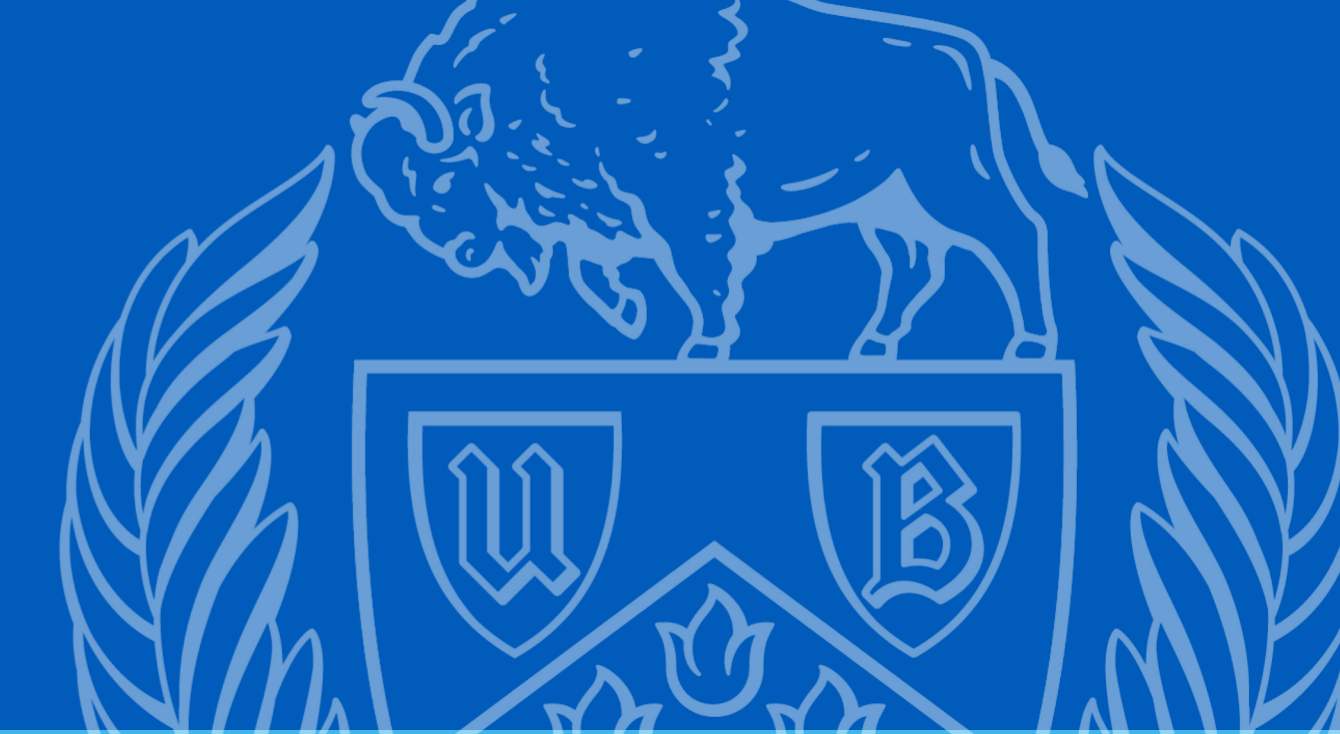# A Tale of Vaccination Debates & Public Responses
Data-Driven Insights from a Multi-medium Exploration during the COVID-19 Era

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INTRODUCTION

The COVID-19 has caused unprecedented impacts on people around the world, resulting in a diverse array of community experiences regarding the pandemic and vaccination. This leads to the question: *How can we learn from those different experiences to be more proactive in response to new emerging public health crises*? To answer this question, and others alike, we applied three distinct data-driven explorations into public perceptions and concerns about the pandemic as well as public sentiments and behaviors towards vaccination.

Utilizing a broad array of media—from social media analysis and comparison with vaccination rates, to the convergent and divergent topics between newspapers and personal interviews—our explorations offer not only a comprehensive view of the multifaceted nature of the pandemic's impacts but also insights of the complex public vaccine discourse, paving the way for future health communication and vaccine coverage enhancement.

PROJECT 1: Identifying Vaccine Sentiments

This project delves into the dynamic sentiments on social media (i.e., Twitter), using machine learning techniques to quantify evolving vaccine sentiments across the United States between 2015-2019 based on over 11.7 million tweets.
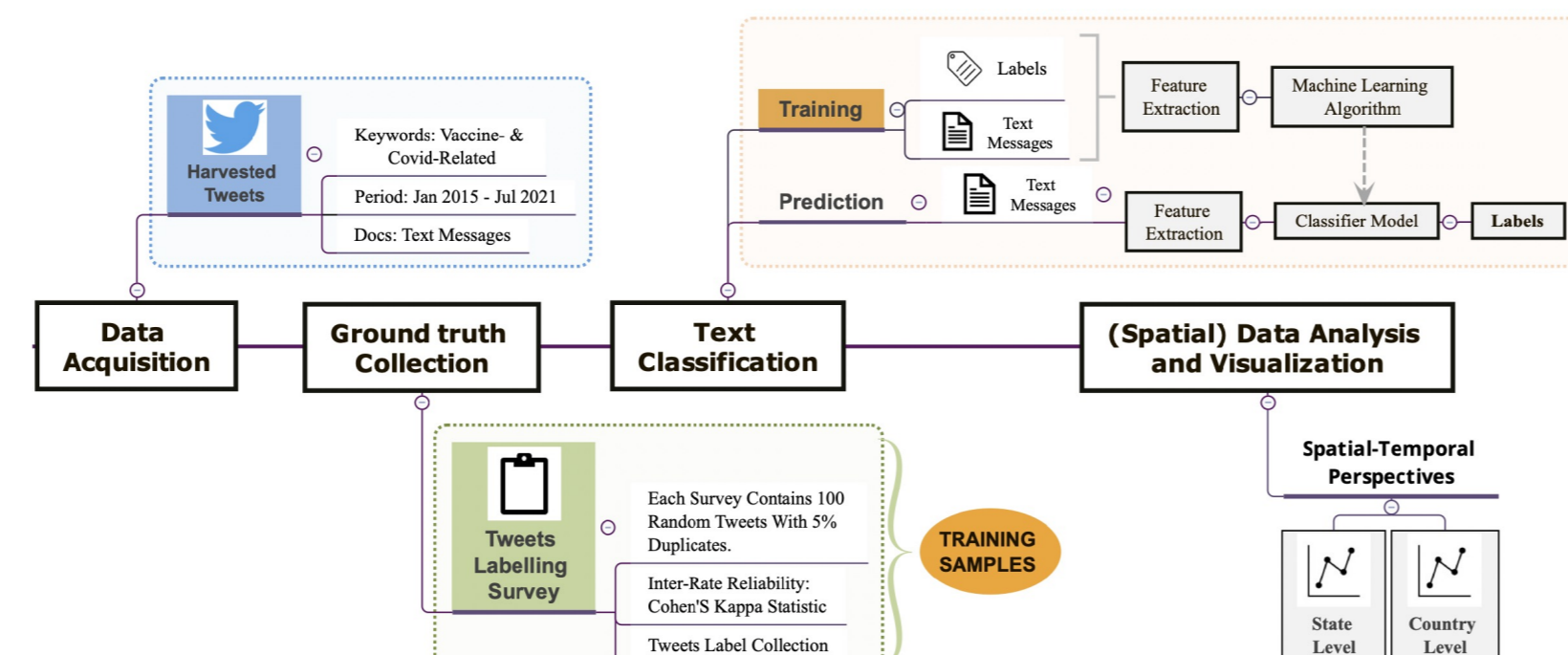

Figure 1. The workflow of identifying vaccine sentiments.

PROJECT 2: Comparing Vaccine Responses

Our second project further contrasts the online discussion with actual vaccination behaviors to uncover the complexities of how public attention shifts and settles among different vaccines (i.e., COVID-19, Influenza, MMR, and HPV).

Figure 3. The workflow of comparing vaccine responses.

PROJECT 3: Decoding COVID-19 Topics

Project 3 transitions from the social media to the digital newspaper and individual interviews, providing a unique blend of quantitative and qualitative insights into the public's pandemic experiences. This "big-thick" approach highlights the convergence

Figure 6. The workflow of decoding COVID-19 topics.

and divergence of pandemic-related topics between newspapers and personal narratives, uncovering insights into the multifaceted nature of the pandemic's impacts and emphasizing the critical role of reliable information in shaping public perceptions and behaviors.

RESULTS

Online vs. Offline

- A positive correlation between 'Pro-vaccine' users (*online*) and the actual vaccination rates (*offline*).
- The identified positive vaccine sentiments online can be used as an indicator for evaluating offline vaccination rates, offering a timely lens into the pulse of the nation's vaccine discourse.

A2P Ratio: Vaccine Hesitancy

- A positive correlation between A2P ratio (*online*) and the estimated vaccine hesitancy from CDC (*offline*).
- A2P ratio can effectively monitor vaccine hesitancy in near real-time.

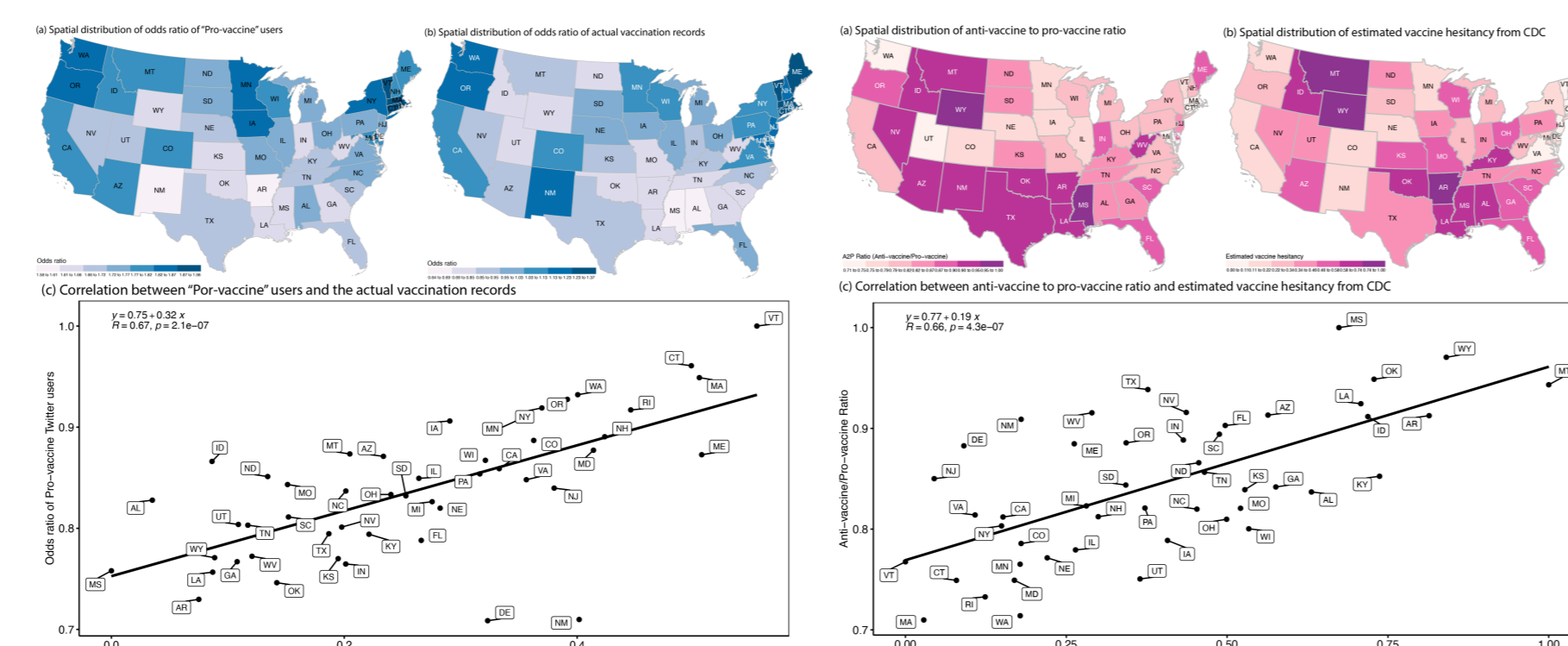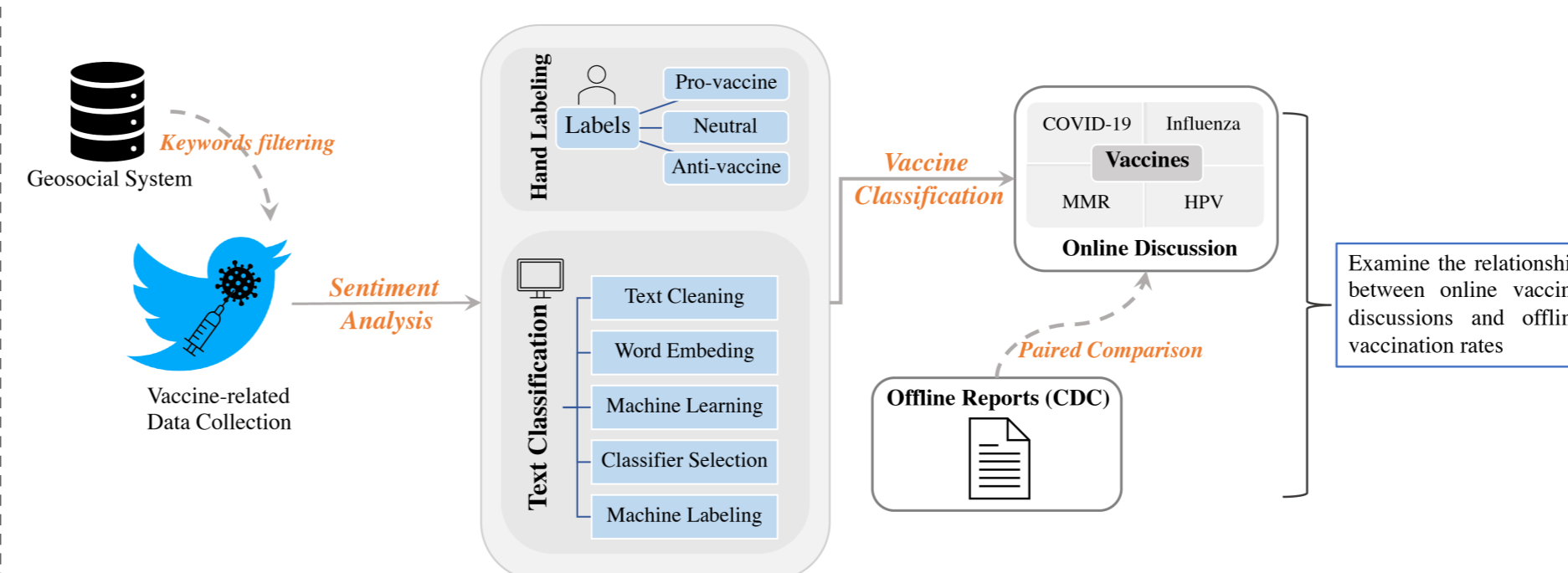$$R_{A2P} = \frac{Odds\ Ratio_{Anti-vaccine}}{Odds\ Ratio_{Pro-vaccine}}$$

Figure 2. Left: Spatial distribution of Pro-vaccine users and its correlation between the actual vaccination records; Right: Spatial distribution A2P ratio and its correlation between the estimated vaccine hesitancy from CDC.

The media has the capability in shaping people's agenda of issues.

- The public's attention switches from one vaccination to another over time.
- A cyclical pattern, with peaks generally occurring during the winter flu seasons before COVID-19 outbreak.

Figure 4. The quarterly distribution of percentage of users by different vaccine discussion from 2015-2021.

- A small peak during winter flu season in 2020 under the dominance of COVID-19 vaccination debate, indicating a link between COVID-19 and flu vaccines, potentially due to perceived similarities in symptoms between the two illnesses.
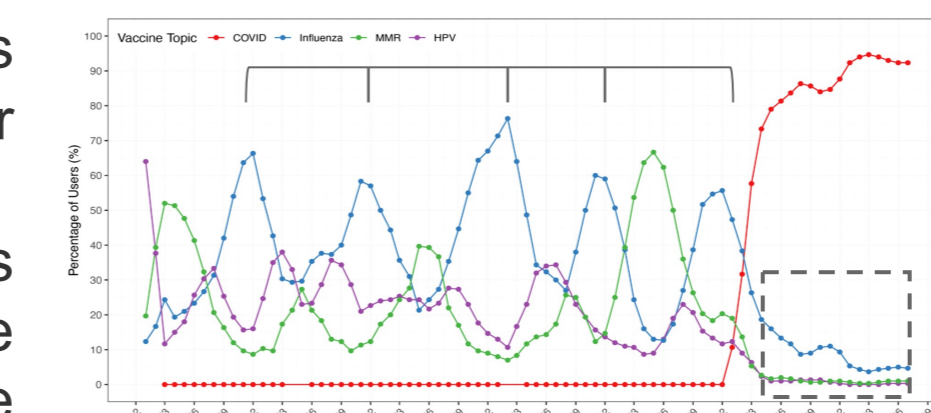
The more media links two issues (e.g., the similarities between COVID and influenza), the more the public may see them as interconnected.

- The *HPV* and *MMR* vaccine rates are rather *volatile*.
- The peak rate of flu vaccinations emerges close to the peak of the flu vaccine discussion on Twitter.
- The prominence of an issue (e.g., COVID-19 vaccine discussion) on social media can affect the public's behavior on another issue (e.g., flu vaccine uptake).
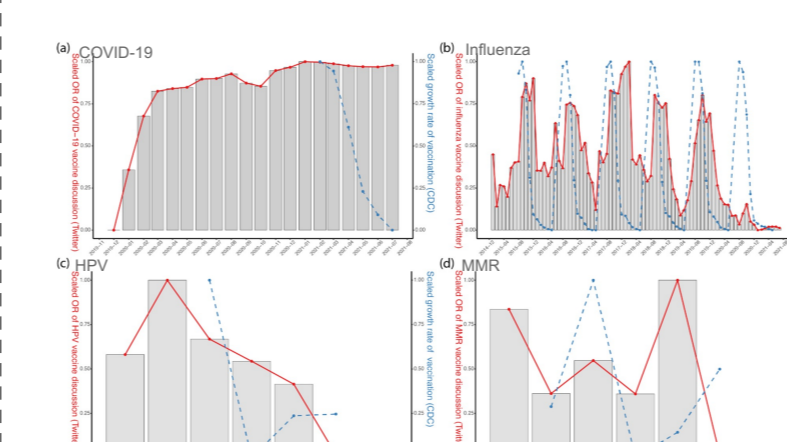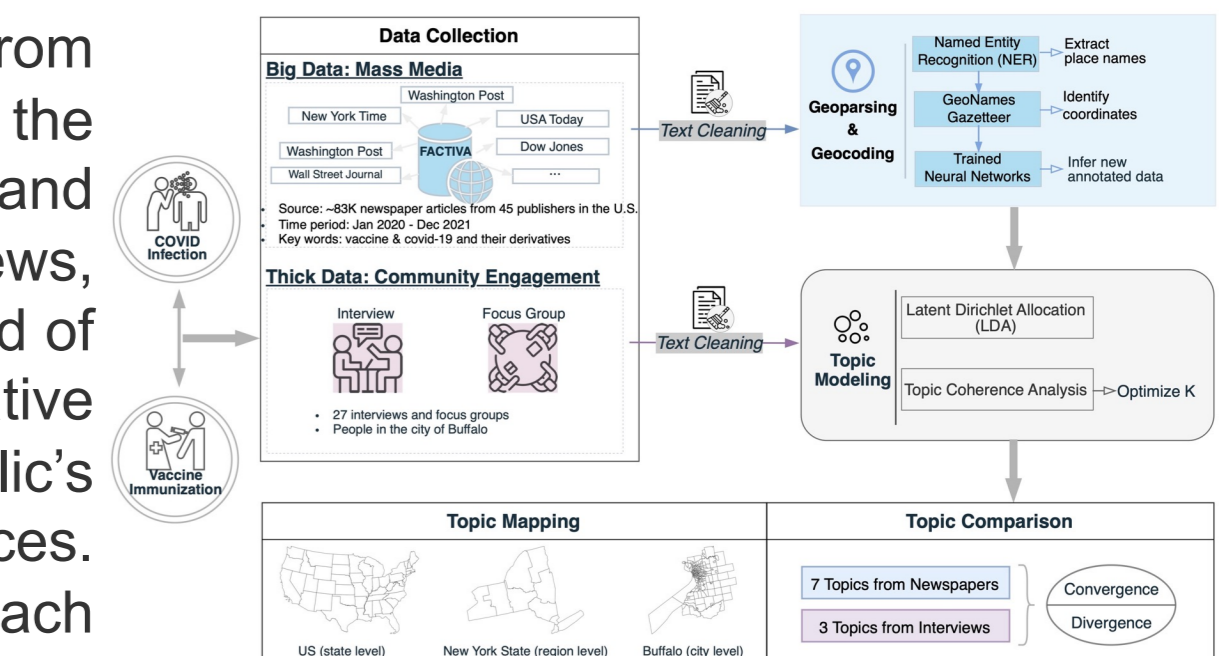
Figure 5. The comparison between different vaccine discussions on Twitter and growth rate of the actual vaccination rate collected from the CDC.

Newspaper: macro-level perspective

- Providing a broader and more comprehensive view covering public health, policies and economics.
- While public health emerged as the most prominent topic, the overall distribution of topics in newspapers was relatively balanced.
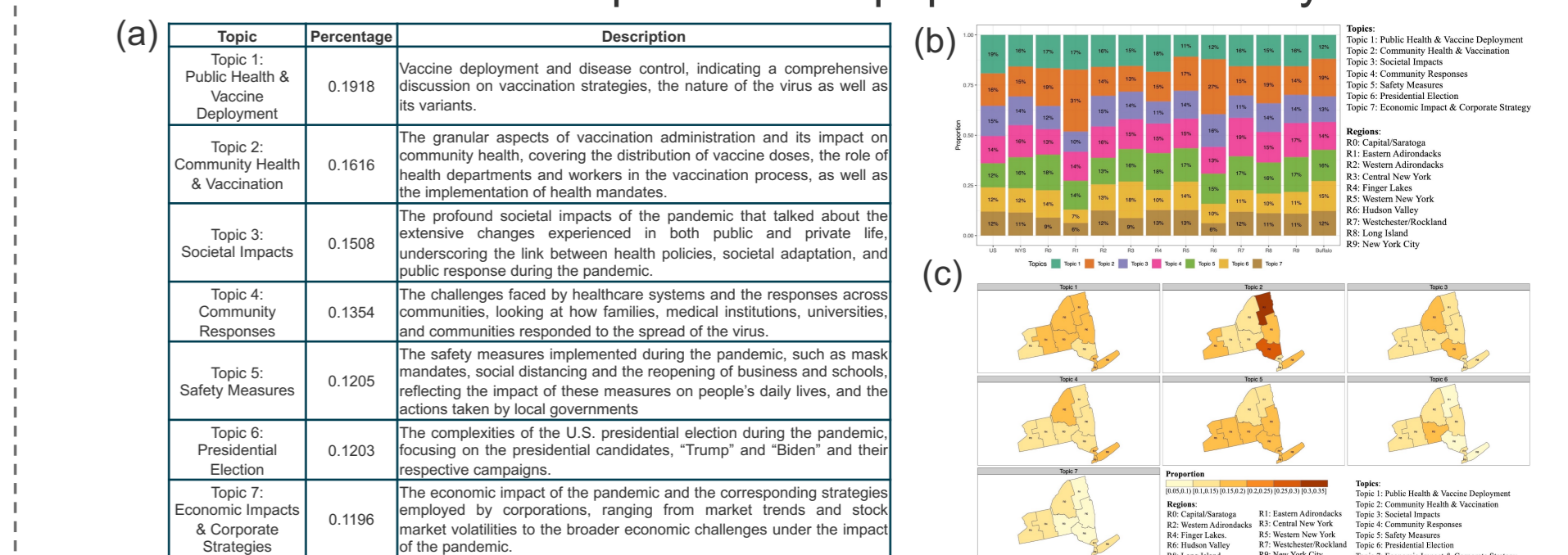

Figure 7: (a) Decoded topics from newspaper; (b) The distribution of identified topics by different scales; (c) The spatial distribution of identified topics across different regions in New York State.

Interviews: micro-level perspective

- Focusing more on individuals' experience, emotions and concerns during the pandemic.
- The distribution of topics in interviews is relatively uneven compared to that of newspapers. But both sources highlighted the profound pandemic impacts on people's daily life.

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Chen, Q., Croitoru, A., & Crooks, A. (2023). A comparison between online social media discussions and vaccination rates: A tale of four vaccines. Digital Health, 9, 20552076231155682.
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