Vaccine Hesitancy and Traffic Deaths: Ecological Analyses

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INTRODUCTION

Traffic crashes disable over a million Americans annually. The underlying cause is typically driver error related to medical diseases (e.g., sleep apnea) or fallible judgment (e.g., speeding).[1] Fallible judgment, however, is difficult to examine due to limitations in survey science.

Routine vaccination is an important indicator of preventive health behavior. Vaccination against influenza, for example, is supported by public campaigns and physician counseling.[2] Influenza vaccination, however, often leads to vitriolic debates similar to disputes around traffic safety policy.[3]

We hypothesized adverse behaviors often cluster together. Herein, we combine health behavior data with traffic fatality data for the entire USA. We focus on influenza vaccination as a relevant important predictor.

METHODS

We identified each state as the unit-of-analysis and combined data on influenza vaccination from the Centers for Disease Control (CDC) with traffic fatality from the National Highway Traffic Safety Administration (NHTSA). Strengths of these data include national sampling with substantial precision at the state level.[4] Weaknesses are the ecological design that characterizes groups but not individuals and the 2–3-year time lag until traffic data were available for analysis.[5]

We collected 8 additional health behaviors as controls to further check a range of psychological influences that might underpin health and driving habits. These included COVID vaccination (John Hopkins Coronavirus Resource Center), a dental visit for any reason, current cigarette smoking, a diet lacking fresh fruit, a diet lacking fresh vegetables, screening colonoscopy, screening mammography, and screening cholesterol. The analysis lacked direct data on psychology or personality.

Our primary analysis focused on adult vaccination rates during the 2018–2019 influenza season and traffic fatality rates in 2019 (most recent data available). Secondary analyses used the same methods (univariate linear regression), explored each alternative health behavior individually, and maintained the same outcome (traffic fatality rates). All analyses reflect univariate correlations unadjusted for alcohol consumption, opioid usage, or other potential determinants of traffic risks.

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RESULTS

Rates of influenza vaccination were available for 49 states (missing New Jersey) in the 2018–2019 season (Fig. 1). The lowest rate was 34% (Nevada) and highest rate was 56% (Rhode Island). Rates of traffic fatalities were available for all states (none missing). The lowest rate was 48 per million (New York) and the highest rate was 254 per million (Wyoming). Patterns of influenza vaccination were similar to prior years (as were patterns in traffic fatalities).

As hypothesized, influenza vaccination and traffic fatality rates were inversely correlated ($r = 0.46$, $p < 0.001$). For example, Mississippi had a low vaccination rate and high traffic fatality rate (40% and 216 per million, respectively) whereas Massachusetts had a high vaccination rate and low traffic fatality rate (54% and 48 per million, respectively). The

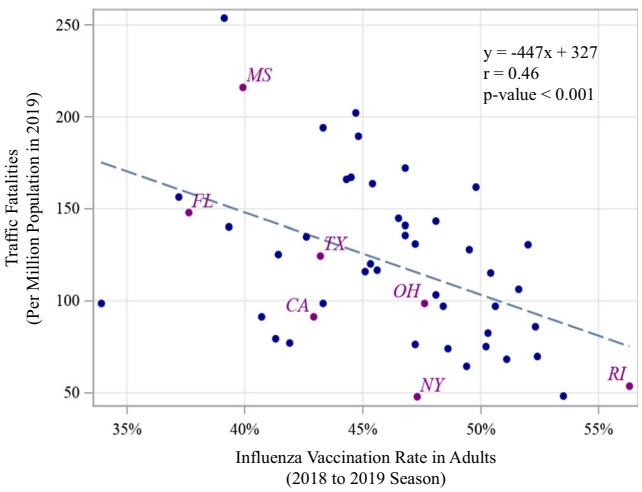

Figure 1 US states traffic fatalities and influenza vaccination. ***Footnote*****: Scatterplot of US states displaying traffic fatalities in 2019 and influenza vaccination rate in adults during the 2018 to 2019 influenza season. *X*-axis shows estimated vaccination rate (CDC data). *Y*-axis shows traffic fatality rate (NHTSA data). Two-letter abbreviations mark selected states (for context). Dashed line shows line-of-best-fit. Sample size is 49 states (missing New Jersey). Statistics based on univariate linear regression. Results show significant correlation interpreted as a 10% absolute increase in vaccination rates predicting a 37% relative reduction in traffic fatality rates**

Table 1 Health Behaviors as Predictors of Traffic Fatalities

Health behavior	*x*-intercept*	*y*-intercept[#]	Slope[Δ]	Confidence interval	*R*	*p*-value
Not influenza vaccinated[†]	0.27	−120	447	193 to 701	0.46	<0.001
18 to 49 years	0.35	−147	415	217 to 614	0.52	<0.001
50 to 64 years	0.12	−35	300	41 to 560	0.32	0.02
≥ 65 years	−0.09	26	299	−50 to 649	0.24	0.09
High risk[§]	0.18	−64	354	166 to 543	0.48	<0.001
Not high risk[§]	0.34	−146	427	205 to 648	0.49	<0.001
Not COVID vaccinated [Ω]	0.07	−26	379	269 to 491	0.71	<0.001
No dental visits[‡]	0.15	−93	638	458 to 818	0.72	<0.001
Cigarette smoking[¶]	0.02	−16	841	518 to 1164	0.61	<0.001
No fruits[∂]	0.25	−199	804	576 to 1032	0.72	<0.001
No vegetables[¥]	−0.36	77	217	−257 to 691	0.13	0.36
No colonoscopy[ψ]	0.09	−39	455	202 to 707	0.46	<0.001
No mammogram[♦]	−0.03	16	468	229 to 707	0.49	<0.001
No cholesterol[π]	−0.73	102	140	−302 to 581	0.09	0.53

Footnote:
**Estimated rate of risky behavior corresponding to 0 traffic deaths*
[#]*Estimated traffic deaths corresponding to complete adherence of healthy behavior*
[Δ]*Slope calculated from univariate linear regression (no other adjustments)*
[†]*Not vaccinated during 2018–2019 season among adults (≥18 years)*
[§]*High-risk conditions in adults 18 to 64 years (e.g., asthma)*
[Ω]*Not fully vaccinated (indexed to December 31, 2021)*
[‡]*No visit to dental clinic for any reason (in past year)*
[¶]*Current smokers*
[∂]*Consumed fruit <1 time per day*
[¥]*Consumed vegetables <1 time per day*
[ψ]*No colonoscopy screening in past 10 years among adults 50–75 years*
[♦]*No mammogram screening in past 2 years among women 50–74 years*
[π]*No cholesterol screening in past 5 years*

correlation equaled a 37% relative reduction in traffic fatalities for each 10% increase in influenza vaccination (Fig. 1).

Most other preventive health behaviors also correlated with lower traffic fatalities (Table 1). For example, traffic fatalities and COVID vaccination were significantly correlated, equal to a 31% relative reduction in traffic fatality rates for each 10% increase in COVID vaccination rates. Similar findings were replicated with medical screening behaviors correlating with lower traffic risks.

DISCUSSION

We analyzed variations in health behaviors and found states with low rates of influenza vaccination tended to have high rates of traffic fatalities. The correlation was substantial, equivalent to a 10% increase in vaccination rates associated with a 37% reduction in traffic fatality rates. These results suggest judgments related to vaccination hesitancy or other health behaviors are also associated with traffic risks.

Ecological analyses are easily misinterpreted. Consider the contrast between Florida and Ohio (large states on the line-of-best-fit). Florida had a 38% vaccination rate and 148 per million traffic fatalities whereas Ohio had a 48% vaccination rate and 99 per million traffic fatalities. This suggests the marginal decrease in vaccine hesitancy predicted a one-third decrease in traffic risks. Of course, Florida and Ohio differ in endless other confounding factors.

Our study suggests adverse health behaviors and traffic risks cluster together. One explanation could be a safety mindset that shapes diverse behaviors. An alternative mechanism could be an ecological fallacy, barriers to access, social inequities, or shared confounders.[6] Our study does not mean vaccination prevents traffic fatalities. Instead, the findings suggest traffic deaths can be related to other behaviors that justify attention at the individual patient level.

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Declarations:

Conflict of Interest: *The authors declare that they do not have a conflict of interest.*

Accountability: *The lead author (DAR) had full access to all the data in the study, takes responsibility for the integrity of the data, and is accountable for the accuracy of the analysis.*

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