data exploration process more intuitive and less complicated.

Bar Chart Implementation:

- **Data Representation:** The bar chart has been successfully integrated to display two sets of bars side by side for each year, representing both death cases and vaccination doses. This layout allows for direct comparison within a single visualization.

- **Axis Configuration:** The x-axis represents the number of deaths and vaccination doses, while the y-axis represents the years. This configuration facilitates easy reading and comparison of trends over time.

- **Dynamic Updates:** The bar chart is responsive, updating in real time based on user interaction with the map. This dynamic functionality ensures that the data remains relevant and specific to the user's selection, enhancing the overall interactivity and utility of the visualization.

Tufte's Principles:

- **Data-Ink Ratio:** The draft maximizes the data-ink ratio by minimizing non-essential elements, ensuring that every part of the visualization conveys meaningful information. According to Tufte (2001), "Above all else show the data" (p. 92). The map and bar charts are designed with clean, simple aesthetics that emphasize the data without unnecessary embellishments. For instance, the choropleth map utilizes a gradient colour scale from light to dark red to represent death rates, making the critical information prominent and easy to interpret. The bar charts, displaying death cases in dark red (maroon) and vaccination doses in dark blue, also adhere to this principle by focusing on the core data values.
- **Graphical Excellence:** The visualizations aim for graphical excellence by presenting complex data in an accessible and informative manner. Tufte (2001) defines graphical excellence as "the well-designed presentation of interesting data—a matter of substance, of statistics, and of design" (p. 51). The combination of a choropleth map and two bar charts allows users to gain insights at multiple levels of detail, from geographical

distribution to temporal trends. This dual representation effectively illustrates the relationship between vaccination efforts and COVID-19 deaths, highlighting areas where higher vaccination rates correlate with lower death rates. This comprehensive approach supports deeper analysis and interpretation, embodying Tufte's principles.

- **Layering and Separation:** The draft uses layering to separate different types of information while maintaining clarity. Tufte (2006) emphasizes the importance of layering and separation to manage complexity and prevent visual overload: "Good design can help viewers find the narratives in the data" (p. 105). The choropleth map displays geographical data with states colour-coded based on death rates, while the bar charts provide detailed quantitative data on death cases and vaccination doses. This separation ensures that each type of data is presented most effectively, avoiding confusion and maintaining a clean visual structure. The interactive elements, such as state-specific updates upon clicking, further enhance the clarity and user engagement, allowing for detailed exploration of the data.

However, some points need to be enhanced for better quality and effectiveness:

Map Details:

- **State Borders:** Currently, state borders are barely visible on the map. Adding a border or stroke between states would improve visibility and make it easier to distinguish between them.
- **State Labels:** The map lacks state labels, making it difficult for the audience to recognize each state. Adding labels would enhance the map's readability and user-friendliness.

- **Colour Legend:** Although the map uses colour to represent data, there is no colour legend to help the audience understand which colour corresponds to which data range. Adding a legend would improve the map's comprehensibility.

Tooltip:

- **Hover Tooltips:** The visualization would benefit from additional tooltips that display the total number of deaths and vaccinations when hovering over each state. This would provide immediate, detailed information without the need for clicking.

Bar Chart Clarity:

- **Bar Identification:** The current bar chart can be confusing as it is unclear which bar represents death cases and which represents vaccination doses. Adding labels or a legend to differentiate between the categories would clarify the data representation.

3.2.4 Final Design: Choropleth and Bar chart

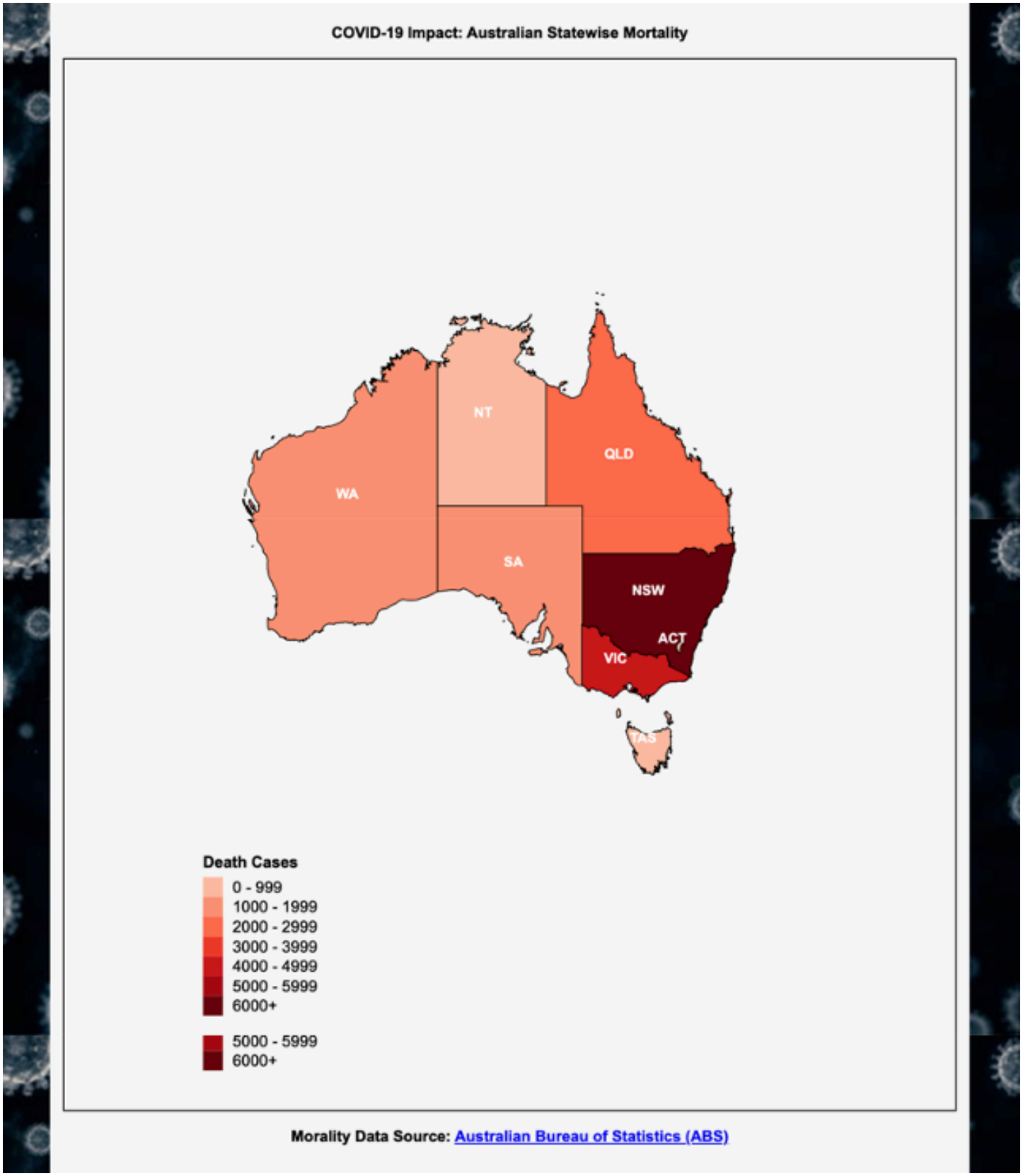


Figure 31. Choropleth Map Final Design

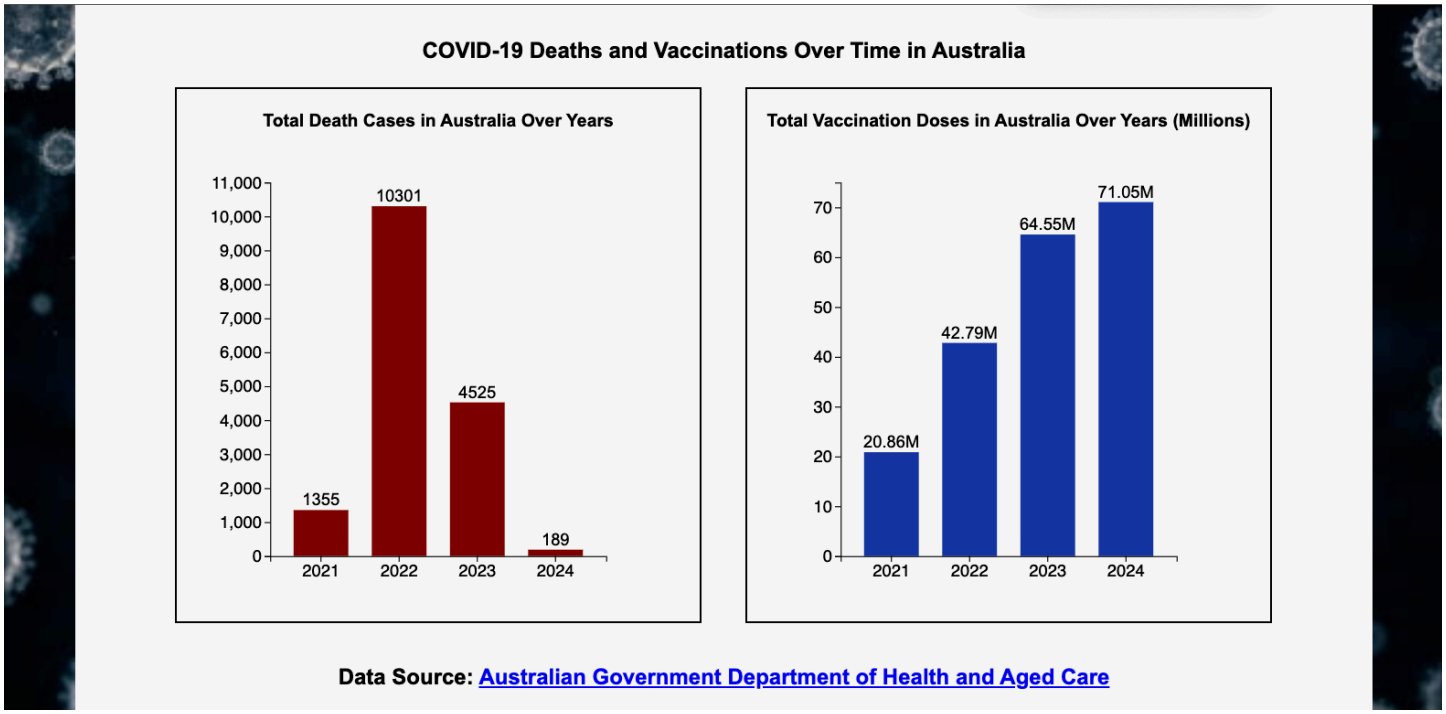


Figure 32. Bar Chart Final Design

The second visualisation consists of two components, which are a choropleth map and a bar chart. This dual-component approach provides a comprehensive analysis of how COVID-19 impact Australia in terms of deaths and vaccinations.

a. Data Representation

- **Choropleth Map**
  - Data type: Quantitative Data (Death Cases)
  - The choropleth map displays the COVID-19 death cases across different Australian states, with each state shaded according to its death cases in total amount. This representation uses a colour gradient from light to dark red, which the higher the death cases, the darker it shades. This visual implementation allows users to identify regions with higher and lower death cases and demonstrate the impact of COVID-19. The map's geographical borders and implemented label of state are clearly shown and ensure easy interpretation. Besides, the interactive functions also incorporate tooltips when hovering over a state, which will display state

statistics. Moreover, it allows users to click on a state to dynamically update the following bar chart with specific data of that state.

- **Bar Chart**
    - Data type: Quantitative Data (Death Cases and Vaccination Doses)
    - The bar chart complements the choropleth map by displaying the vaccination doses administered and death cases over the years from 2021 to 2024. While the X-axis represents the number of death cases and vaccination doses in millions, the Y-axis shows the years. Each vaccination bar is coloured dark blue which contrasts with the death cases bar chart. These layout facilities align with the total data each year, which can directly help compare vaccination efforts and the government's corresponding impact on death cases within the same timeframe. This straightforward implementation helps users track the trend of death cases over the specified period, making it easy for audiences to observe changes and patterns in the data.

b. Interactivity

State Label Encoding: State labels are encoded using abbreviations (e.g., Victoria is VIC), making it easier for users to identify each immediately.

Hover Effects:

- **State Highlighting:** When a user hovers over a state, it turns black with a white state label, contrasting the default colour scheme. This enhances visibility and focus, aligning with Tufte's principle of enhancing the data-ink ratio.
- **Tooltip Display:** Hovering over a state triggers a tooltip that displays detailed information about death rates and vaccination doses. This on-demand information delivery improves data accessibility without cluttering the map.

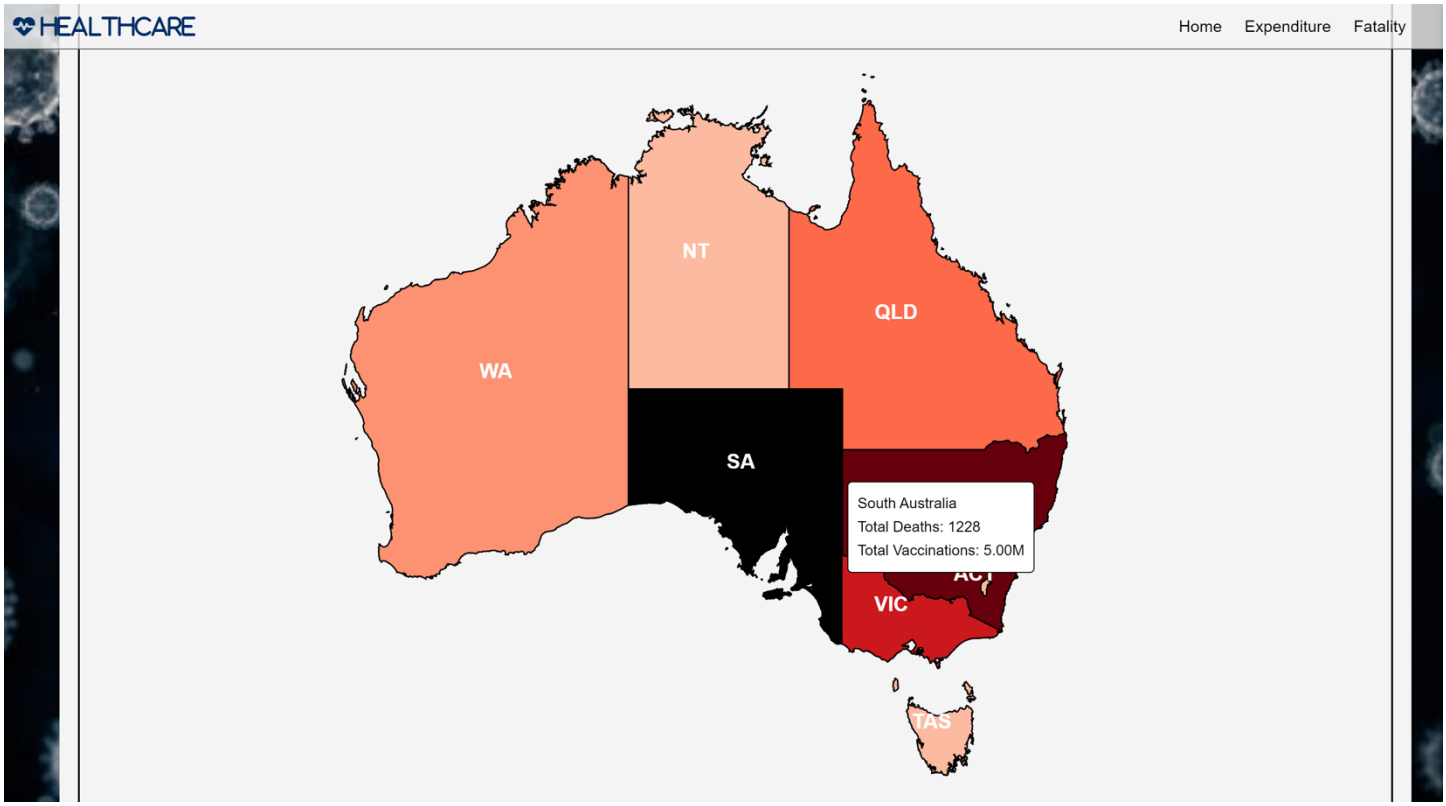


Figure 33. Hover effect

Click Interaction:

- **State Selection:** A state's colour turns grey upon clicking, allowing users to distinguish the selected state clearly. This interaction updates the bar charts to show detailed data for the selected state, providing a deeper look into yearly death cases and vaccination doses.
- **Dynamic Title Update:** The bar chart titles initially show totals for Australia. When a state is selected, the title updates to reflect the selected state's name, ensuring clarity and context.

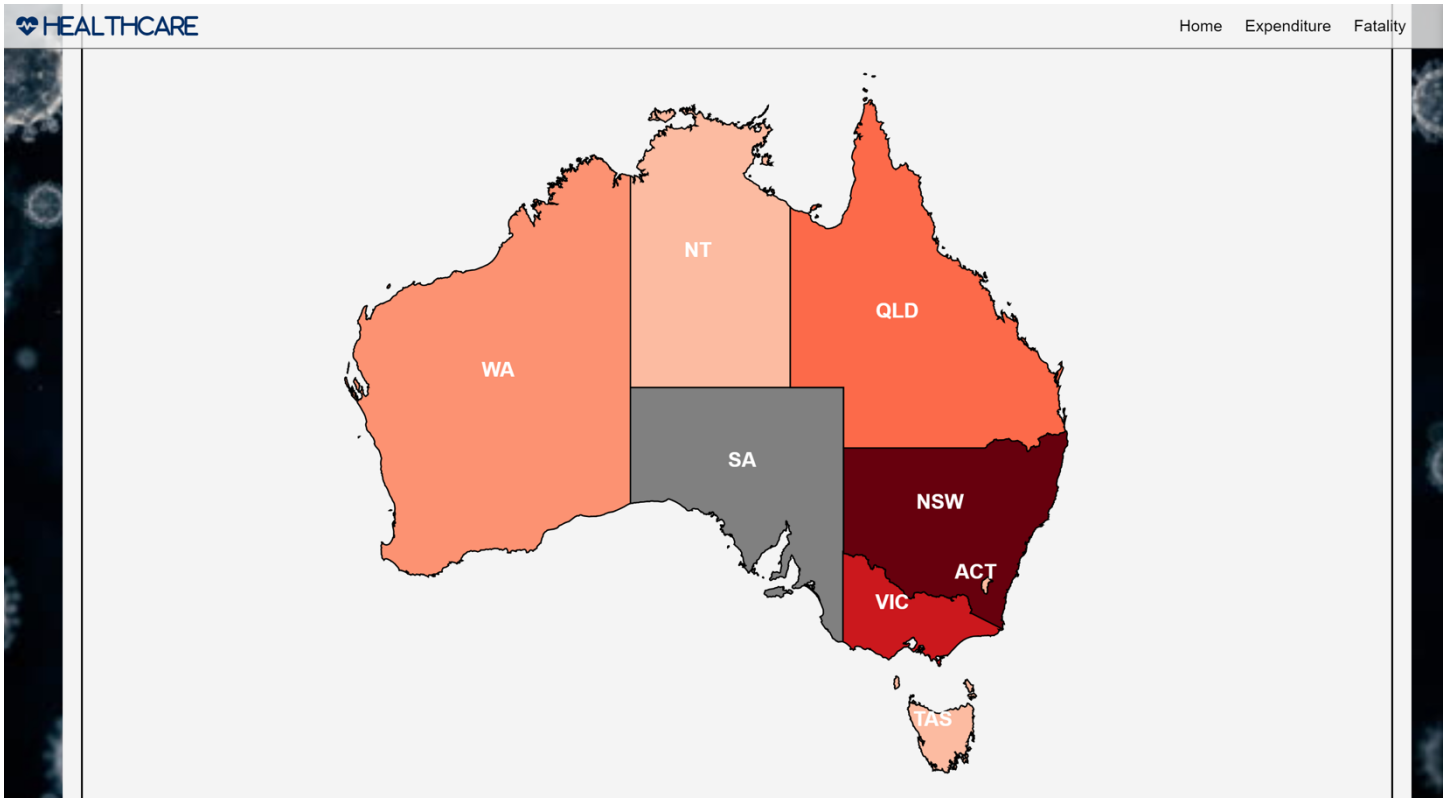


Figure 34. Clicking interactivity

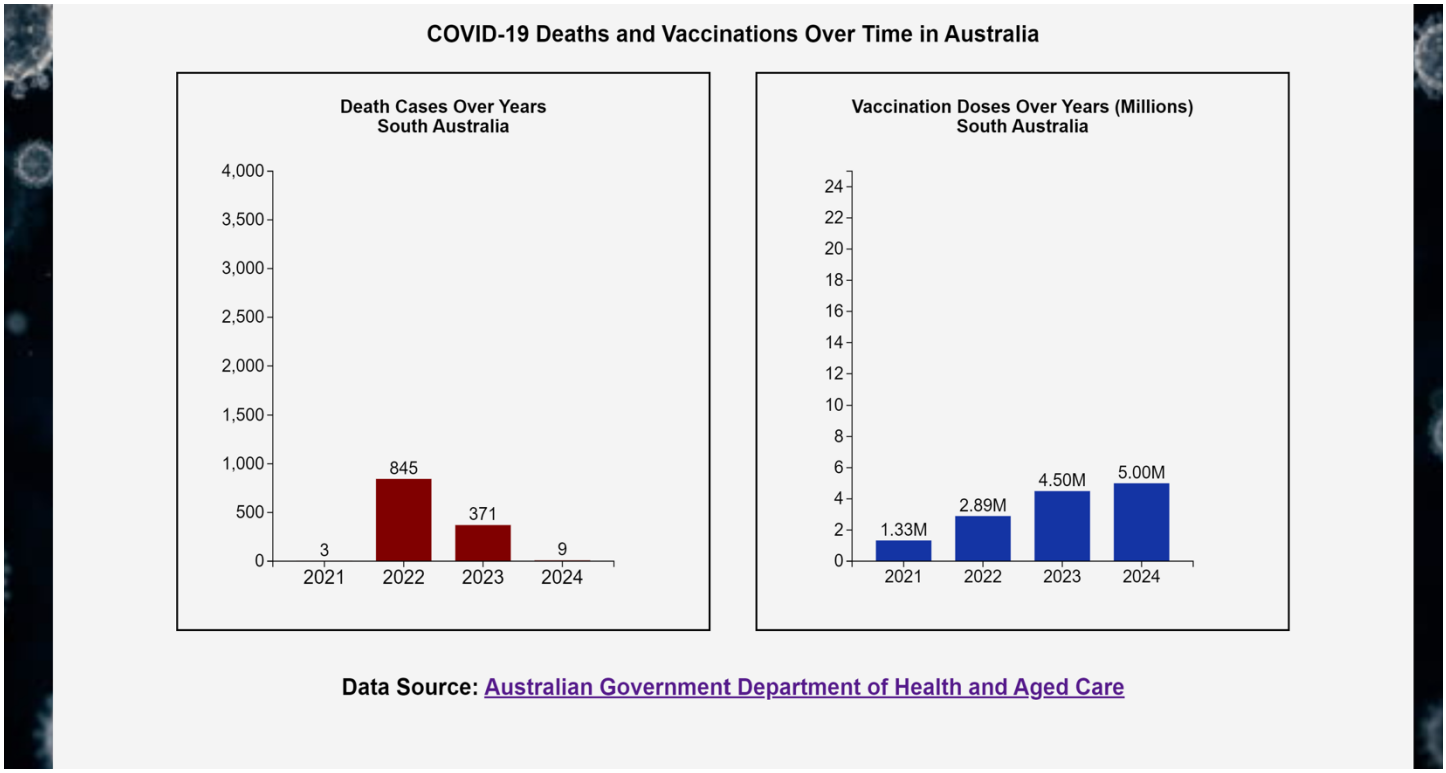


Figure 35. Bar Chart displaying State's records

Bar Chart Data Display:

- **Yearly Totals:** The bar charts display total death cases and vaccination doses for each year. The data is presented in millions, making it easier for users to comprehend large numbers. This aligns with Tufte's principle of presenting data clearly and straightforwardly, facilitating quick and accurate interpretation.

Overall, the interactive elements enhance the usability and clarity of the visualization. By adhering to Tufte's principles, the design maintains a high data-ink ratio and focuses on the data itself.

c. Colour Palette

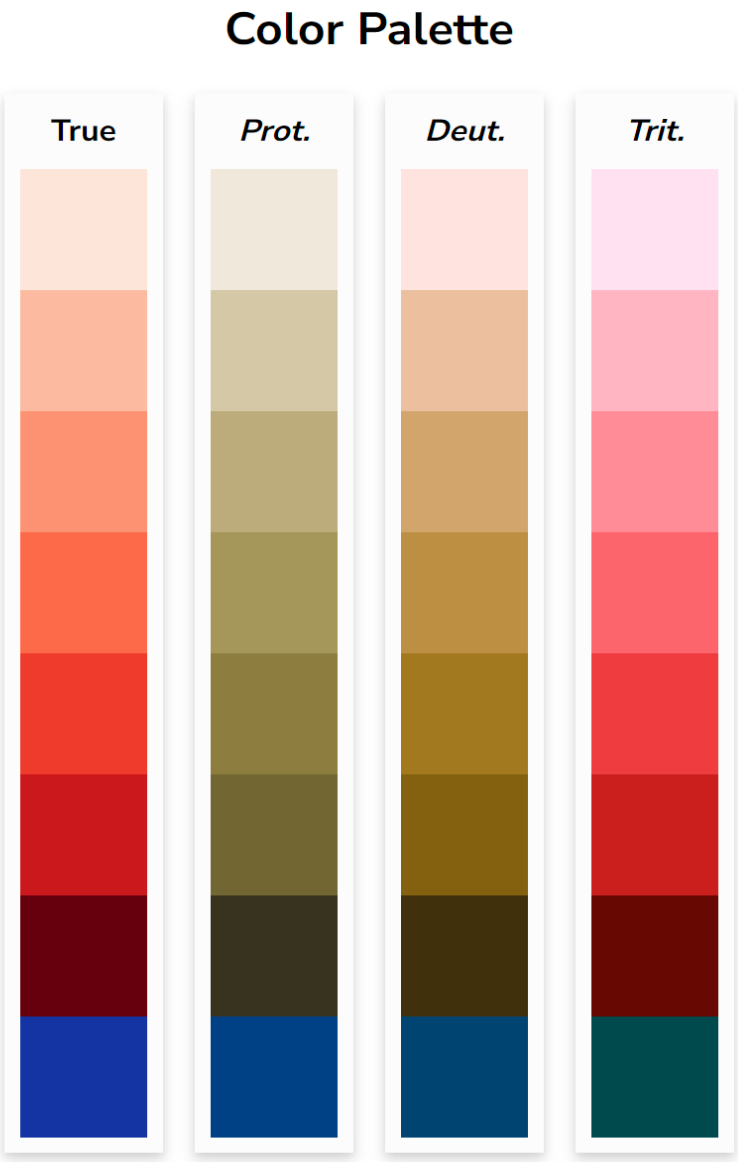


Figure 35. Colour Palette of Choropleth and Bar Chart

- **Choropleth Map:**
    - The map utilises a gradient of red tones to highlight the severity of COVID-19 deaths in local government areas. The reason for choosing this colour is that warm colours such as red and orange warn about dangers more effectively than other cool colours (Engeset et al., 2022). As depicted in the map, the higher death tolls are recorded, the darker the shades are. As a result, viewers can immediately define which area is most severely affected by the coronavirus.
    - The colour of a certain state turns black with white labels when hovered over, creating a high-contrast effect that makes state boundaries and labels easily visible. This high contrast ensures that interactive elements stand out without adding visual noise.

- **Bar Chart:** The bar chart continues using red for the number of death cases, which maintain thematic consistency across linked visualisations. In combination with that, vaccination data is depicted in blue. It not only provides a clear visual distinction between the two metrics but also makes the visualisations accessible to audiences suffering from colour vision deficiency. The combination of blue and red is a colourblind-friendly palette (Shaffer, 2016), ensuring that the visualisation remains informative for all users regardless of their colour visual capabilities.

d. Data Ink Ratio

The data-ink ratio is a fundamental principle in data visualization aimed at minimizing the non-essential ink used to display graphics, thereby maximizing the ink used to present data. In the choropleth map and bar charts, the following strategies have been applied to optimize the data-ink ratio, ensuring that the visualizations are clear, efficient, and focused on the data:

Minimalist Design:

- Choropleth Map: The map uses a simple gradient colour scale to represent death rates, ranging from light to dark red. This colour scheme ensures that the data is prominently displayed without the need for additional decorative elements. The gradient effectively

highlights differences in death rates across states, with lighter shades indicating lower rates and darker shades representing higher rates. The design is also colourblind-friendly, tested to ensure accessibility for viewers with various types of colour vision deficiencies, further minimizing distractions and enhancing clarity.

- Bar Charts: The bar charts use straightforward bars to represent the number of death cases and vaccination doses. Each bar's height directly correlates with the data value, and the use of plain bars without 3D effects or shadows keeps the focus on the data itself. "Graphical elegance is often found in simplicity of design and complexity of data" (Tufte, 2001).

Clear and Direct Labelling:

- **State Labels**: State labels are encoded using standard abbreviations (e.g., VIC for Victoria). This approach reduces visual clutter while still providing necessary information. The abbreviations are easy to recognize and take up less space, contributing to a cleaner design.
- **Axis Labels**: Axis labels are concisely placed. For instance, the Y-axis on the bar charts is labelled in millions, making it easier for viewers to understand the scale of the data without lengthy descriptions.

By adhering to these principles, the final design maintains a high data-ink ratio, ensuring that every element on the visual serves a clear, data-driven purpose. This approach enhances the clarity, readability, and overall effectiveness of the visualization, aligning with Tufte's principle of minimizing non-data ink and maximizing data presentation.

e. Tooltips

Dynamics Updates:

- **State-Specific Data:** When a user clicks on a state, the tooltip content updates dynamically to reflect the selected state's data over multiple years. This feature supports deeper exploration and understanding of trends within a specific state.

- **Title Updates:** The title of the bar charts updates based on the selected state, ensuring that users can always contextualize the information presented. For example, clicking on Victoria (VIC) will update the bar chart title to reflect data specifically for VIC.

On-Demand Information:

- **Hover Activation:** Tooltips are activated when a user hovers over a state on the choropleth map or a bar in the charts. This ensures that additional information is displayed only when needed, keeping the main visualization clean and focused. For instance, when a user hovers over a state, the state turns black, contrasting sharply with white labels to highlight the selected area clearly.
- **Detailed Data:** The tooltips provide specific data on death rates and vaccination doses for the hovered state and year. This allows users to gain precise insights without needing to refer to external sources or perform mental calculations. For example, hovering over a state will show the exact death rate and the number of vaccination doses administered in that state.

User Engagement:

- **Interactive Highlighting:** Tooltips enhance user engagement by making the visualization interactive and responsive. Specifically, when a user hovers over a state, that state turns black with white labels, providing an immediate cue that the element is interactive and inviting users to explore further.
- **Visual Feedback:** When a user clicks on a state, the selected state turns grey, providing clear visual feedback and indicating that the data for that state is displayed in the bar charts. This visual feedback helps users understand the context of the data they are viewing and ensures they are aware of the state they have selected.

f. Improvements from the draft

The final implementation of the visualisations has been improved over the initial design and draft, which are discussed as follows:

- **Separate Bar Charts:** To improve readability, the visualisation now includes two distinct bar charts for COVID-19 deaths and immunisation data. This division reduces visual clutter, allowing viewers to focus on each dataset separately and analyse the information more efficiently.
- **Data Refinements:** The data visualisation inside the choropleth map has been optimised to clearly distinguish across states based on death rates, making variances readily obvious. Similarly, the bar charts now provide for a clear, side-by-side comparison of vaccine doses and fatality instances over time, which improves comparative analysis. Interactive elements such as tooltips have been completely incorporated, considerably improving the user experience by allowing for a comprehensive understanding of the data.
- **Tooltips:** Tooltips have been added to both the map and the bar charts to label state names and easily display relevant information. This update helps to make the data more accessible and easier to understand immediately.
- **Colours In Use:**
    - The updated colour scheme utilises red to represent death instances and blue to denote vaccine doses, creating a striking contrast that assists in properly monitoring pandemic-related health responses.
    - On the choropleth map, different hues of red represent the severity of the impact among states. This strategy aids in immediately identifying the locations most afflicted by the epidemic, providing an immediate visual indication to the severity of the problem in various places.

These enhancements to the visualisation tools not only make the data more accessible and simpler to interpret but also boost users' capacity to do an in-depth analysis of the patterns and implications of COVID-19 throughout Australia.

4. Validation

4.1. Methodology

For the validation of our developed data visualisation platform, our team carried out an evaluation form to delve into user experience in reality.

The participants were given the task of completing a series of activities aimed at assessing the usability and interaction of data visualisations. These activities included answering scenario-based questions based on information retrieved from the visualisations. Upon each question, users are prompted to rate the complexity on a scale ranging from “Very Easy” (1) to “Very Hard” (5). Our goal was to make the visualisations as user-friendly as possible, with the tasks considered minimally demanding.

The research we conducted included 9 participants aged 18-34, who were chosen via convenience sampling. The majority (66.7%) had Computer Science and technical field experience, with a large percentage specialising in web development.

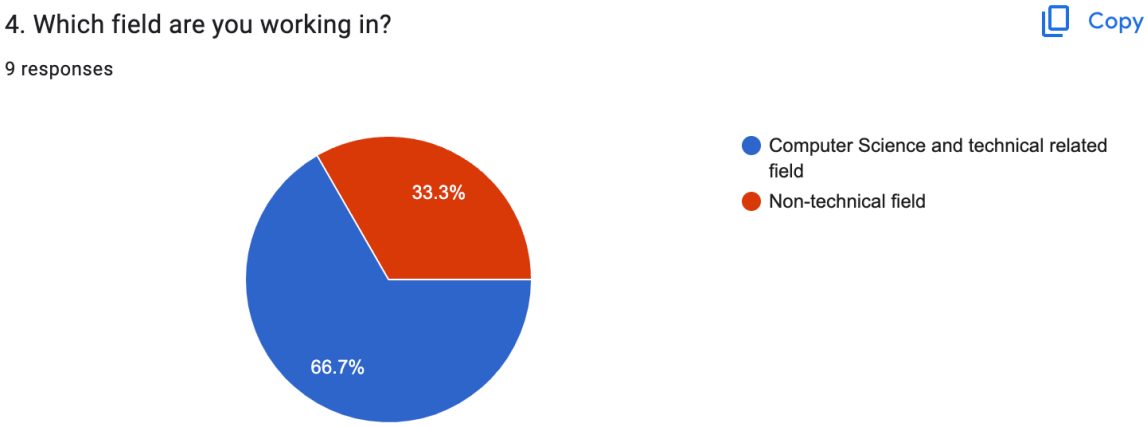


Figure 36. Evaluation Form Result Analysis

4.2. Overall trends in Health spending over the years

4.2.1 Survey Responses

For the first visualisation, we asked two specific questions aimed at estimating how effectively users could navigate and interact with the graph's features. These questions analysed users' familiarity with the graph's interactive features, including hovering and locating information.

The survey responses to the first question about the year Australia spent the most on healthcare reveal that most participants (77.8%) correctly selected 2022 as the year with the highest spending, suggesting a solid understanding of the visual data provided. This is corroborated by the difficulty rating for this question: the majority of participants (66.7%) considered it extremely easy (ranked as 1), with a smaller minority (33.3%) ranking it as easy (3). This shows that the chart was excellent at expressing information simply, allowing viewers to appropriately analyse the data with minimum effort.

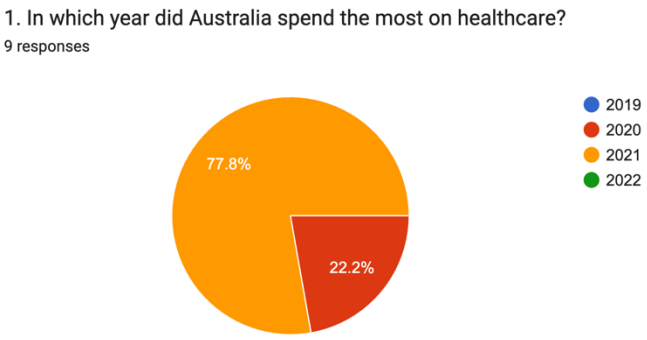


Figure 37. Evaluation Form Result Analysis

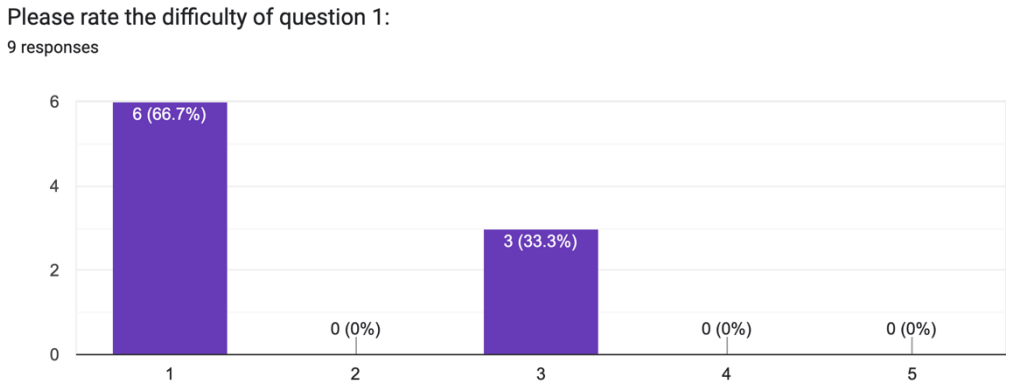


Figure 38. Evaluation Form Result Analysis

The survey's findings for the second question, which tested participants' ability to identify the year when Australia's health expenditure was between $130 billion and $140 billion, reveal that 77.8% of respondents correctly identified the year. This suggests that most people could successfully read the graph to obtain numerical data. This question, however, had a wider range of difficulty ratings than the first: 55.6% ranked it as very easy, 22.2% as easy, and 11.1% as very hard. The variation indicates that, while the graph effectively communicated the necessary information for the majority, only a small number found the task slightly more difficult.

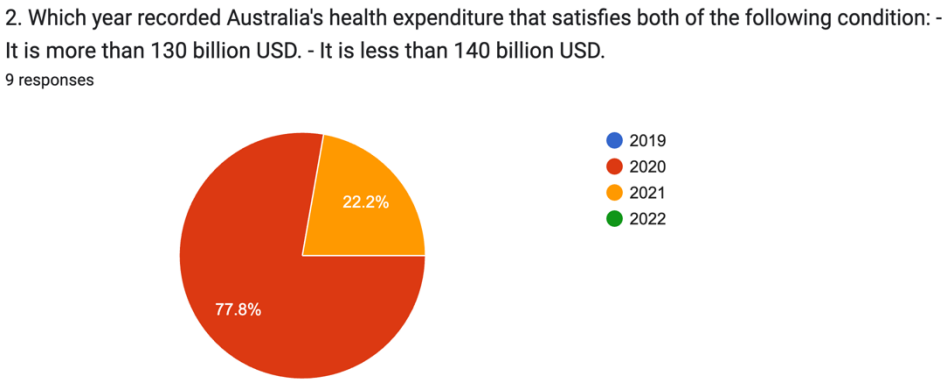


Figure 39. Evaluation Form Result Analysis

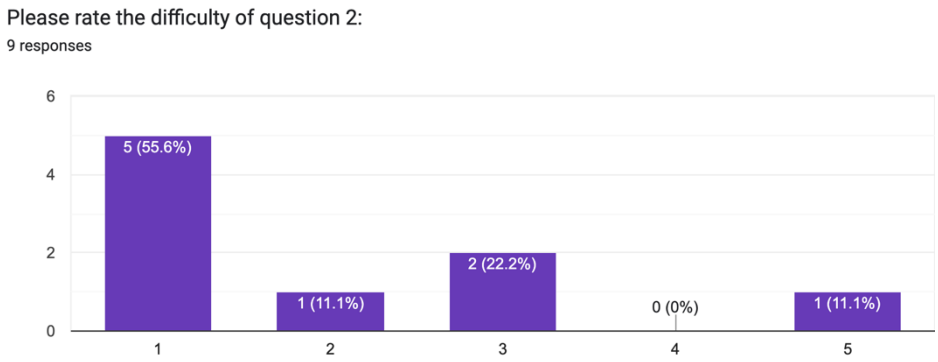


Figure 40. Evaluation Form Result Analysis

4.2.2 Recommendations

According to the survey results, while most people were able to properly extract critical data from the visualisation, the graph's clarity and interaction design still need to be improved. To increase usability, consider Improving colour contrast between parts would not only make the chart more visually attractive but also more accessible and understandable. Clarifying the "Rank" part is also important, as it appears to generate misunderstanding among users. Providing a brief explanation inside the chart such as a footnote or an interactive tooltip of what "Rank" means (e.g., comparing Australia's health spending to other nations) might assist viewers in better grasping this part of the data. These changes would most likely increase user comprehension and engagement with the visualisation.

4.3. Covid-19 Vaccination and Death Rates

4.3.1 Survey Responses

The survey results for the third question, which asked participants to identify the state with the highest mortality rate from the map, reveal that the majority (88.9%) correctly identified New South Wales (NSW). However, the difficulty assessment for this question was mixed: 55.6% ranked it extremely easy, 33.3% as easy, and 11.1% as moderately easy. This implies that, while the map effectively transmitted the essential information to most participants, there may still be space to improve the clarity with which different levels of data are separated.

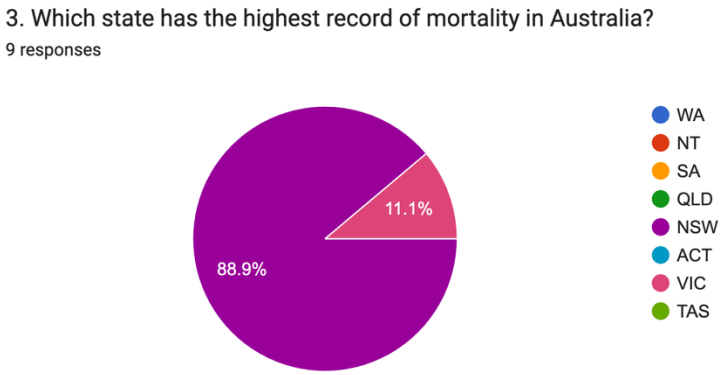


Figure 41. Evaluation Form Result Analysis

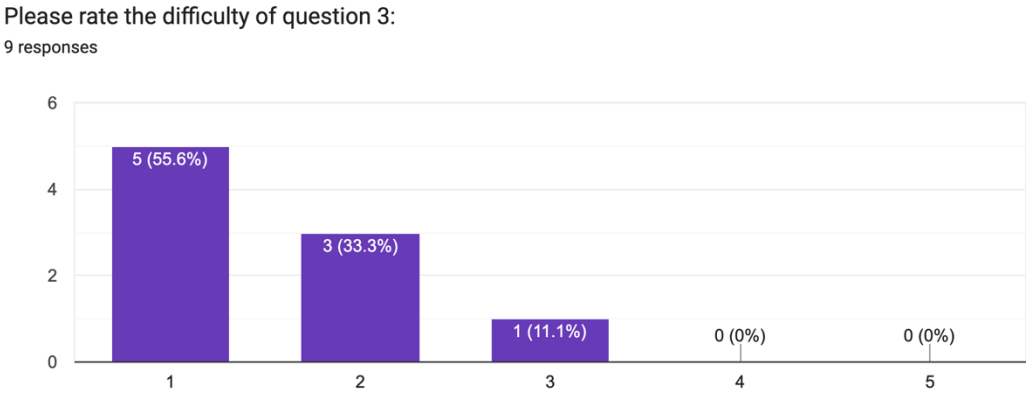


Figure 42. Evaluation Form Result Analysis

The responses to the fourth question, which asked about the overall number of death cases in Australia in 2023, revealed that a large majority (66.7%) correctly recognised the statistic as 4,525. This suggests that the graphic representation was clear for most participants. However, the difficulty rating indicates a variable level of ease in comprehending this data, with 44.4% ranking it as extremely challenging and 33.3% as simple, revealing some differences in data comprehension across participants. This variation in difficulty ratings suggests that, while the visual assistance was useful to some, others may benefit from further explanations or reduced data presentation to increase understanding.

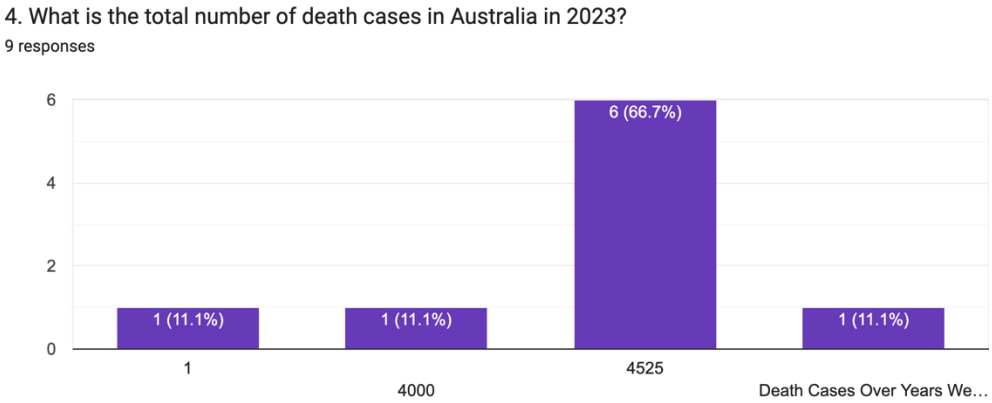


Figure 43. Evaluation Form Result Analysis

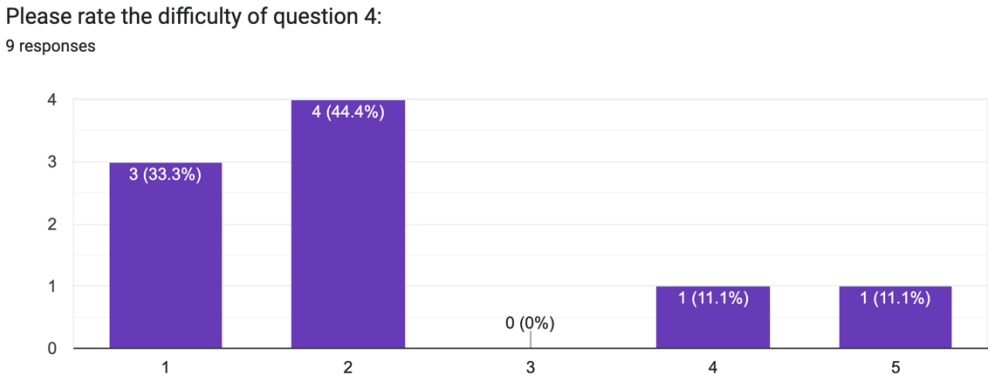


Figure 44. Evaluation Form Result Analysis

The survey results detect some difficulties participants had while using the interactive features between charts 2 and 3 to extract accurate information. A substantial proportion of users failed to grasp why interacting with the two charts was required to discover the answers, demonstrating an issue in the visualisations' straightforward usage. This feedback implies that the visualisations should include clearer instructions to direct users on how to engage with them correctly.

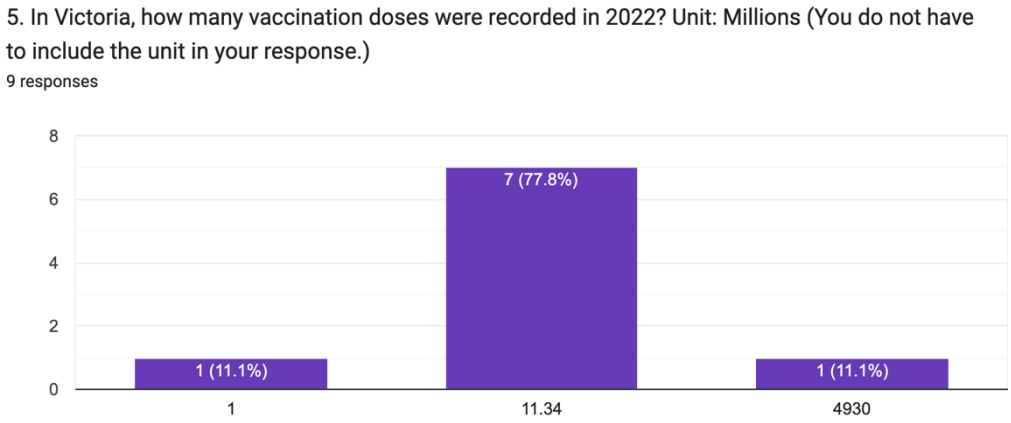


Figure 45. Evaluation Form Result Analysis

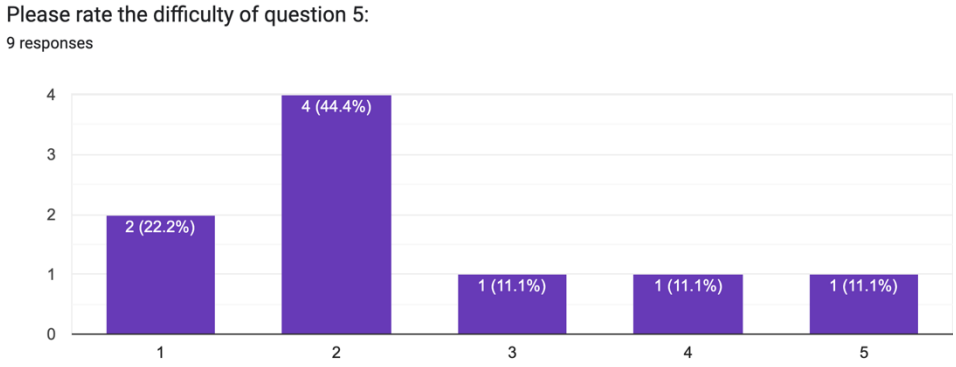


Figure 46. Evaluation Form Result Analysis

The results of the survey for question 6, which concerns the total amount of vaccination doses provided in Queensland until now, demonstrate that the majority (55.6%) correctly identified 13.3 million doses. This suggests a reasonable amount of clarity in how the material was displayed or accessible, with the majority retrieving the proper information. However, the difficulty ratings for this question varied, with a significant percentage (44.4%) finding it very easy and 33.3% rating it somewhat tough, suggesting that some participants may have had difficulties accessing the data. This feedback suggests that, while the visualisation works well overall, improving navigational signals might enhance user experience and retrieval accuracy.

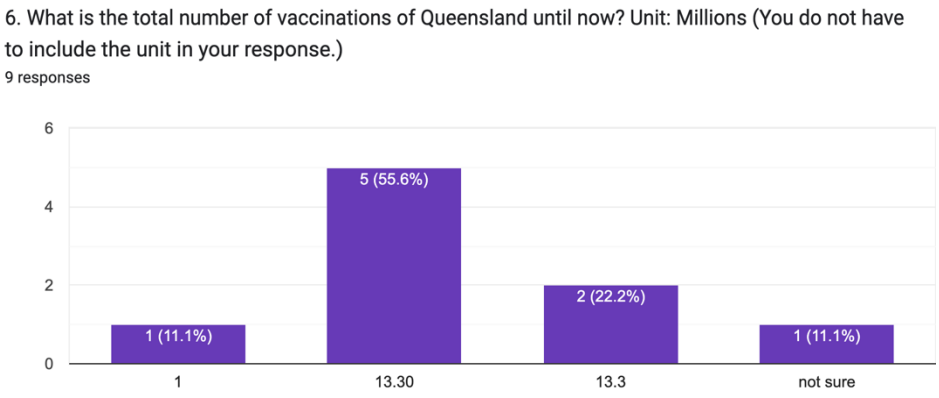


Figure 47. Evaluation Form Result Analysis

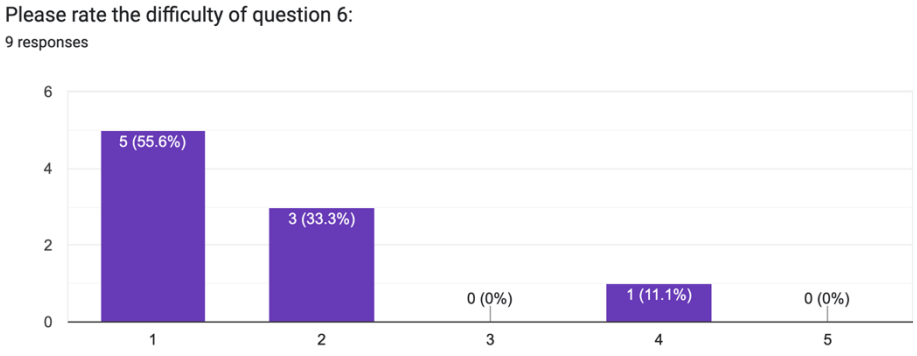


Figure 48. Evaluation Form Result Analysis

4.3.2 Recommendations

Based on survey feedback, it is recommended that related charts, especially charts 2 and 3, should appear on the same page to clarify their interconnection and allow for better navigation. This change would greatly increase user interaction and understanding. Furthermore, adding tools like sorting or filtering might improve the charts' usefulness and user experience, making the data more accessible and easier to analyse.

5. Conclusion

In this project, we have transformed complicated statistics into intuitive visualizations showing the various effects of COVID-19 on the Australian healthcare system. By utilizing interactive charts, our team has efficiently displayed the trends of healthcare spending, death rates and vaccination process. Supported by these statistics, the public as well as the government are encouraged to make the most feasible decision. According to our user surveys, the visualizations were proved to be helpful and the users are capable of comprehending the data with ease. However, there were still some inevitable flaws as some users suggested improvements in navigational cues and clarity of connected visual components. Overall, the project achieved its goal of delivering informed knowledge of the pandemic's effect on Australia, which necessitates more educated approaches to future healthcare programmes and policies.

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