

Visualization_Project_#2

May 9, 2021

1 Creating Deceptive or Misleading Graphic

2 Immunization in Ontario: Non-Medical Immunization Exemptions

Point to prove: Increasing non-medical immunization exemptions rate among children 7 years old in Ontario is harmless. Ngone Lo
March 2021

3 Libraries

```
[1]: # for working with the data
import pandas as pd
import numpy as np

# for visualization
import matplotlib.pyplot as plt
from pylab import rcParams
import matplotlib.colors as mcolors
from mpl_toolkits.mplot3d import Axes3D
from matplotlib.collections import PolyCollection
import seaborn as sb
import plotly.graph_objects as go
from plotly.subplots import make_subplots
import plotly.express as px
```

4 Strategy

We plan to make use of the following misleading techniques: - Transparency: data exclusion along with limited scope (see introduction and context) - Color: single hue with varying shades(luminance) - Scale: one shared and fixed y-axis rather than independent y-axes - Theme: plain white or dark theme with no gridlines (to put emphasis on the general trend) - Chart type: bubble plots (with size) and bar charts - Speed and attention: moving bubbles and bars with speed adjusted for maximum effect - Complexity: all above

5 Introduction and Context

Under Ontario's Immunization of School Pupils Act (ISPA), primary and secondary school students are required to provide proof of immunization against nine infectious diseases: diphtheria, tetanus, pertussis (as of the fall of 2014), poliomyelitis, measles, mumps, rubella, meningococcal disease or MCC (as of the fall of 2014), and varicella or chickenpox (as of the fall of 2014, applicable to children born in 2010 or later) (<https://www.ontario.ca/laws/statute/90i01>). However, exemptions, whether medical or non-medical (philosophical or religious), are available. Under the pretext that non-medical exemptions lead to major outbreaks of multiple vaccine-preventable diseases, there have been calls to curbe or end non-medical immunization exemptions with the steady increase in philosophical and religious exemptions, least up until the school year 2017-2018 for the group of students of 7 years old of age (<https://www.cbc.ca/news/canada/toronto/toronto-vaccination-outbreak-hesitancy-measles-1.5343220>, <https://www.cbc.ca/news/canada/toronto/toronto-public-health-calling-on-province-to-end-non-medical-exemptions-for-vaccines-in-schools-1.5285012>). See **Figure 1**.

We decided to focus on the non-medical immunization exemptions for the group of students of 7 years old of age. For fair comparaisn, we made the school year 2014-2015 the starting point since immunization for pertusis, varicella, and MCC became mandatory in the fall of 2014. Although varicella immunization became mandatory in fall 2014, it was excluded from our analysis because it is only applicable to children born in 2010, meaning its first tracking year for the 7 yers old of age was the school year 2017-2018. There have been no cases of diphteria (since 1995), poliomyelitis (since 1994), and rubella (since 2015) in Ontario. Thus, these three diseases were also excluded from our analysis.

We want to prove that increase in non-medical immunization exemptions rate is harmless. Thus, although data is available until the school year of 2018-2019, our analysis will only span up until the school year of 2017-2018 when the increase in non-medical immunization exemptions rate stops. See **Figure 2**.

Final dataset: using MS Excel, we extracted and compiled immunization and incidence data from datasets available on the Public Health. Immunization: <https://www.publichealthontario.ca/en/health-topics/immunization/vaccine-coverage>
Cases incidence: <https://www.publichealthontario.ca/en/data-and-analysis/infectious-disease/reportable-disease-trends-annually#/16> All initial datasets wil be included in the zip file.

```
[2]: # Use pandas to read in the dataset
df = pd.read_csv("datasets/vaccine_dataset_compiled.csv",encoding='cp1252')
df.dropna(inplace = True)
```

```
[3]: df.head()
```

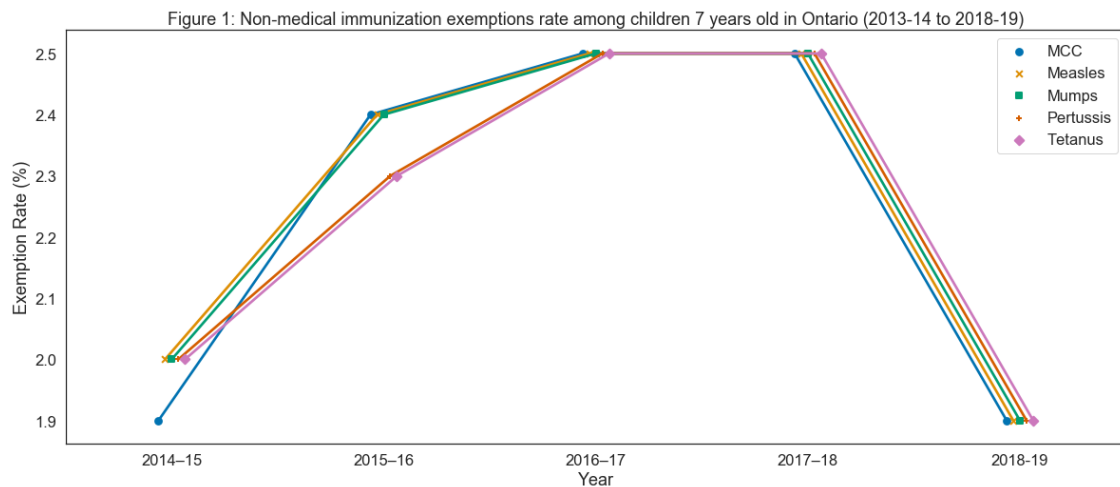
```
[3]: SchoolYear  ExemptionRate  Disease  AllAgesTotalCases  AllAgesTotalRate  \
0    201415      1.9         MCC          34              0.25
1    201516      2.4         MCC          29              0.21
2    201617      2.5         MCC          31              0.22
3    201718      2.5         MCC          32              0.22
4    2018-19      1.9         MCC          36              0.25
```

```
AgeGroupTotalCases  AgeGroupTotalRate
```

0	0	0.00
1	0	0.00
2	1	0.13
3	0	0.00
4	2	0.27

```
[4]: #set general theme
%matplotlib inline
rcParams['figure.figsize'] = 20, 8
rcParams["axes.labelsize"] = 20
sb.set(font_scale = 1.5)
sb.set_style("white")

#lineplot
sb.pointplot(x="SchoolYear", y="ExemptionRate", s=80, hue="Disease",
             markers=["o", "x", "s", "+", "D"],
             palette="colorblind", data=df, dodge=True).set(title="Figure 1:
→Non-medical immunization exemptions rate among children 7 years old in
→Ontario (2013-14 to 2018-19)",
                                                           xlabel="Year",
                                                           ylabel="Exemption Rate (%)")
plt.legend(loc='upper right');
```



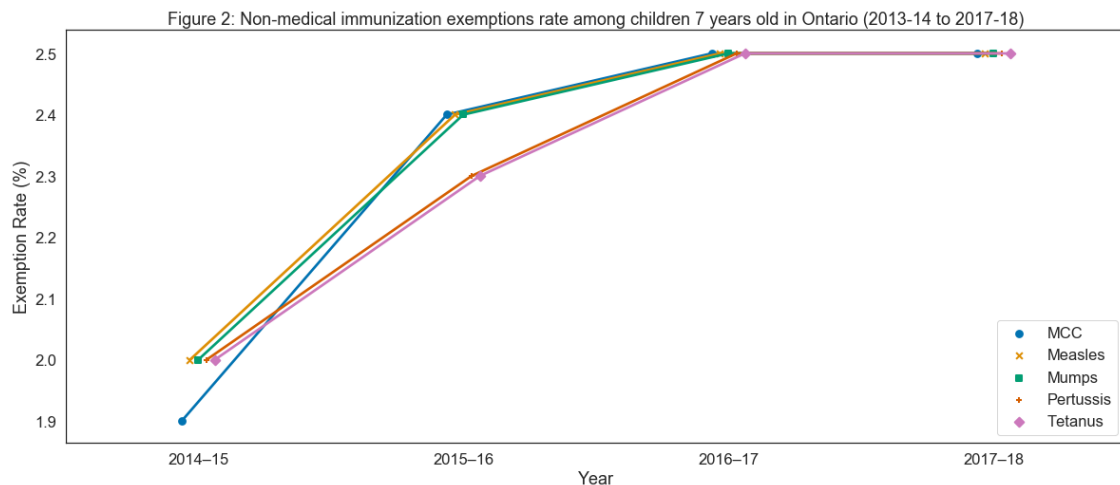
```
[5]: #Excludes the school years 2018-2019 from further analysis
df = df[df.SchoolYear != "2018-19"] #excludes the school years 2018-2019
df.head()
```

```
[5]: SchoolYear  ExemptionRate  Disease  AllAgesTotalCases  AllAgesTotalRate  \
0      201415          1.9      MCC          34          0.25
1      201516          2.4      MCC          29          0.21
2      201617          2.5      MCC          31          0.22
3      201718          2.5      MCC          32          0.22
```

5 201415 2.0 Measles 20 0.15

	AgeGroupTotalCases	AgeGroupTotalRate
0	0	0.00
1	0	0.00
2	1	0.13
3	0	0.00
5	1	0.14

```
[6]: #lineplot
sb.pointplot(x="SchoolYear", y="ExemptionRate", s=80, hue="Disease",
             markers=["o", "x", "s", "+", "D"],
             palette="colorblind", data=df, dodge=True).set(title="Figure 2:
→Non-medical immunization exemptions rate among children 7 years old in
→Ontario (2013-14 to 2017-18)",
             xlabel="Year",
             ylabel="Exemption Rate (%)")
plt.legend(loc='lower right');
```



6 Iteration Round 1: Static Plots

For our first iteration, we will use static plots relying on the misleading effect of the data exclusion (See introduction and context). First, ignoring the variable *school year*, we plot exemption rate against incidence and incidence rate for both the age group 5-9 years old and the general population (all age groups). For inclusion reasons, we are using a colorblind palette to distinguish between the diseases. We are also making use of a dismissive title to drive our message home.

```
[7]: #make matplotlib subplots
fig, axes = plt.subplots(2, 2, figsize=(25, 10))
```

```

fig.suptitle('P1: Increasing non-medical immunization exemptions among children,
→7 years old has no negative effect on incidence and incidence rate in,
→Ontario (2013-14 to 2017-18)')

sb.lineplot(ax=axes[0, 0], x="ExemptionRate", y="AgeGroupTotalRate",
→hue="Disease",
            markers=["o", "x", "s", "+", "D"],
            palette="colorblind", data=df).set(title="5-9 years old",
                                                xlabel="",
→ylabel="Incidence Rate (per 100k)")

sb.lineplot(ax=axes[1, 0], x="ExemptionRate", y="AgeGroupTotalCases",
→hue="Disease",
            markers=["o", "x", "s", "+", "D"],
            palette="colorblind", data=df, legend= False).set(xlabel="",
→ylabel="Incidence (Total Cases)")

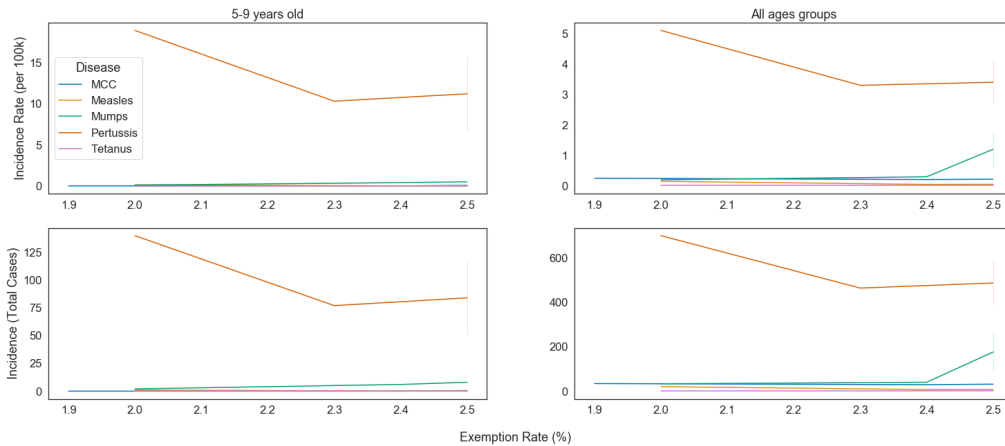
sb.lineplot(ax=axes[0, 1], x="ExemptionRate", y="AllAgesTotalRate",
→hue="Disease",
            markers=["o", "x", "s", "+", "D"],
            palette="colorblind", data=df, legend= False).set(title="All ages,
→groups",
                                                                xlabel="",
→ylabel="")

sb.lineplot(ax=axes[1, 1], x="ExemptionRate", y="AllAgesTotalCases",
→hue="Disease",
            markers=["o", "x", "s", "+", "D"],
            palette="colorblind", data=df, legend= False).set(title="",
                                                                xlabel="",
→ylabel="")

#general common x-axis label
fig.text(0.5, 0.04, 'Exemption Rate (%)', ha='center');

```

P1: Increasing non-medical immunization exemptions among children 7 years old has no negative effect on incidence and incidence rate in Ontario (2013-14 to 2017-18)



From **P1**, we can see that incidence and incidence rate generally remain constant or decrease with increasing non-medical exemption rate for all five diseases. Because the general population (all ages) is easier to generalize than a specific age group, we will focus on *all ages* going forward. The graphic above is not complex enough for our misinformation agenda. Hence, we use static bubble plots for our next prototype. We decided to use a single hue and the color green in order to confer a sense of safety. We also arbitrarily set the color range to 0-1000 (total cases) to fit our narrative.

```
[8]: # bubble using plotly express
fig = px.scatter(df,
                 x="SchoolYear",
                 y="ExemptionRate",
                 size="AllAgesTotalRate",
                 color="AllAgesTotalCases",
                 range_color=[0,1000],
                 color_continuous_scale=[[0, "#00441b"],[0.1, "#006d2c"], [0.
→3, "#238b45"],
                                     [0.4, "#74c476"], [0.6, "#a1d99b"], [0.
→7, "#e5f5e0"], [1.0, "#f7fcf5"]],
                 hover_name="Disease",
                 size_max=100,
                 template="simple_white",
                 title="P2: Increasing non-medical immunization exemptions_
→among children 7 years old has no negative effect on<br>incidence and_
→incidence rate in Ontario (2013-14 to 2017-18)",
                 labels={"SchoolYear":"Year", "ExemptionRate":"Exemption Rate",_
→"AllAgesTotalRate": "Incidence Rate (per 100k)", "AllAgesTotalCases":_
→"Incidence (Total Cases)"}
                 )

#Set title font size
fig.update_layout(titlefont=dict(size=16))
```

```

#Add annotations
fig.add_annotation(x=-0.1, y=2.7,
                  text="Hover on bubbles for more info <br>Bigger bubble means higher  

→incidence rate<br>Lighter shade means more cases",
                  align="left",
                  font=dict(size=9),
                  showarrow=False)
fig.add_annotation(x=3, y=1.75,
                  text="Not all ISPA designated diseases.<br>Only MCC, measles,  

→mumps, pertussis,<br>and tetanus are included.",
                  align="left",
                  font=dict(size=5),
                  showarrow=False)

fig.show()

```

7 Iteration Round 2: Moving Bubble Plots

For our second iteration round, we want to incorporate movement and speed to allow for not only more interactivity but also more complexity and distraction (attention). To achieve that, we make use of moving bubble plots with a speeded-up of movement.

```

[23]: # bubble using plotly express
fig = px.scatter(df,
                x="ExemptionRate", y="AllAgesTotalRate",
                animation_frame="SchoolYear",
                size="AllAgesTotalRate",
                color="AllAgesTotalCases",
                range_color=[0,1000],
                color_continuous_scale=[[0, "#00441b"],[0.1, "#006d2c"], [0.
→3, "#238b45"],
                                [0.4, "#74c476"], [0.6, "#a1d99b"], [0.
→7, "#e5f5e0"], [1.0, "#f7fcf5"]],
                hover_name="Disease",
                size_max=100,
                template="simple_white",
                title="P3: Increasing non-medical immunization exemptions  

→among children 7 years old has no negative effect on<br>incidence and  

→incidence rate in Ontario (2013-14 to 2017-18)",
                labels={"SchoolYear": "Year", "ExemptionRate": "Exemption Rate",  

→"AllAgesTotalRate": "Incidence Rate (per 100k)", "AllAgesTotalCases":  

→"Incidence (Total Cases)"}
                )

```

```

#Set fixed axes range
fig.update_xaxes(range=[1.85, 2.57])
fig.update_yaxes(range=[-0.2, 8])

#Set title font size
fig.update_layout(titlefont=dict(size=16))

#Add annotations
fig.add_annotation(x=1.95, y=7.8,
                    text="Hover on bubbles for more info <br>Bigger bubble means higher_
→incidence rate<br>Lighter shade means more cases",
                    align="left",
                    font=dict(size=9),
                    showarrow=False)
fig.add_annotation(x=2.5, y=7.8,
                    text="Not all ISPA designated diseases.<br>Only MCC, measles,
→mumps, pertussis,<br>and tetatnos are included",
                    align="left",
                    font=dict(size=5),
                    showarrow=False)

#Set speed (duration)
fig.layout.updatemenus[0].buttons[0].args[1]["frame"]["duration"] = 750

fig.show()

```

The P3 prototype has a redundancy problem with incidence rate being represented both by the size of the bubble and the y-axis (y-position of the bubble). This can be a good thing for misleading purposes. However, we do not want to go overboard and be too obvious. Hence, we try to remedy the problem by getting rid of the y-axis in P4.

```

[10]: # bubble using plotly express
fig = px.scatter(df,
                 x="ExemptionRate",
                 animation_frame="SchoolYear",
                 size="AllAgesTotalRate",
                 color="AllAgesTotalCases",
                 range_color=[0,1000],
                 color_continuous_scale=[[0, "#00441b"],[0.1, "#006d2c"], [0.
→3, "#238b45"],
                                     [0.4, "#74c476"], [0.6, "#a1d99b"], [0.
→7, "#e5f5e0"], [1.0, "#f7fcf5"]],
                 hover_name="Disease",
                 size_max=100,
                 template="simple_white",

```



```

        title="P4: Increasing non-medical immunization exemptions_
→among children 7 years old has no negative effect on <br> incidence and_
→incidence rate in Ontario (2013-14 to 2017-18)",
        labels={"SchoolYear": "Year", "ExemptionRate": "Exemption Rate",_
→"AllAgesTotalRate": "Incidence Rate (per 100k)", "AllAgesTotalCases":_
→"Incidence (Total Cases)"}
    )

#Set fixed axes range
fig.update_xaxes(range=[1.85, 2.57])

#Remove y-axis ticks and ticklabels
fig.update_yaxes(showticklabels=False, ticks="")

#Remove y-axis title
fig.update_layout(yaxis_title="")

#Set title font size
fig.update_layout(titlefont=dict(size=16))

#Add annotations
fig.add_annotation(x=1.95, y=29,
        text="Hover on bubbles for more info <br>Bigger bubble means higher_
→incidence rate<br>Lighter shade means more cases",
        align="left",
        font=dict(size=9),
        showarrow=False)
fig.add_annotation(x=2.5, y=29,
        text="Not all ISPA designated diseases.<br>Only MCC, measles,_
→mumps, pertussis,<br>and tetatnos are included",
        align="left",
        font=dict(size=5),
        showarrow=False)

#Set speed (duration)
fig.layout.updatemenus[0].buttons[0].args[1]["frame"]["duration"] = 500

fig.show()

```

For both iteration rounds 1 and 2, the bubble plots present an overlapping problem with the pertussis bubbles often engulfing the other diseases' bubbles making it hard to distinguish them. As a remedy, we use faceting for separated and moving bar charts in our third and final round of iteration.

8 Iteration Round 3: Separated and Moving Bar Charts

8.1 (and 3d scatterplot out of curiosity)

```
[11]: fig = px.bar(df, x="ExemptionRate", y="AllAgesTotalRate", facet_col="Disease",
                  animation_frame="SchoolYear",
                  color="AllAgesTotalCases",
                  range_color=[0,1000],
                  color_continuous_scale=[[0, "#00441b"],[0.1, "#006d2c"], [0.3,
→"#238b45"],
                                                    [0.4, "#74c476"], [0.6, "#a1d99b"], [0.
→7, "#e5f5e0"], [1.0, "#f7fcf5"]],
                  hover_name="Disease",
                  template="simple_white",
                  title="P5: Increasing non-medical immunization exemptions among
→children 7 years old has no negative effect on<br>incidence and incidence
→rate in Ontario (2013-14 to 2017-18)",
                  labels={"SchoolYear": "Year", "ExemptionRate": "Exemption Rate",
→"AllAgesTotalRate": "Incidence Rate (per 100k)", "AllAgesTotalCases":
→"Incidence (Total Cases)"}
                  )

#Change this value for bar widths
for data in fig.data:
    data["width"] = 0.10

#Style x-axis label by removing duplicates labels
fig['layout']['xaxis']['title']['text']=''
fig['layout']['xaxis2']['title']['text']=''
fig['layout']['xaxis4']['title']['text']=''
fig['layout']['xaxis5']['title']['text']=''

#Set fixed axes range
fig.update_xaxes(range=[1.83, 2.55])
fig.update_yaxes(range=[-0.2, 5.3])

#Set title font size and width
fig.update_layout(titlefont=dict(size=16), width=1013)

#Add annotations
fig.add_annotation(x=2.23, y=5,
                  text="Hover on bubbles for more info <br>Lighter shade means more
→cases",
                  align="left",
                  font=dict(size=9),
```

```

        showarrow=False)
fig.add_annotation(x=2.12, y=4.7,
                  text="Not all ISPA designated diseases included",
                  align="left",
                  font=dict(size=5),
                  showarrow=False)

#Set speed (duration)
fig.layout.updatemenus[0].buttons[0].args[1]["frame"]["duration"] = 750

fig.show()

```

Just out of curiosity, we also tried our hands on 3D visualization.

```

[12]: fig = px.scatter_3d(df,
                        x="ExemptionRate", y="SchoolYear", z="AllAgesTotalRate",
                        color="AllAgesTotalCases",
                        color_continuous_scale=[[0, "#00441b"], [0.1, "#006d2c"], [0.
→3, "#238b45"],
                                                [0.4, "#74c476"], [0.6, "#a1d99b"], [0.
→7, "#e5f5e0"], [1.0, "#f7fcf5"]],
                        range_color=[0,1000],
                        hover_name="Disease",
                        symbol="Disease",
                        template="simple_white",
                        title="P6: Increasing non-medical immunization exemptions among
→children 7 years old has no negative effect on<br>incidence and incidence
→rate in Ontario (2013-14 to 2017-18)",
                        labels={"SchoolYear": "Year", "ExemptionRate": "Exemption Rate",
→"AllAgesTotalRate": "Incidence Rate (per 100k)", "AllAgesTotalCases":
→"Incidence (Total Cases)"}))

#Set fixed axes range
fig.update_layout(
    scene = dict(xaxis = dict(nticks=4, range=[1.83,2.55]),
                  zaxis = dict(nticks=4, range=[0,6])))

#Move colorbar. Set title font size and width
fig.update_layout(coloraxis_colorbar=dict(yanchor="top", y=1, x=0), width=1000,
→height=700,titlefont=dict(size=16))

fig.show()

```

9 Final Graphic

Although P4 is more confusing and attention wise might be more misleading, we decided to make P5 our final graphic because we find it more convincing and misleading as it emphasizes the effect of the shared and fixed y-axis better. This effect coupled with the effect of the varying height of the bars does a better job at making it seem like the incidence rate is actually decreasing with the increasing exemption rate.

```
[13]: fig = px.bar(df, x="ExemptionRate", y="AllAgesTotalRate", facet_col="Disease",
                  animation_frame="SchoolYear",
                  color="AllAgesTotalCases",
                  range_color=[0,1000],
                  color_continuous_scale=[[0, "#00441b"],[0.1, "#006d2c"], [0.3,
→"#238b45"],
                  [0.4, "#74c476"], [0.6, "#a1d99b"], [0.
→7, "#e5f5e0"], [1.0, "#f7fcf5"]],
                  hover_name="Disease",
                  template="simple_white",
                  title="Final Graphic: Increasing non-medical immunization
→exemptions among children 7 years old has<br>no negative effect on incidence
→and incidence rate in Ontario (2013-14 to 2017-18)",
                  labels={"SchoolYear": "Year", "ExemptionRate": "Exemption Rate",
→"AllAgesTotalRate": "Incidence Rate (per 100k)", "AllAgesTotalCases":
→"Incidence (Total Cases)"}
                  )

#Change this value for bar widths
for data in fig.data:
    data["width"] = 0.10

#Style x-axis label by removing duplicates labels
fig['layout']['xaxis']['title']['text']=''
fig['layout']['xaxis2']['title']['text']=''
fig['layout']['xaxis4']['title']['text']=''
fig['layout']['xaxis5']['title']['text']=''

#Set fixed axes range
fig.update_xaxes(range=[1.83, 2.55])
fig.update_yaxes(range=[-0.2, 5.3])

#Set title font size and width
fig.update_layout(titlefont=dict(size=16), width=1013)

#Add annotations
fig.add_annotation(x=2.23, y=5,
```

```

        text="Hover on bubbles for more info <br>Lighter shade means more_
→cases",
        align="left",
        font=dict(size=9),
        showarrow=False)
fig.add_annotation(x=2.12, y=4.7,
        text="Not all ISPA designated diseases included",
        align="left",
        font=dict(size=5),
        showarrow=False)

#Set speed (duration)
fig.layout.updatemenus[0].buttons[0].args[1]["frame"]["duration"] = 750

fig.show()

```

10 Other Prototypes

10.1 The Red Prototypes (from a fear/harm/danger perspective)

```

[14]: # bubble using plotly express
fig = px.scatter(df,
        x="SchoolYear",
        y="ExemptionRate",
        size="AllAgesTotalRate",
        color="AllAgesTotalCases",
        range_color=[0,1000],
        color_continuous_scale=[[0, "#fff5f0"],[0.1, "#fee0d2"], [0.
→3, "#fcbba1"],
                                [0.4, "#fb6a4a"], [0.6, "#ef3b2c"], [0.
→7, "#a50f15"], [1.0, "#67000d"]],
        hover_name="Disease",
        size_max=100,
        template="plotly_dark",
        title="Increasing non-medical immunization exemptions among_
→children 7 years old has no negative effect on<br>incidence and incidence_
→rate in Ontario (2013-14 to 2017-18)",
        labels={"SchoolYear": "Year", "ExemptionRate": "Exemption Rate",_
→"AllAgesTotalRate": "Incidence Rate (per 100k)", "AllAgesTotalCases":_
→"Incidence (Total Cases)"}
        )

#Set title font size
fig.update_layout(titlefont=dict(size=16))

```

```

#Set linecolor to white and remove gridlines
fig.update_xaxes(showgrid=False, linecolor="white")
fig.update_yaxes(showgrid=False, linecolor="white")

#Add annotations
fig.add_annotation(x=-0.1, y=2.7,
                    text="Hover on bubbles for more info <br>Bigger bubble means higher incidence rate<br>Darker shade means more cases",
                    align="left",
                    font=dict(size=9, color="white"),
                    showarrow=False)
fig.add_annotation(x=3, y=1.75,
                    text="Not all ISPA designated diseases.<br>Only MCC, measles, mumps, pertussis,<br>and tetanus are included",
                    align="left",
                    font=dict(size=5, color="white"),
                    showarrow=False)

fig.show()

```

[15]: # bubble using plotly express

```

fig = px.scatter(df,
                 x="ExemptionRate", y="AllAgesTotalRate",
                 animation_frame="SchoolYear",
                 size="AllAgesTotalRate",
                 color="AllAgesTotalCases",
                 range_color=[0,1000],
                 color_continuous_scale=[[0, "#fff5f0"], [0.1, "#fee0d2"], [0.3, "#fcbba1"], [0.4, "#fb6a4a"], [0.6, "#ef3b2c"], [0.7, "#a50f15"], [1.0, "#67000d"]],
                 hover_name="Disease",
                 size_max=100,
                 template="plotly_dark",
                 title="Increasing non-medical immunization exemptions among children 7 years old has no negative effect on incidence and incidence rate in Ontario (2013-14 to 2017-18)",
                 labels={"SchoolYear": "Year", "ExemptionRate": "Exemption Rate", "AllAgesTotalRate": "Incidence Rate (per 100k)", "AllAgesTotalCases": "Incidence (Total Cases)"})

#Set fixed axes range, linecolor to white and hid gridlines
fig.update_xaxes(range=[1.85, 2.57], showgrid=False, linecolor="white")
fig.update_yaxes(range=[-0.2, 8], showgrid=False, linecolor="white")

```

```

#Set title font size
fig.update_layout(titlefont=dict(size=16))

#Add annotations
fig.add_annotation(x=1.95, y=7.8,
                    text="Hover on bubbles for more info <br>Bigger bubble means higher_
→incidence rate<br>Darker shade means more cases",
                    align="left",
                    font=dict(size=9, color="white"),
                    showarrow=False)
fig.add_annotation(x=2.5, y=7.8,
                    text="Not all ISPA designated diseases.<br>Only MCC, measles,
→mumps, pertussis,<br>and tetatnos are included",
                    align="left",
                    font=dict(size=5, color="white"),
                    showarrow=False)

#Set speed (duration)
fig.layout.updatemenus[0].buttons[0].args[1]["frame"]["duration"] = 750

fig.show()

```

```

[16]: # bubble using plotly express
fig = px.scatter(df,
                  x="ExemptionRate",
                  animation_frame="SchoolYear",
                  size="AllAgesTotalRate",
                  color="AllAgesTotalCases",
                  range_color=[0,1000],
                  color_continuous_scale=[[0, "#fff5f0"],[0.1, "#fee0d2"], [0.3,
→"#fcbba1"],
                  [0.4, "#fb6a4a"], [0.6, "#ef3b2c"], [0.
→7, "#a50f15"], [1.0, "#67000d"]],
                  hover_name="Disease",
                  size_max=100,
                  template="plotly_dark",
                  title="Increasing non-medical immunization exemptions among_
→children 7 years old has no negative effect on <br> incidence and incidence_
→rate in Ontario (2013-14 to 2017-18)",
                  labels={"SchoolYear": "Year", "ExemptionRate": "Exemption Rate",
→"AllAgesTotalRate": "Incidence Rate (per 100k)", "AllAgesTotalCases":
→"Incidence (Total Cases)"})

#Set fixed axes range,. Remove gvertical gridlines. Line color to whithe

```

```

fig.update_xaxes(range=[1.85, 2.57], showgrid=False, linecolor="white")

#Remove y-axis ticks ticklabels and horizontal gridlines. Set linecolor to
→white
fig.update_yaxes(showticklabels=False, ticks="", showgrid=False,
→linecolor="white")

#Remove y-axis title
fig.update_layout(yaxis_title="")

#Set title font size
fig.update_layout(titlefont=dict(size=16))

#Add annotations
fig.add_annotation(x=1.95, y=30,
                    text="Hover on bubbles for more info <br>Bigger bubble means higher
→incidence rate<br>Darker shade means more cases",
                    align="left",
                    font=dict(size=9, color="white"),
                    showarrow=False)
fig.add_annotation(x=2.5, y=30,
                    text="Not all ISPA designated diseases.<br>Only MCC, measles,
→mumps, pertussis,<br>and tetatnos are included",
                    align="left",
                    font=dict(size=5, color="white"),
                    showarrow=False)

#Set speed (duration)
fig.layout.updatemenus[0].buttons[0].args[1]["frame"]["duration"] = 750

fig.show()

```

```

[17]: fig = px.bar(df, x="ExemptionRate", y="AllAgesTotalRate", facet_col="Disease",
                  animation_frame="SchoolYear",
                  color="AllAgesTotalCases",
                  range_color=[0,1000],
                  color_continuous_scale=[[0, "#fff5f0"],[0.1, "#fee0d2"], [0.3,
→"#fcbba1"],
                  [0.4, "#fb6a4a"], [0.6, "#ef3b2c"], [0.
→7, "#a50f15"], [1.0, "#67000d"]],
                  hover_name="Disease",
                  template="plotly_dark",
                  title="Increasing non-medical immunization exemptions among
→children 7 years old has no negative effect on<br>incidence and incidence
→rate in Ontario (2013-14 to 2017-18)",

```



```

        labels={"SchoolYear":"Year", "ExemptionRate":"Exemption Rate",
        →"AllAgesTotalRate": "Incidence Rate (per 100k)", "AllAgesTotalCases":
        →"Incidence (Total Cases)"}
    )

    #Change this value for bar widths
    for data in fig.data:
        data["width"] = 0.10

    #Style x-axis label by removing duplicates labels
    fig['layout']['xaxis']['title']['text']=''
    fig['layout']['xaxis2']['title']['text']=''
    fig['layout']['xaxis4']['title']['text']=''
    fig['layout']['xaxis5']['title']['text']=''

    #Set fixed axes range
    fig.update_xaxes(range=[1.83, 2.55], showgrid=False, linecolor="white")
    fig.update_yaxes(range=[-0.2, 5.5], showgrid=False, linecolor="white")

    #Set title font size and width
    fig.update_layout(titlefont=dict(size=16), width=1012)

    #Add annotations
    fig.add_annotation(x=2.23, y=5,
        text="Hover on bubbles for more info <br>Darker shade means more
        →cases",
        align="left",
        font=dict(size=9, color="white"),
        showarrow=False)
    fig.add_annotation(x=2.12, y=4.7,
        text="Not all ISPA designated diseases included",
        align="left",
        font=dict(size=5,color="white"),
        showarrow=False)

    #Set speed (duration)
    fig.layout.updatemenus[0].buttons[0].args[1]["frame"]["duration"] = 750

    fig.show()

```

[]:

10.2 Focus on the 5-9 years old group

```
[18]: # bubble using plotly express
fig = px.scatter(df,
                 x="SchoolYear",
                 y="ExemptionRate",
                 size="AgeGroupTotalRate",
                 color="AgeGroupTotalCases",
                 range_color=[0,200],
                 color_continuous_scale=[[0, "#00441b"],[0.1, "#006d2c"], [0.
→3, "#238b45"],
                                     [0.4, "#74c476"], [0.6, "#a1d99b"], [0.
→7, "#e5f5e0"], [1.0, "#f7fcf5"]],
                 hover_name="Disease",
                 size_max=100,
                 template="simple_white",
                 title="Increasing non-medical immunization exemptions among
→children 7 years old has no negative effect on<br>incidence and incidence
→rate for 5-9 years old (Ontario, 2013-14 to 2017-18)",
                 labels={"SchoolYear": "Year", "ExemptionRate": "Exemption Rate",
→"AgeGroupTotalRate": "Incidence Rate (per 100k)", "AgeGroupTotalCases":
→"Incidence (Total Cases)"})

#Set title font size
fig.update_layout(titlefont=dict(size=16))

#Add annotations
fig.add_annotation(x=-0.1, y=2.7,
                  text="Hover on bubbles for more info <br>Bigger bubble means higher
→incidence rate<br>Lighter shade means more cases",
                  align="left",
                  font=dict(size=9),
                  showarrow=False)
fig.add_annotation(x=3, y=1.75,
                  text="Not all ISPA designated diseases.<br>Only MCC, measles,
→mumps, pertussis,<br>and tetatnos are included",
                  align="left",
                  font=dict(size=5),
                  showarrow=False)

fig.show()

[19]: # bubble using plotly express
fig = px.scatter(df,
                 x="ExemptionRate", y="AgeGroupTotalRate",
```

```

        animation_frame="SchoolYear",
        size="AgeGroupTotalRate",
        color="AgeGroupTotalCases",
        range_color=[0,200],
        color_continuous_scale=[[0, "#00441b"],[0.1, "#006d2c"], [0.
→3, "#238b45"],
                                [0.4, "#74c476"], [0.6, "#a1d99b"], [0.
→7, "#e5f5e0"], [1.0, "#f7fcf5"]],
        hover_name="Disease",
        size_max=100,
        template="simple_white",
        title="Increasing non-medical immunization exemptions among
→children 7 years old has no negative effect on<br>incidence and incidence
→rate for 5-9 years old (Ontario, 2013-14 to 2017-18)",
        labels={"SchoolYear":"Year", "ExemptionRate":"Exemption Rate",
→"AgeGroupTotalRate": "Incidence Rate (per 100k)", "AgeGroupTotalCases":
→"Incidence (Total Cases)"}
    )

#Set fixed axes range
fig.update_xaxes(range=[1.9, 2.55])
fig.update_yaxes(range=[-0.7, 30])

#Set title font size
fig.update_layout(titlefont=dict(size=14))

#Add annotations
fig.add_annotation(x=1.99, y=30,
    text="Hover on bubbles for more info <br>Bigger bubble means higher
→incidence rate<br>Lighter shade means more cases",
    align="left",
    font=dict(size=9),
    showarrow=False)
fig.add_annotation(x=2.5, y=30,
    text="Not all ISPA designated diseases.<br>Only MCC, measles,
→mumps, pertussis,<br>and tetatnos are included",
    align="left",
    font=dict(size=5),
    showarrow=False)

#Set speed (duration)
fig.layout.updatemenus[0].buttons[0].args[1]["frame"]["duration"] = 750

fig.show()

```

```

[20]: # bubble using plotly express
fig = px.scatter(df,
                 x="ExemptionRate",
                 animation_frame="SchoolYear",
                 size="AgeGroupTotalRate",
                 color="AgeGroupTotalCases",
                 range_color=[0,200],
                 color_continuous_scale=[[0, "#00441b"],[0.1, "#006d2c"], [0.
→3, "#238b45"],
                                     [0.4, "#74c476"], [0.6, "#a1d99b"], [0.
→7, "#e5f5e0"], [1.0, "#f7fcf5"]],
                 hover_name="Disease",
                 size_max=100,
                 template="simple_white",
                 title="Increasing non-medical immunization exemptions among
→children 7 years old has no negative effect on <br> incidence and incidence
→rate for 5-9 years old (Ontario, 2013-14 to 2017-18)",
                 labels={"SchoolYear": "Year", "ExemptionRate": "Exemption Rate",
→"AgeGroupTotalRate": "Incidence Rate (per 100k)", "AgeGroupTotalCases":
→"Incidence (Total Cases)"})

#Set fixed axes range
fig.update_xaxes(range=[1.9, 2.55])

#Remove y-axis ticks and ticklabels
fig.update_yaxes(showticklabels=False, ticks="")

#Remove y-axis title
fig.update_layout(yaxis_title="")

#Set title font size
fig.update_layout(titlefont=dict(size=16))

#Add annotations
fig.add_annotation(x=1.99, y=28,
                  text="Hover on bubbles for more info <br>Bigger bubble means higher
→incidence rate<br>Lighter shade means more cases",
                  align="left",
                  font=dict(size=9),
                  showarrow=False)
fig.add_annotation(x=2.5, y=28,
                  text="Not all ISPA designated diseases.<br>Only MCC, measles,
→mumps, pertussis,<br>and tetatnos are included",
                  align="left",
                  font=dict(size=5),

```

```

        showarrow=False)

#Set speed (duration)
fig.layout.updatemenus[0].buttons[0].args[1]["frame"]["duration"] = 750

fig.show()

[24]: fig = px.bar(df, x="ExemptionRate", y="AgeGroupTotalRate", facet_col="Disease",
                  animation_frame="SchoolYear",
                  color="AgeGroupTotalCases",
                  range_color=[0,200],
                  color_continuous_scale=[[0, "#00441b"], [0.1, "#006d2c"], [0.3,
→ "#238b45"],
                  [0.4, "#74c476"], [0.6, "#a1d99b"], [0.
→ 7, "#e5f5e0"], [1.0, "#f7fcf5"]],
                  hover_name="Disease",
                  template="simple_white",
                  title="Increasing non-medical immunization exemptions among
→ children 7 years old has no negative effect on<br>incidence and incidence
→ rate for 5-9 years old (Ontario, 2013-14 to 2017-18)",
                  labels={"SchoolYear": "Year", "ExemptionRate": "Exemption Rate",
→ "AgeGroupTotalRate": "Incidence Rate (per 100k)", "AgeGroupTotalCases":
→ "Incidence (Total Cases)"})

#Change this value for bar widths
for data in fig.data:
    data["width"] = 0.10

#Style x-axis label by removing duplicates labels
fig['layout']['xaxis']['title']['text']=''
fig['layout']['xaxis2']['title']['text']=''
fig['layout']['xaxis4']['title']['text']=''
fig['layout']['xaxis5']['title']['text']=''

#Set fixed axes range
fig.update_xaxes(range=[1.9, 2.55])
fig.update_yaxes(range=[-0.2, 15])

#Set title font size and width
fig.update_layout(titlefont=dict(size=16), width=1013)

#Add annotations
fig.add_annotation(x=2.26, y=14,

```

```

        text="Hover on bubbles for more info <br>Lighter shade means more_
→cases",
        align="left",
        font=dict(size=9),
        showarrow=False)
fig.add_annotation(x=2.16, y=13,
        text="Not all ISPA designated diseases included",
        align="left",
        font=dict(size=5),
        showarrow=False)

#Set speed (duration)
fig.layout.updatemenus[0].buttons[0].args[1]["frame"]["duration"] = 750

fig.show()

```

[]:

[]: