

# Quantify Vaccine Hesitancy

## Deep Shringi & Raheem Paxton

### HHDDA Data Science Vaccines

#### Background

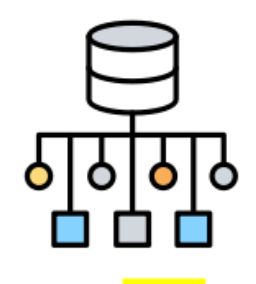
Human papillomavirus (HPV) is the most common sexually transmitted infection (STI) in the world. Approximately 80% of all sexually active persons will acquire HPV by age 45. Despite the prevalence and severity of HPV, vaccination rates remain low. Vaccine hesitancy (i.e., delay, reluctance, or refusal to vaccinate) is a crucial barrier to higher uptake. It may contribute to the low HPV vaccination rates (VCRs) worldwide (60% vs. 90% for routine vaccinations). As a result, there is a need to quantify hesitancy and its impact on VCRs worldwide.

#### Purpose

- Understand the factors that contribute to low HPV vaccination rates worldwide – short term
- Develop a vaccine hesitancy score that distinguishes countries based on their hesitancy level – short-term
- Understand how the model can be used to impact business and marketing decisions – long-term


#### Methodology

##### Data Source



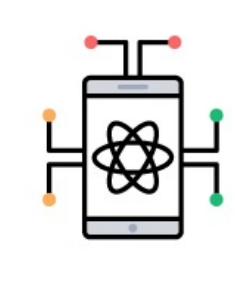
- Data selected based on research and literature review
- Some of the important features in model are current health expenditure (%GDP), HIV prevalence, rural population, negative vaccine safety and effectiveness, literacy, etc

##### Data Preparation



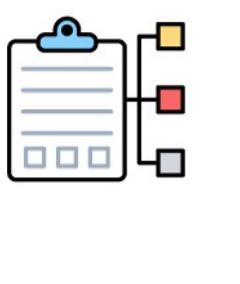
- Missing data imputed using methodologies like forward fill, backward fill and KNN imputer
- Not all countries have VCRs; missing VCRs are calculated using a regression model

##### AI/ML Model



- Multiple regression models are used to check for the best performing model to predict VCR
- K-means cluster analysis based on 10 features used to compare similar countries

##### Hesitancy Score Algorithm



- For each country, 'Calculated VCR' = the mean of all VCRs of 5 similar countries based on top features (i.e., avg. paediatric vaccination rate, population, religion, out of pocket spend, etc.)
- If the Actual VCR > Calculated VCR, then the country has lower hesitancy else higher hesitancy

#### Hesitancy Score Algorithm (France example)

##### STEP 1

5 most similar countries to France are Canada, Germany, UK, Austria and Sweden

##### STEP 2

Mean of HPV vaccine coverage for those 5 countries is 31. Actual coverage for France is 39

##### STEP 3

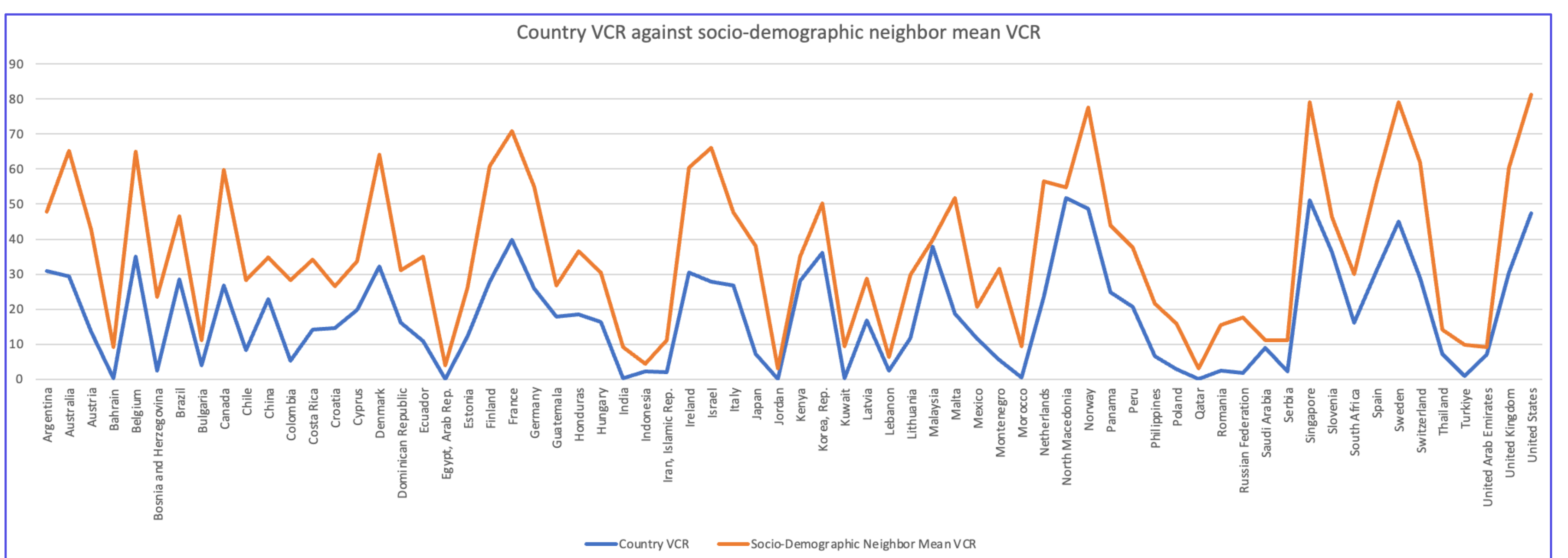
Actual coverage of France > Mean coverage. It indicates France is less hesitant country.

##### STEP 4

Based on the sign and magnitude, France is a very low hesitant country

-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10
Very Low Hesitancy				Low Hesitancy				Moderate				High Hesitancy				Very High Hesitancy			

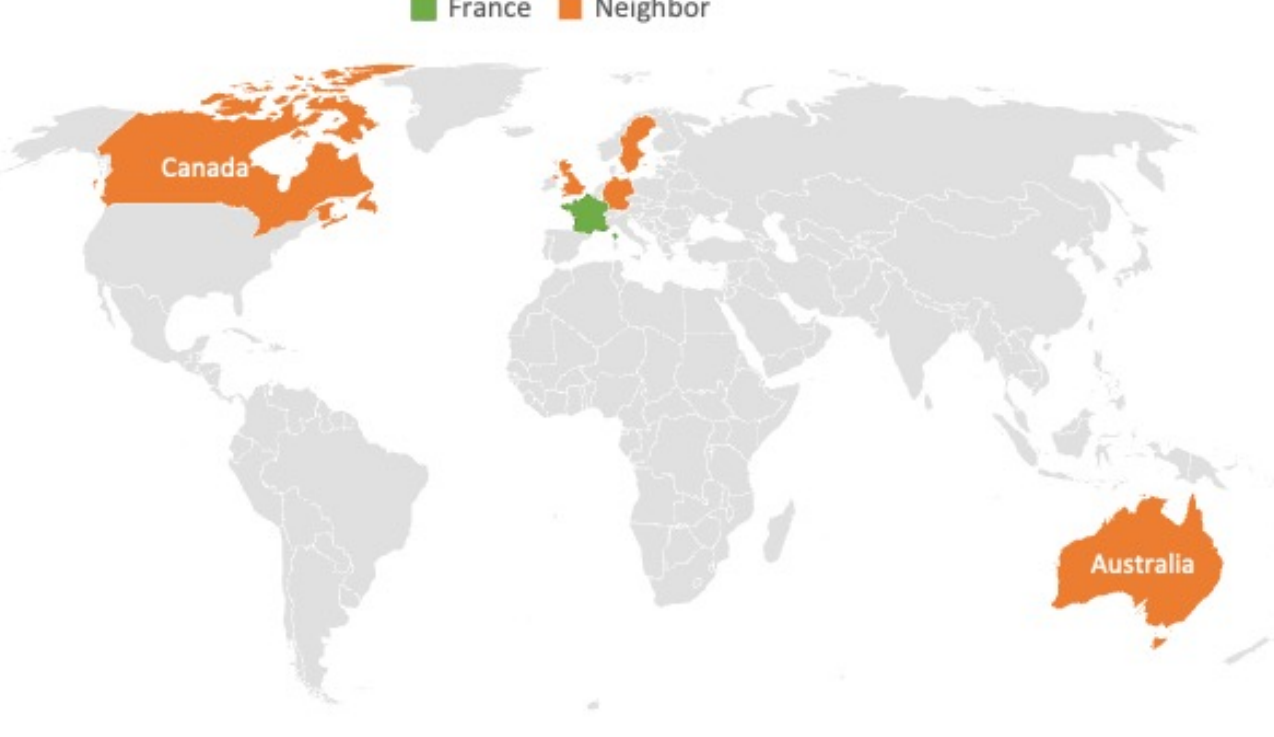
#### Results



- VCRs for several countries are much lower than cluster-matched countries with similar socio-economic, and medical factors (e.g., Austria, Japan, Columbia etc.)

#### Calculator (France example)

##### Socio Demographic Neighbors



Drivers for France	Impact
Out of Pocket Expenditure	Low
Rural Population %	Low
Current Health Expenditure(% of GDP)	Low
Covid Vaccination Complete	Low
Perceived Vaccine Safety	High
HIV Prevalence	Low
Average Household Income	Low
Pharmacy per 10K people	Low
Religion	Low
Avg Child Vaccination Rate	Low
Population	Low

- France is comparable to other countries such as Canada, Austria, Germany, UK, and Sweden on factors such as average household income, religion, and health landscape.
- However, France has a higher VCR compared to its neighbors which makes France less hesitant.

#### Conclusions

- Model will help identify leading hesitancy indicators to help drive impact on Vaccination Coverage Rate
- Scalable for other vaccines and at sub-national level

#### Acknowledgements

Ian Pitcher, Liz Byrns, Robin Doroff, Siby Daniel, Howard Caldwell, Data Strategy and Governance Team, Mina Bahig, Stephen McCarthy

REFERENCES: Available upon request