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**IDENTIFYING CLUSTERS OF HIGH VACCINATION
EXEMPTION RATES AMONG SCHOOLS AND
THEIR DETERMINANTS.**

OUTLINE

- ✘ Background
- ✘ History
- ✘ Arizona and Vaccine Exemption
- ✘ Methods
- ✘ Results
- ✘ Discussion

BACKGROUND: VACCINATION AS A PUBLIC HEALTH STRATEGY

- ✘ “One of the greatest achievements of biomedical science and public health”
- ✘ Who cannot be vaccinated?
- ✘ Herd Immunity
 - + The entire community reaps the benefits of immunization through high levels of vaccination
- ✘ What is a Personal Belief Exemption (PBE)?

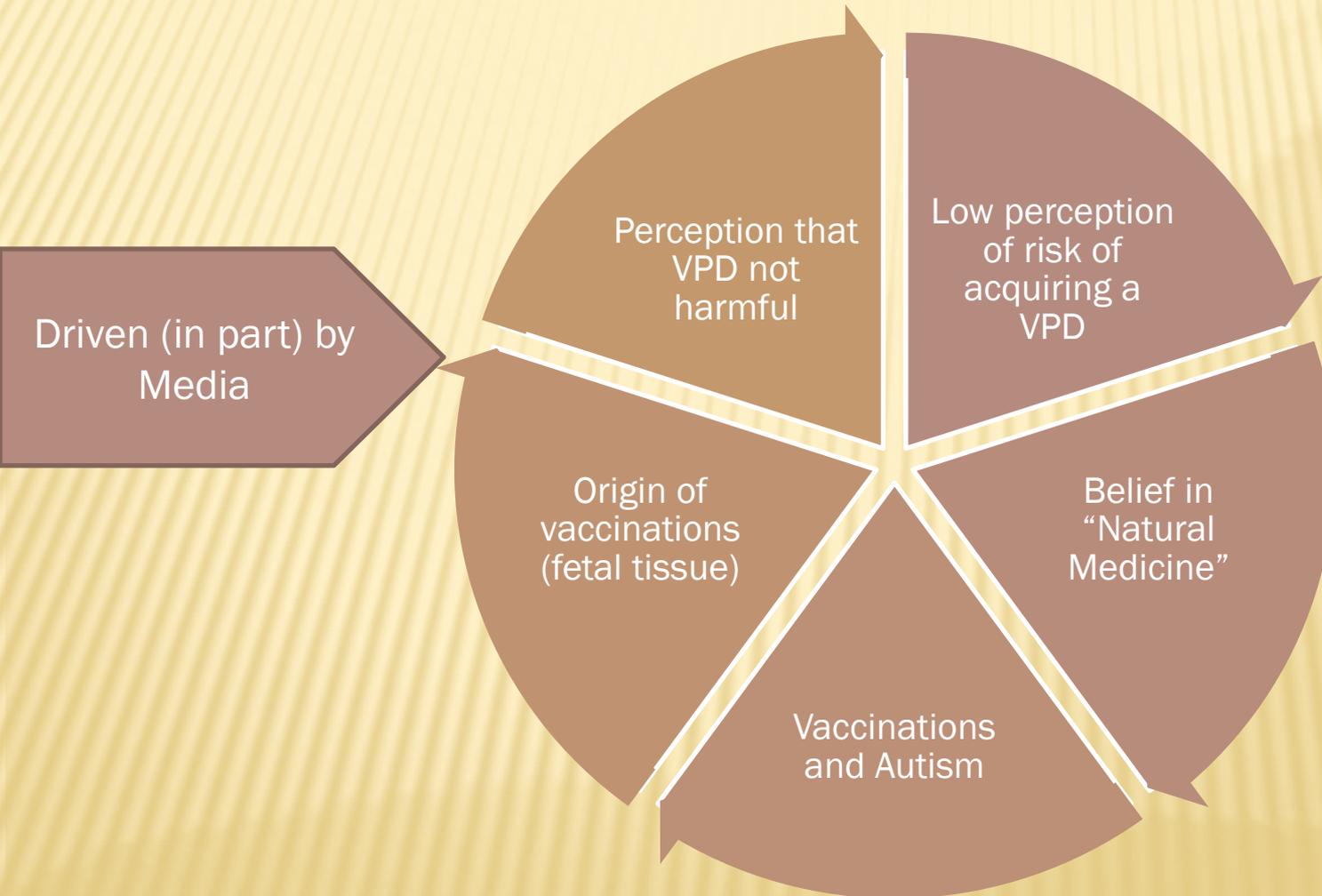
HISTORY

- ✘ Anti-vaccine movements are nothing new
 - + Because vaccines are so effective, the specific VPD is no long relevant to the public
 - + Rely on strong emotional appeal

HISTORY

- ✘ Vaccine opposition is long-standing
- ✘ Late 1800s
 - + The public's understanding of how to prevent smallpox was through sanitary conditions (miasma)
 - + Mandatory vaccination in England met with strong backlash
- ✘ 2008: Measles outbreak in San Diego
 - + “[Parents of the cases] believed vaccination was unnecessary, because most vaccine preventable diseases had already been reduced to very low risk by improvements in water, sanitation, and hygiene and were best prevented by ‘natural lifestyles’” ...

REASONS FOR VACCINATION OPPOSITION



POPULAR MEDIA AND PUBLIC FIGURES SUPPORTING ANTI-VACC

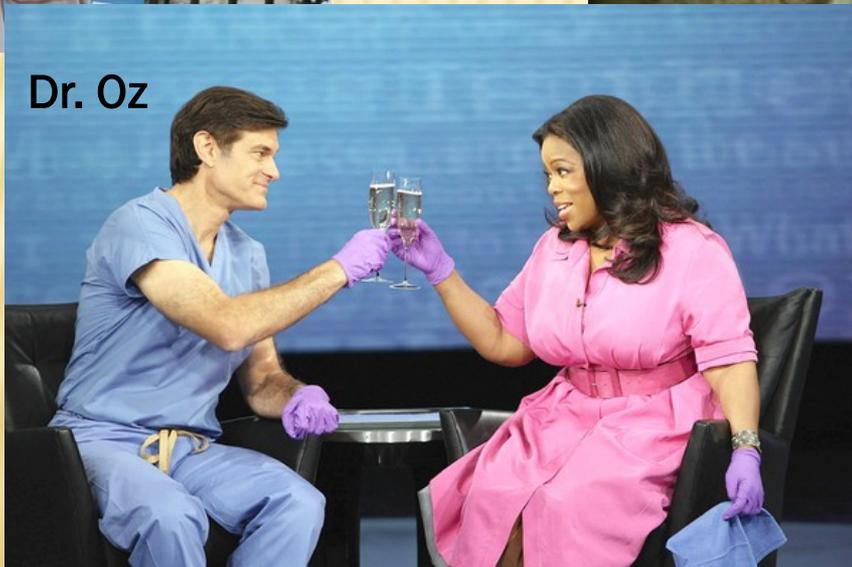
Jenny McCarthy



Dr. Bob Sears



Dr. Oz



EXEMPTION PROTOCOLS AND IMMUNIZATION RATES

Ease of Obtaining PBE ¹	Vaccine coverage (% \pm sd)				
	MMR	DTP/DTAP/DT	Poliovirus	Hepatitis B	Varicella (1 dose) ²
Easy (n=7)	92.7 \pm 3.2	92.3 \pm 3.3	93.7 \pm 2.1	95.1 \pm 2.6	97.9 \pm 1.6
Medium (n=7)	93.6 \pm 4.2	94.8 \pm 3.9	95.7 \pm 3.6	95.9 \pm 3.2	94.8 \pm 3.2
Difficult (n=4)	97.2 \pm 4.1	97.1 \pm 2.0	97.5 \pm 1.9	98.2 \pm 1.2	98.8 \pm 0.7
p-trend ³	0.06	0.03	0.05	0.09	0.76

- But which came first, the exemptions or the call for exemptions?
- Ecological fallacy

CURRENT ARIZONA EXEMPTION PROTOCOL

- ✘ Relatively simple for Kindergarten (K) entry
- ✘ No personal belief exemptions available for pre-school (though religious exemptions are allowed)
- ✘ Form completed by parent at time of enrollment of child in K, 5th and 9th grade
 - + Available online or at school
(<http://www.azdhs.gov/phs/immun/pdf/school-exemption-form.pdf>)
 - + Signature of parent only
 - + Can exempt all or select vaccines

GROWING TREND

- ✘ Many states are experiencing increases in immunization exemptions

State	Overall Personal Belief Exemption Rate	Year Rate Determined	Grades Included	Lowest County PBE Rate	Highest County PBE Rate
Arizona	2.8%	2009/2010	Kinder	0.6%	8.5%
Arkansas	0.9%	2010-2011	K-12	0.0% ¹	0.9%
California	1.6%	2007-2008	Kinder	0.0%	13.2%
Idaho	3.2%	2010-2011	K-12	0.0%	13%
North Dakota	1.2%	2010-2011	K-12	0.0%	18.2%
Pennsylvania	1.0% Public ² 4.2% Private	2010-2011		0.1% Public 0.0% Private	5.5% Public 88.9% Private
Vermont	5.4%	2010-2011	Kinder	2.1%	10.4%
Washington	5.1%	2010-2011	K-12	1.0%	25.3%

Table 2. Selected inter-state ranges of immunization exemptions.

¹32 of 75 counties

²Pennsylvania reported exemptions separately for public and private schools; the overall exemption rate for Pennsylvania was 1.4%.

SPATIAL VARIABILITY

- ✘ Overall coverage may be acceptable but spatial clustering may lead to rates below community immunity levels

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North Dakota	1.2%	2010-2011	K-12	0.0%	18.2%
Pennsylvania	1.0% Public ² 4.2% Private	2010-2011		0.1% Public 0.0% Private	5.5% Public 88.9% Private
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ARIZONA AND VACCINE EXEMPTION

- ✘ Non-Medical exemption on the rise
 - + In the 2011 year Arizona experienced a 14% increase in non-medical exemption over 2010
 - + Since 2005-2006: 78% increase
 - + Since 2000-2001: 129% increase

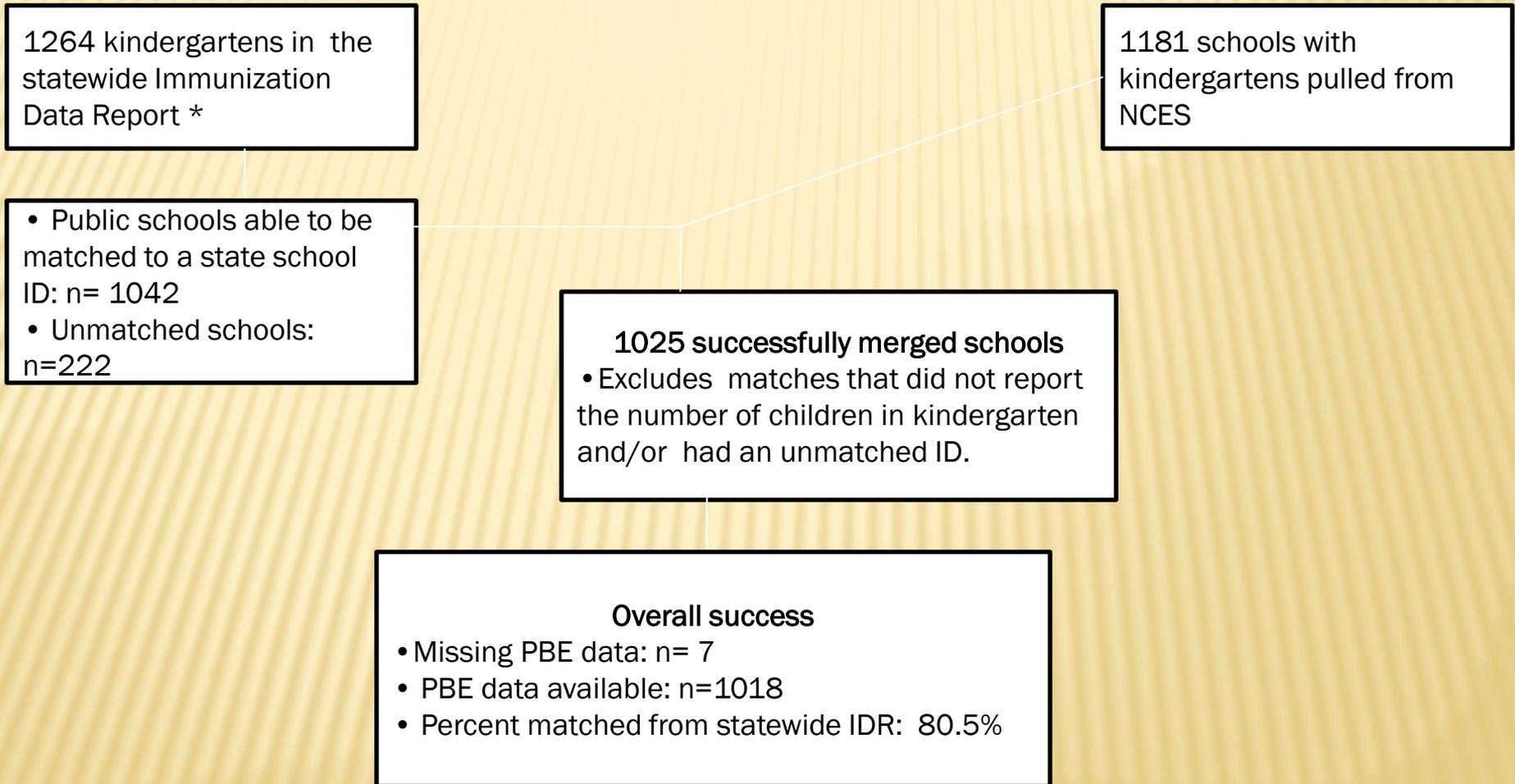
RESEARCH GOALS

- ✘ Characterize the Arizona schools with high rates of permanent PBE among kindergartners
- ✘ Determine to what degree they aggregate across the state

METHODS

- ✘ Merge data from NCES and Arizona's statewide Immunization Data Report
- ✘ Bivariate Analyses
- ✘ Negative binomial regression to find characteristics associated with higher incidence of PBE
 - + Appropriate because of count data in this ecological study
 - + Data had an incorrect distribution for Poisson
- ✘ Use Getis-Ord G_i^* for hot spot analysis
 - + Mapping used longitude and latitude from NCES
 - + Presented using an interpolation method that will show the areas where high schools are, but won't show the schools themselves.

LINKING DATA SOURCES



* Includes private school, who do not have a state school ID and were excluded from the study. Pima county gathers their reports separately from the state

SAMPLE CHARACTERISTICS

	<i>No.</i>	<i>(%)</i>	Permanent PBE	Count of Students	PBE per 1,000 Children
Overall	1018	(100.0)	2050	75788	27.05
Urban Category					
City	448	(44.0)	880	34792	25.29
Suburb	197	(19.4)	436	16211	26.90
Town	101	(9.9)	148	7588	19.50
Rural	272	(26.7)	586	17197	34.08
Statewide Region					
Central	650	(63.9)	1576	53883	29.25
North	93	(9.1)	219	4579	47.83
South	211	(20.7)	169	13003	13.00
West	64	(6.3)	86	4323	19.89
Agency Type					
Public school	838	(82.3)	1530	67206	22.77
Charter school	176	(17.3)	518	8411	61.59
Other	4	(0.4)	2	171	11.70

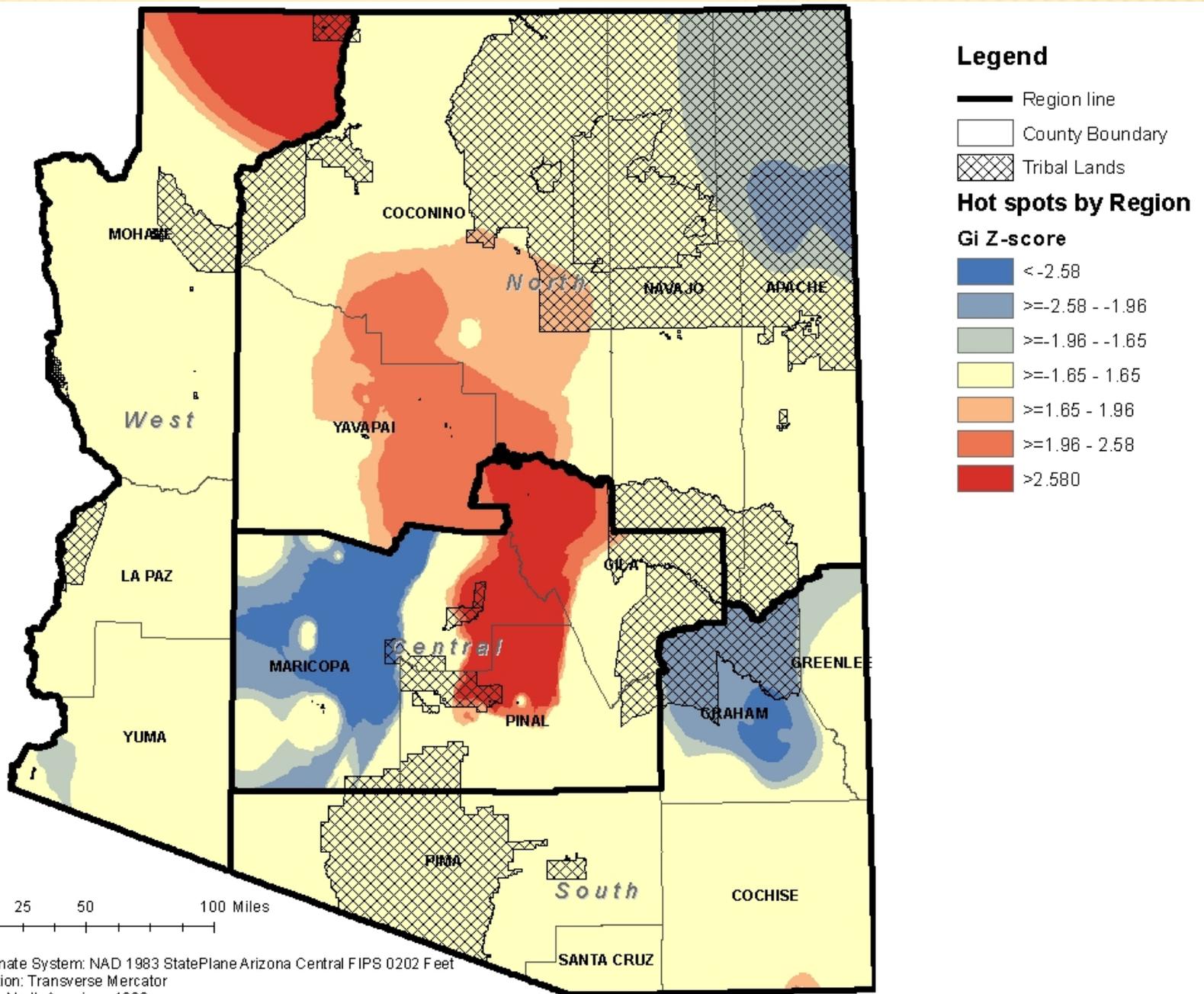
SAMPLE CHARACTERISTICS

	No.	(%)	Permanent PBE	Count of Students	PBE per 1,000 Children
Free and Reduced Lunch percent					
Under 25	245	(24.7)	842	20001	42.10
25-50	198	(20.0)	533	14566	36.59
50-75	265	(26.8)	432	18290	23.62
75+	282	(28.4)	147	21758	6.76
White percent Quintile					
1st Quintile (0-9%)	203	(19.9)	50	17615	2.84
2nd Quintile (9-35%)	204	(20.0)	208	15568	13.36
3rd Quintile (35-59%)	204	(20.0)	376	14131	26.61
4th Quintile (59-75%)	204	(20.0)	612	15121	40.47
5th Quintile (75%+)	203	(19.9)	804	13353	60.21
<i>PBE Rate in Ranked Groups (range)</i>					
<i>1st and 2nd (0%)</i>	430	(42.2)	0	29222	0.00
<i>3rd (0-2%)</i>	181	(17.8)	248	17641	14.06
<i>4th (3-5%)</i>	204	(20.0)	576	16310	35.32
<i>5th (5-68%)</i>	203	(19.9)	1226	12615	97.19

Table 2. Incidence Rate Ratios and 95% Confidence Intervals from Negative Binomial Regression among 1018 Kindergartens in Arizona

	Crude IRR	95% CI	Adjusted IRR	95% CI
Urban Category				
City	Ref.	--	Ref.	--
Suburb	0.99	0.77,1.27	0.85	0.70,1.03
Town	0.79	0.56,1.12	0.71	0.52,0.95
Rural	1.27	1.00,1.61	0.96	0.79,1.16
White percent Quintile				
1st Quintile (0-9%)	Ref.	--	Ref.	--
2nd Quintile (9-35%)	4.86	3.39,6.97	4.22	2.94,6.06
3rd Quintile (35-59%)	10.40	7.34,14.75	7.62	5.20,11.16
4th Quintile (59-75%)	15.13	10.74,21.32	10.52	7.11,15.56
5th Quintile (75%+)	24.97	17.74,35.14	14.11	9.47,21.03
Region				
Center	Ref.	--	Ref.	--
North	1.74	1.27,2.40	1.38	1.06,1.81
South	0.46	0.36,0.61	0.64	0.51,0.80
West	0.78	0.52,1.16	0.92	0.64,1.33
Agency Type				
Public school	Ref.	--	Ref.	--
Charter school	3.07	2.43,3.86	2.04	1.68,2.48
Other	0.38	0.05,3.04	0.64	0.11,3.59
Fee/Reduced Lunch				
0-25%	Ref.	--	Ref.	--
25-50%	0.87	0.69,1.11	1.05	0.85,1.30
50-75%	0.60	0.48,0.75	1.03	0.82,1.29
75+%	0.15	0.12,0.20	0.68	0.50,0.93

Regional Hotspots of High and Low Vaccine



KEY FINDINGS

- ✘ Schools with fewer minorities were much more likely to have high exemption rates
- ✘ Charter schools were more likely to have higher numbers of exemptors
- ✘ Schools with high levels of Free/Reduced Lunch was associated with lower level of exemptions.
- ✘ Cluster analysis identified pockets of high exemption levels throughout the state and within counties.
 - + Sedona, Colorado City, East Maricopa

POTENTIAL INTERVENTIONS TO IMPROVE COVERAGE

- ✘ Further investigation of vaccine safety
- ✘ Improvement of post-marketing adverse event surveillance
- ✘ Thorough education of healthcare professionals and patients
- ✘ Requirement of physician visit prior to acceptance of personal belief exemption provisions

DISCUSSION

- ✘ How do we hope the results are used?
 - + Target at risk areas prior to an outbreak
 - + Gear interventions towards the population of the school

- ✘ Limitations
 - + Ecological study design
 - + Mismatch in years

STUDIES UNDERWAY

✘ Physician Survey

- + Attitudes towards permanent personal vaccination exemptions
- + Parental outreach and education



The image shows a screenshot of a Forbes article page. At the top, there is a dark navigation bar with the Forbes logo on the left and three menu items: "New Posts" (with a sub-item "+1 posts this hour"), "Most Popular" (with a sub-item "America's Coolest Cities"), and "Lists" (with a sub-item "America's Top Co..."). Below the navigation bar, the article content is displayed. On the left side, there are three social sharing buttons: a Facebook "Share" button with a count of 80, a Twitter "Tweet" button with a count of 140, and a LinkedIn "Share" button with a count of 2. The main content area features a profile picture of Steven Salzberg, a contributor, with his name and title "Steven Salzberg, Contributor" and a bio: "Celebrating good science by fighting pseudoscience and bad medicine". Below the bio is a "+ Follow (69)" button. The article title is "Should Doctors Fire Their Anti-Vaccine Patients?" and the metadata includes "PHARMA & HEALTHCARE | 2/25/2012 @ 5:15PM | 3,855 views".

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Should Doctors Fire Their Anti-Vaccine Patients?

STUDIES UNDERWAY

✘ School-based

- + Identify high exemption schools (>10% K)
- + Cross-sectional surveys in schools
 - ✘ Parental knowledge, attitudes and practices regarding vaccinations
 - ✘ Key reasons for vaccinating or not vaccinating
- + Record review
 - ✘ Identify timing of exemption paperwork
 - ✘ Completeness of vaccination despite waivers
- + Town Halls
 - ✘ Open forums for vaccine discussions

REFERENCES

Impact of vaccines universally recommended for children--United States, 1990-1998. 1999.

(<http://www.cdc.gov/mmwr/preview/mmwrhtml/00056803.htm>).

Colgrove J. Immunity for the people: the challenge of achieving high vaccine coverage in American history. Public Health Rep. 2007; 122:248-57.

Craddock S. Sewers and scapegoats: spatial metaphors of smallpox in nineteenth century San Francisco. Soc Sci Med. 1995; 41:957-68.

Sugerman DE, Barskey AE, Delea MG, Ortega-Sanchez IR, Bi D, Ralston KJ, et al. Measles outbreak in a highly vaccinated population, San Diego, 2008: role of the intentionally under vaccinated. Pediatrics. 2010; 125:747-55

Office AIP. Arizona Immunization Exemption Rates by Facility/Grade [<http://www.azcentral.com/ic/pdf/business/AZ-ImmunizationExemptions-July-2011.pdf>].

THANK YOU!
