THE UNIVERSITY OF SYDNEY

Assignment Coversheet – GROUP ASSIGNMENT

Please fill in your details below. Use one form for each group assignment.

Assignment Details:

Assignment Title	**Assignment 2 (Group)**				
Assignment number	**2**				
Unit of Study Tutor	**Roy**				
Group or Tutorial ID	**RE-7**				
Due Date	**5/11/2021**	Submission Date	**5/11/2021**	Word Count	**3326**

Membership

Group Name/Number	RETUT07-04				
Family Name	Given Name (s)	Student Number (SID)	Unikey	Contribution + percentage	Signature
Suvorov	Pavel	470375383	psuv5515	First wave + final report polishing – 20%	
Li	Yuchen	500187513	yuli3199	Second wave: testing – 20%	
Peng	Chengwei	480188609	cpen2847	Second wave: overview – 20%	
Wu	Chensizhu	500334737	chwu6727	Intermediate period – 20%	
Cai	Yutong	510135555	Ycai3455	Second wave: vaccination – 20%	

Declaration:

1. I understand that all forms of plagiarism and unauthorised collusion are regarded as academic dishonesty by the university, resulting in penalties including failure of the unit of study and possible disciplinary action.
2. I have completed the **Academic Honesty Education Module** on Canvas.
3. I understand that failure to comply with the Academic Dishonesty and Plagiarism in Coursework Policy can lead to the University commencing proceedings against me for potential student misconduct under Chapter 8 of the ***University of Sydney By-Law 1999*** (as amended).
4. This work is substantially my own, and to the extent that any part of this work is not my own I have indicated that it is not my own by acknowledging the source of that part or those parts of the work.
5. The assessment has not been submitted previously for assessment in this or any other unit, or another institution.
6. I acknowledge that the assessor of this assignment may, for the purpose of assessing this assignment may:
   a. Reproduce this assignment and provide a copy to another member of the school; and/or
   b. Use similarity detection software (which may then retain a copy of the assignment on its database for the purpose of future plagiarism checking).
7. I have retained a duplicate copy of the assignment.

Please type in your group number here to acknowledge this declaration:	RETUT07-04

COMP5048 Assignment 2 (Group)

I. Introduction

The SARS-CoV-2 virus is a cause of the COVID-19 disease, which has had a significant impact on both personal and global humanity levels [5]. In order to prevent further spread of the disease and reduce the number of infected, it is extremely important to identify what procedures and policies turned out to be the most effective against the virus. The corresponding space of actions can be split into 4 major categories:

- Encouraging hygienic procedures
- Encouraging testing
- Controlling the flow of people (incl. international and interstate travel restrictions)
- Vaccination

The goal of this work is to identify what policies (or their combinations) were the most effective against the spread of COVID-19 in NSW, Australia, and what policies were not. For this purpose, a set of visualisations is proposed to be created. The number of infections is set to be the key goal indicator (KGI) and the number of daily cases was selected as the corresponding key performance indicator (KPI).

The overall pandemic in NSW can be split into three main periods: the first wave (March 2020), the intermediate period, and the second wave (Summer-Fall 2021). It is proposed to assess these periods separately, as the conditions in each situation were different.

All numeric data used for this assignment is taken from the official governmental sources [2-5].

II. First Wave (March 2020)

Even though the first cases of COVID-19 in NSW were registered in January 2020, the situation started to get serious only in March.

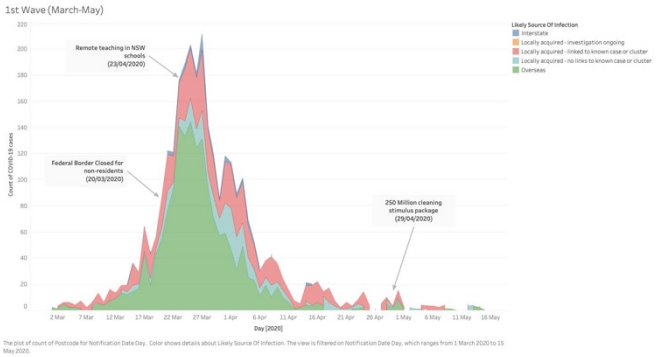

Fig 1. First wave visualisation

In figure 1, the illustration of the situation in the corresponding period is shown. The x-axis corresponds to the day selected, and y-axis corresponds to the number of cases in that day. The idea of such an orthogonal arrangement is to clearly show the change in the selected KPI over the corresponding period. The plot additionally utilises cumulative areas in order to show the changes in the nature of cases more efficiently. The colour retinal variable was used to represent the corresponding categories of cases, so that the analysis can be simplified. Additionally, text annotations are added to show when each of the policies discussed was introduced. Finally, this visualisation was decided to be made interactive (please see the media file attached). User can select what exact decision they wish to assess, which helps to isolate the assessment of the corresponding policies. This allows a better storytelling, which is crucial when you need to introduce someone to the new problem. Overall, the idea of this visualisation is to let the users easily spot the main source of infections and how different policies affected them, using an interaction of axes and area.

It can be noted that the main source of infections during that period was overseas cases. Thus, the corresponding decision to close an international border had an almost immediate effect in two weeks, when the number of overall cases started to drop. The corresponding decisions to introduce remote teaching in state's schools and the later passed 250$ million cleaning stimulus package helped to control and avoid the spread of locally acquired cases.

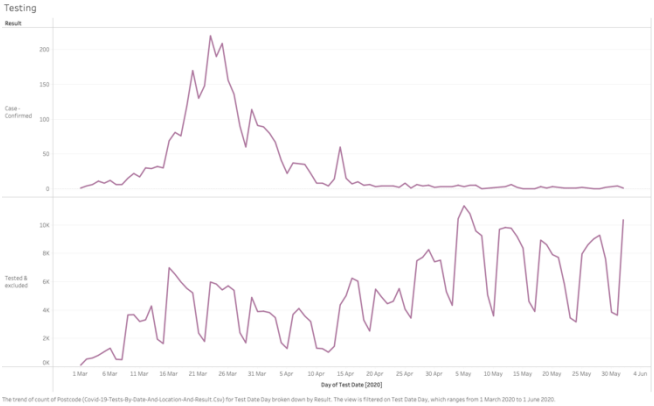

Fig 2. Tests during the first wave

In figure 2, again an orthogonal imposition is utilised. However, now multiple vertical axes are used. The upper one corresponds to the KPI and the lower one to the number of tests conducted. Such a layout was chosen for a simpler comparison of the two time-series, as that is the main goal of this visualisation – to contrast between 2 trendlines. The overall logic is that by utilising such a layout, the user's cognitive abilities would be enhanced, thus allowing an easier perception of trends. No additional retinal variables were used, as these would not add any value or insight, thus would be only distracting the user from the focus of the illustration. Such a minimalistic non-verbal communication method allows the best interaction with the user, as their perception is not distracted by any noise information.

From the figure, we can conclude two interesting facts. The first one is that the tests were conducted cyclically, which might be related to the business days and private clinics being closed during the weekends. Another interesting fact is that with the number of tests conducted growing, the number of cases started to drop. However, we cannot argue the effectiveness of this measure per se, given the other policies introduced during the same period. Though, it can still be claimed that the tests were helpful in controlling the spread of the disease.

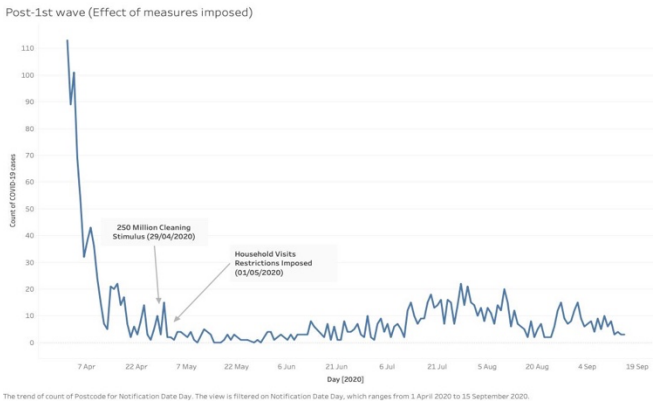

Fig 3. End of the first wave policies

In figure 3, an identical approach is used for the axes arrangement, as in figure 1. Orthogonal diagram with the x-axis ordered by time helps easily spot the changes in the situation. No additional retinal variables were used, as the idea of the graph is to communicate the effect of policies combined on the KPI only. The minimalistic approach aligns with the gestalt principle, as such an approach to interaction allows the whole comprehensive perspective to be "loaded" into the user's perception. This was done to ensure that the user could easily perceive the effect of these policies.

As it was mentioned earlier, the authorities were trying to stop the local cases as well. To do this, the authorities proposed an already mentioned cleaning stimulus and the follow up restriction on households' visits. As it can be seen, after these two policies were proposed, the number of cases got under control for a rather long period of several months.

III. Intermediate Period

Between the two waves of COVID-19, there was a rather long period when the cases were controlled rather well, given an outbreak in the neighbouring Victoria state.

A. *Travel Restrictions*

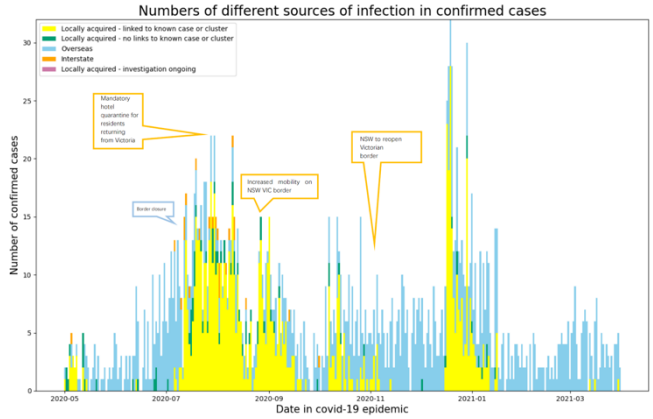

Fig 4. Travel Restriction during the intermediate period

In figure 4, the illustration of the cases and their nature during the intermediate period is present. The axes are again utilised in same way, however now, the stacked bar chart is used. The retinal variable of colour is used to encode different sources of infection. Additionally, to better convey the information, deeper colours represent the lower-proportion sources of infection. By utilising the bright colours, it is aimed to again improve the interaction with the graph by simplifying the perception of different sources of infection, as the user could immediately contrast these, which links their attention to 2 most significant peaks being analysed.

Firstly, we can clearly notice that the continuing closure of the international border ensured a small number of overseas cases, as those were now limited to the returning residents only. Secondly, there was no outbreak of interstate cases, as these were effectively tackled by the corresponding decisions to firstly close the Victorian border and then reopen it once the situation got back under control. This is signified by the fact that after the border got reopened, there were 0 registered interstate cases.

B. *Tests encouraging*

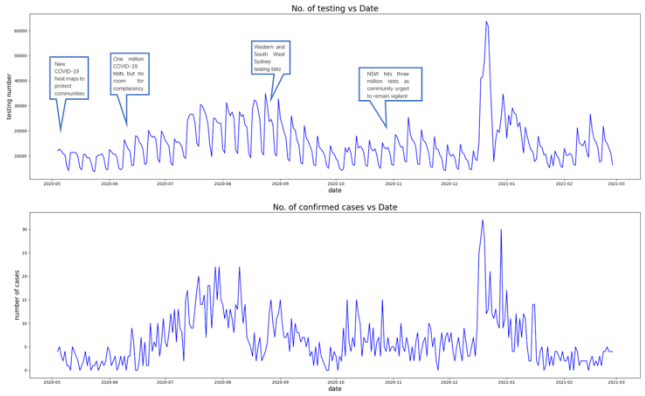

Fig 5. Tests data during the intermediate period

In figure 5, the x-axis represents time, while the vertical arrangement uses multiple axes. In the bottom one it stands for the number of cases, while in the top one it stands for the number of cases detected. The approach that was used here is quite like the one used in figure 2, as these cover the same topic. However, now the additional captions are added to the graph, as the period covered is longer and to ensure that the user does not lose their focus these were added for an improved storytelling.

There is a clear correlation between the number of tests and number of positive cases. There are 2 possible factors attributing to this: the first one is that the higher the number of tests, the higher the chance of testing someone with COVID. The second one is that the higher number of tests is possibly associated with the higher number of false positive results. Overall, we can conclude, that the government's approaches with blitzes did not have a proper effect on testing and thus had no significant effect on the number of cases.

C. *Hygienic Processes & Gatherings Flow Control*

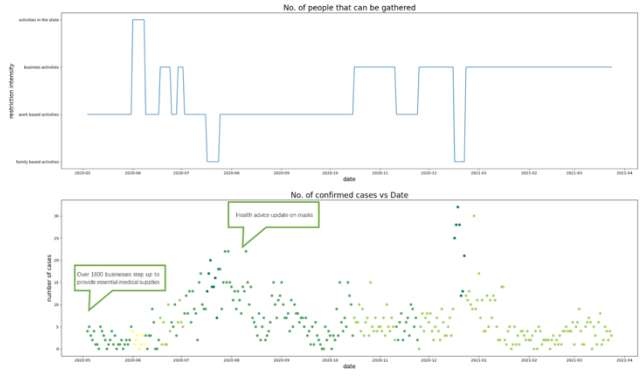

Fig 6. Number of cases vs allowed gathering size

For the corresponding period, a set of hygienic procedures and crowd flow control measures were taken. Since the

beginning of the first wave, the authorities were recommending wearing gloves and face masks. In figure 6, the x-axis corresponds to the time flow and the vertical axis again utilizes multiple axes arrangement. The top one stands for one out of 4 main categories of restrictions: {state-level, business-level, daily work-level, family-level}, the lower one again stands for KPI. Additionally, a retinal variable of colour value is used to represent one out of four categories to simply the perception. The deeper the colour, the greater the intensity of restrictions. These features help the user to easily notice a correlation between different levels of restrictions and the number of cases.

We can easily spot two peaks and the corresponding additional restrictions imposed. Interestingly, immediately after the new restrictions are introduced, the number of cases starts to drop. On the other hand, at the first peak, the state authorities released a reminder to wear face masks. However, acknowledging that this was done since the beginning of the pandemic, we cannot argue the effectiveness of such decisions.

IV. Second Wave (Summer-Fall 2021)

As we can see from the previous section, the situation got controlled rather well. According to the media releases, since January 2021, the number of local cases was minimal and was equal to zero since the 5th of May 2021. Most of the cases occurring were linked to overseas infections from those residents who were returning to Australia. However, the situation changed dramatically in June 2021, when the infections in Bondi cluster happened, which caused the second wave of the pandemic in NSW.

A. Flow control and hygienic procedures

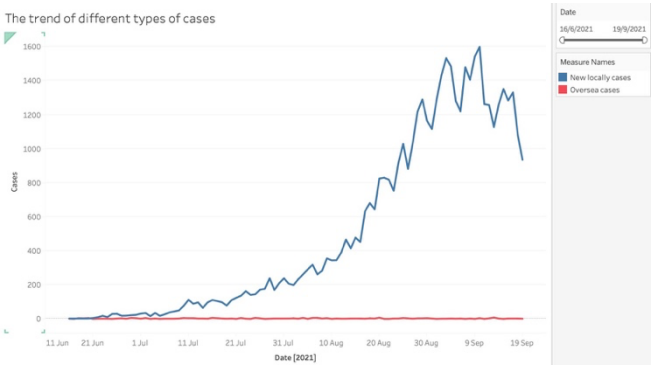

Fig 7. General overview of the second wave

In figure 7, the x-axis represents the dates from June 16th till September 19th, which should help the user spot the trends during the relevant period. The y-axis represents the daily cases. Additionally, a colour hue retinal variable is used to categorise cases by either overseas or locally acquired source of infection. This additional feature helps the user to easily differentiate between two separate trends. Again, no extra information is present, as this would distract the user's interaction.

From this chart, it gets obvious that the second wave had a different nature comparing to the first wave. In contrast with the first one, the overseas cases number stayed almost constant, while the number of locally acquired cases was the cause of the wave. Thus, the same procedures that were used during the first wave, might not have worked, as the international travelling was already under a good control. Given that at that moment a new, even more infectious delta strain of COVID got developed, a different approach was needed.

Another graph can help us assess, the source of these locally acquired cases.

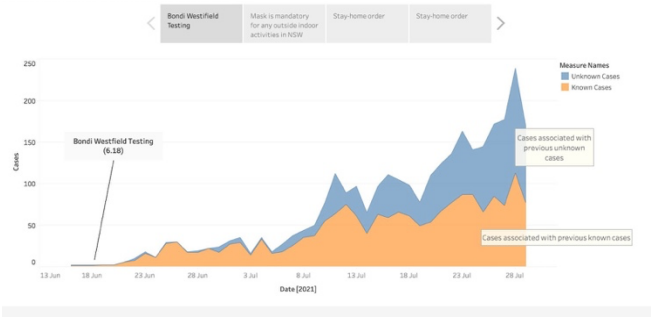

Fig 8. Nature of locally acquired cases during the second wave

In figure 8, the x-axis of the graph represents the timeline, while the y-axis represents the number of cases, which is once again used to simplify the perception of trends during the relevant period. The retinal variable of colour hue is used to show different natures of locally acquired cases, thus simplifying the analysis and perception of the situation. The proposed visualisation is interactive (please see the media file attached) and allows the user to select the event, which they want to focus on. This interactive feature again allows a better storytelling, as it lets the user to get into such a complex process in a "playful" manner, allowing the user to stay and focus on the exact policy/action they want to assess in detail and also reduce the cognitive noise.

From this graph, it is clear that in the beginning of the wave, most of the cases were linked to the known cluster (likely the Bondi one), while later on, given the higher infectiousness of the delta strain, new unknown-link cases started to appear. Additionally, we can notice how different firstly soft policies were helpless against the spread. This was an overall issue and was not caused by the growth in just one cluster, as it can be seen in the next visualisation.

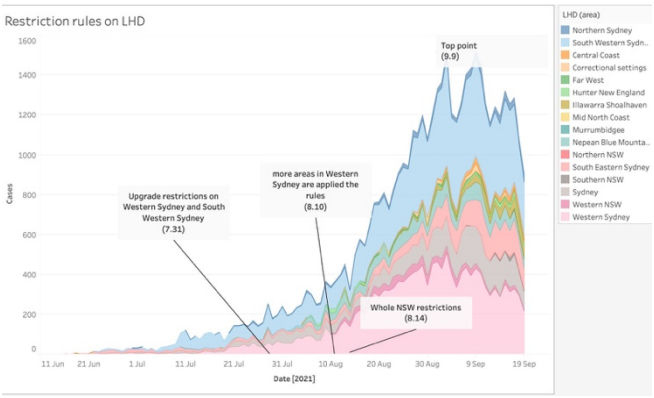

Fig 9. Effect of different restrictions during the second wave

In figure 9, the axes arrangement is kept same for the comparability with the previous graphs in the section. It utilizes a retinal variable of colour hue to represent different local areas in NSW. Additionally, notes with the corresponding governmental policies are put to tell user a story of what was done in attempts to prevent the virus. The idea of the interaction is to tell the effectiveness of different policies. To ensure the best interaction, we had to add some verbal communication, though tried to keep it minimal. This allows the user not to just see the trends but puts these trends

into the broader context, which assists in the analysis and utilization of the provided information.

Since 18th of June face masks got strongly encouraged in all public venues, and mandatory in public transport. Starting from 26th of June, a stay-at-home order was released state-wide, with a corresponding prolongation on 10th of July. It can be noticed that the decisions were getting stricter and stricter with the timeline. However, there was no corresponding drop in the number of cases in two weeks after each, which is considered a maximum duration of the incubation period [1]. This shows that these decisions solely were not effective in controlling the spread of the disease.

B. *Encouraging tests*

Another perspective to consider is the effect of tests conducted. On the one hand, the tests themselves increase the number of cases, which is logical and expected, simply because the recall of the procedure gets higher. On the other hand, theoretically, tests can help isolate patients under investigation and link them to some known cluster and thus prevent a new outbreak of the infection.

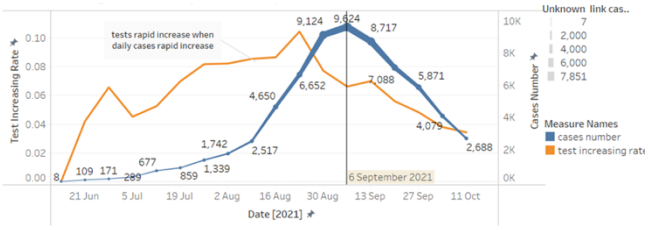

Fig 10. Tests during the second wave

In figure 10, the x-axis represents the timeline and y-axis consists of two axes one representing the change in the testing rate and the second one is the number of cases. Orthogonal arrangement with multiple vertical axes aligned allows the user to easily spot the relationship between different processes. Additional retinal variable of area is used to represent the number of unknown-link cases, thus providing an additional perspective without the further complication of the graph. User can notice the interaction between the rate of testing and the number of cases.

From this figure, we can notice that the increasing number of tests does not stop per se but allows to spot those cases that have no link to the existing clusters. This can help isolate these cases. We can notice that after the peak of testing growth, the number of cases with the unknown source started to drop.

C. *Vaccine*

One of the most significant differences of the second wave from the first one was the availability of the vaccine. With the start of the second wave, it was realized how important it is to speed up the vaccination of the population

Fig 11. Vaccination vs New daily cases vs New daily deaths

Figure 11, once again utilizes the orthogonal arrangement of axes, given the need to show the temporal effect of vaccination. The x-axis naturally stands for time, while multiple vertical axes represent the cumulative number of vaccinated people and daily cases/death at the right and left ordinates correspondingly. Given multiple perspectives, the user can easily spot the interaction between two subjects. The main idea is that the user's interaction would be simplified by utilizing multiple vertical axes, which allows a simpler comparison of two trends, giving a holistic overview on the effectiveness of vaccination.

We can spot that the number of vaccinated people was constantly growing and after the national rate achieved a number of 8 million, the number of cases in NSW started to finally decrease in a horizon of two weeks. This shows that indeed getting a collective immunity might help stop the spread of the virus. Additionally, this plot helps us notice that there was no corresponding jump in deaths, thus the policies selected were rather effective.

V. Discussion

Now after assessing the policies in these three corresponding periods, we can discuss what of these policies and their combination were effective and what were not.

Firstly, encouraging good hygienic procedures was done in the beginning of the pandemic. A recommendation to wear medical masks and wash hands properly was in place since the beginning of the pandemic. Additional measures, such as cleaning stimulus packages have shown additional help. However, given how the situation was developing during the second wave of COVID in NSW, this strategy cannot be effective per se. On the other hand, we cannot argue that these measures were useless, as we don't know how the situation would be developing without these measures.

Secondly, encouraging testing does not help to stop the spread per se, as it was seen in both waves one and two, however allows to spot the cases that are not linked to any of the clusters, which might be helpful to prevent the further spread if other measures are taken.

Thirdly, people flow control can be rather effective if the virus is not extremely infectious. Travel restrictions imposed in the beginning of the pandemic were extremely effective against the overseas cases. On the other hand, these don't guarantee that the virus would not be spreading locally, as it happened during the second wave. Interstate travelling itself was quite effective, as it was shown in the intermediate period. However, if the virus gets extremely spreadable (like it happened with the delta strain), this strategy gets wicker and wicker. Even though a 5-km restriction was imposed during the second wave, it gave no immediate effect on the spread, as the number of cases was still on the rise. Turns out that the soft crowd control restrictions are effective during rather calm periods of pandemic and get almost powerless when the situation gets outside the control

Finally, the vaccination turned out to be a very effective tool against the pandemic. However, it was not available during the first wave, thus its application was rather limited. Another limitation is that it was needed to vaccinate almost half of the nation before the cases started to drop. However, it was the only effective tool against the delta strain and lead to the corresponding lift of restrictions.

VI. Conclusion

This work shows that given the rapidly changing environment and conditions, it is extremely important to stay agile in decision-making. Policies that worked in one situation might get less effective in a different setting. A good example is controlling the flow of people, which worked rather well in one case (allowing more than a year of minimal infections) and getting powerless in a different setting (against a delta strain of virus).

Out of all four policies, the vaccination turned out to be the most efficient tool against the spread of virus, as only it was able to stop the second wave. In an extreme situation, both 4 policies should be used in to stop the wave as soon as possible. The extent to which the other tactics were useful depended on the context in which they were applied a lot. The visualizations proposed helped to identify the effectiveness of each approach by enhancing the cognitive abilities of the users.

References

[1] Harvard Health Publishing. (2021). If You've been exposed to the coronavirus. Retrieved from https://www.health.harvard.edu/diseases-and-conditions/if-youve-been-exposed-to-the-coronavirus

[2] Data NSW. (2021). NSW COVID-19 Data. Retrieved from https://data.nsw.gov.au/nsw-covid-19-data

[3] Department of health – Australian Government. (2021). Resources. Retrieved from https://www.health.gov.au/resources

[4] NSW Government. (2021). Covid-19 news and media. Retrieved from https://www.nsw.gov.au/covid-19/news-and-media

[5] World Health Organisation. (2020). Coronavirus Disease (COVID-19). Retrieved from https://www.who.int/emergencies/diseases/novel-coronavirus-2019