



The Vaccine-preventable Diseases Report, 2016

The risk and cost of not fully protecting our children against infectious diseases in Colorado

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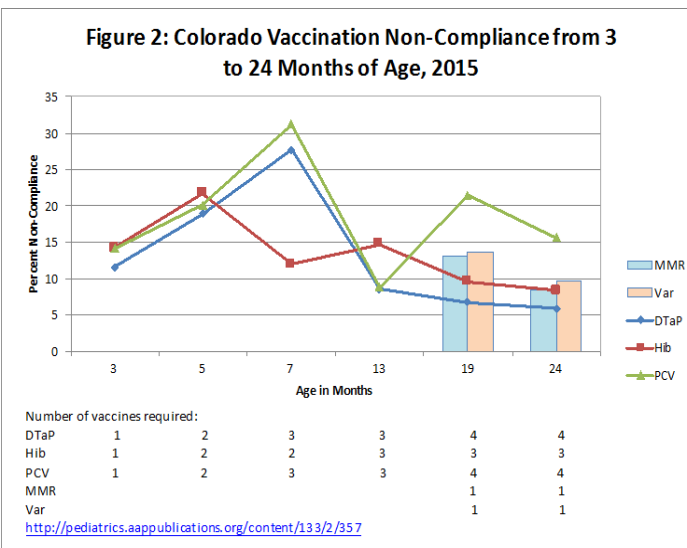
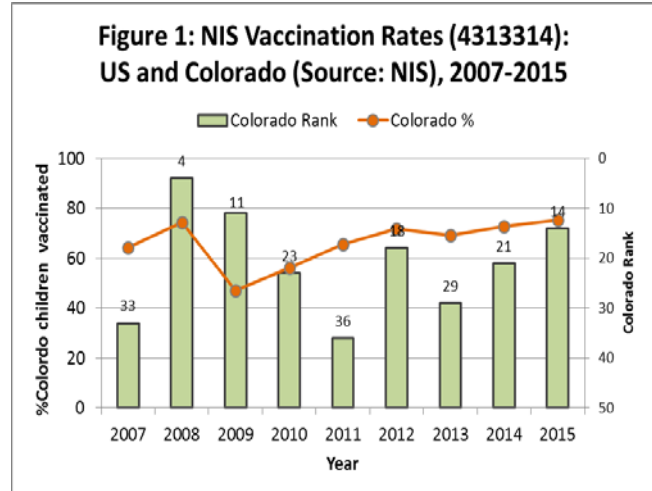
❖ Summary

The *2016 Vaccine-Preventable Diseases in Colorado's Children* report summarizes our annual analysis of rates of childhood vaccination and vaccine-preventable illness in 2015, and the cost implications and risks for the health of Colorado's population. For the first time, this report includes emergency department (ED) visits as well as hospitalizations. Colorado ranks 14th among US states in on-time vaccination rates for children 19-35 months of age, with statewide rates continuing to hover under 80% - the Healthy People 2020 goal for immunization coverage. A few counties exceed that level but most, including many rural areas, have estimated vaccination rates that are much lower. This includes 17 counties (27%) where less than 50% of their children are up-to-date on their vaccinations. Similarly, childhood ED and hospital vaccine preventable-disease cases (predominantly influenza, pertussis, chicken pox and pneumococcal disease) are seen throughout most counties in Colorado where vulnerable children with diseases such as asthma or cancer are living. The highest proportion of hospitalizations for children with vaccine-preventable diseases continues to be in those under four years of age. Overall, ED and hospitalization charges for children with potentially preventable infectious diseases approach \$35 million annually, with Adams (\$6.1million), Arapahoe (\$5.1million), Denver (\$4.7million) and El Paso (\$4.4million) counties accounting for about 58% of the statewide hospital and ED charges.

❖ Analysis

Vaccination coverage has improved, but Colorado continues to have a significant percentage of incompletely protected children.

In 2015, Colorado ranked 14th among US States in vaccination rates for children 19-35 months of age (Figure 1). More importantly, 24.6% of children surveyed in the NIS had received less than the recommended number of doses of Colorado Board of Health approved vaccines (4313314: 4 doses of DTaP, 3 doses of polio [IPV], 1 dose of measles/mumps/rubella [MMR], 3 doses of hepatitis-B, full series of *Haemophilus influenzae* type B [HiB], 1 dose of varicella and 4 doses of pneumococcal conjugate vaccine [PCV]), leaving them potentially vulnerable to these harmful infectious diseases. Colorado's overall vaccination rate improved in 2015 following consecutive low rates in the last five years, but it is still short of the target set by Healthy People 2020 of reaching 80% coverage for the childhood series.



Much of this gap stems from incomplete vaccination of young children (Figure 2). This is especially concerning, since the highest burden of preventable illness occurs in this age group. For instance, coverage with MMR vaccine improved but was still 91.5%, below the >93-95% levels, which are required to protect a population against outbreaks of measles¹. While DTaP, MMR and Varicella at 24 months of age improved compared to 2014, at least one in four 7-month old infants in Colorado are still behind in DTaP and PCV vaccinations, and pneumococcal disease and

pertussis were the second and third most common reasons for hospitalization from vaccine-preventable diseases in young children in Colorado in 2015 (Table 1).

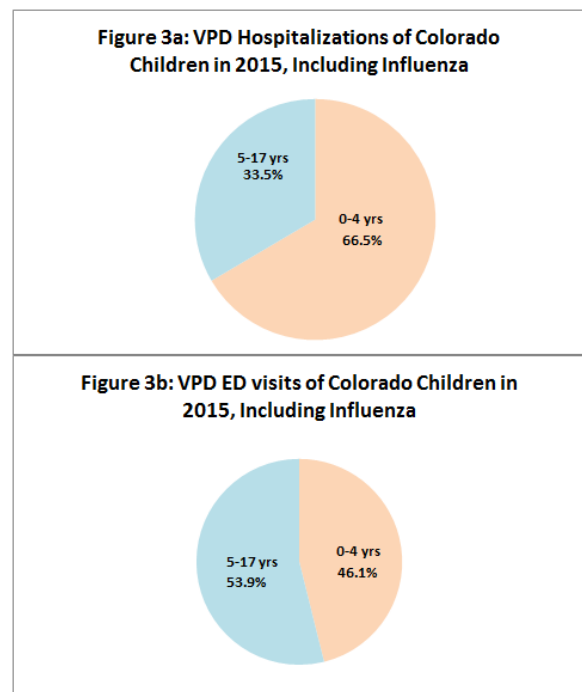
Table 1: Cases, rates and charges for Colorado children 0-17 years of age with vaccine-preventable diseases, 2015.

Vaccine	Hospitalized Cases	Rate per 100,000	Hospital Charges	ED Cases	Rate per 100,000	ED Charges	Total Charges
Diphtheria	0	0.00	\$0	0	0.00	\$0	\$0
H. influenzae	4	0.32	\$315,958	0	0.00	\$0	\$315,958
Hepatitis A	0	0.00	\$0	0	0.00	\$0	\$0
Hepatitis B	2	0.16	\$189,162	3	0.24	\$7,565	\$196,727
Influenza	369	29.87	\$18,570,610	4,045	327.41	\$7,036,436	\$25,607,046
Measles	0	0.00	\$0	3	0.24	\$10,193	\$10,193
Mumps	2	0.16	\$30,908	8	0.65	\$20,381	\$51,289
Pertussis	24	1.94	\$587,018	58	4.69	\$109,088	\$696,106
Pneumococcal disease	69	5.58	\$7,938,270	13	1.05	\$29,345	\$7,967,615
Polio	0	0.00	\$0	0	0.00	\$0	\$0
Rubella	1	0.08	\$22,850	0	0.00	\$0	\$22,850
Tetanus	1	0.08	\$641,969	1	0.08	\$345	\$642,314
Varicella	4	0.32	\$130,104	116	9.39	\$102,096	\$232,200
Total*	472	38.20	\$28,080,090	4,247	343.76	\$7,315,449	\$35,395,539

* Four hospitalized children had both influenza and pertussis.

Vaccine-preventable diseases are a major cause of hospitalization of Colorado’s youngest children and result in high cost to parents, businesses and taxpayers

By far the greatest burden of disease requiring hospitalization falls on infants and young children (Figure 3a). In contrast, ED visits for VPD were more frequent among those 5-17 years (Figure 3b). A more detailed breakdown of hospitalizations and ED visits from vaccine-preventable illnesses is presented in Table 1, using data from the Colorado Hospital Association databases. These data document, not only the numbers of cases of preventable infectious disease, but also the hospital and ED charges associated with these illnesses. The most common vaccine-preventable cause of hospitalization or ED visits was influenza, which resulted in 369 hospitalizations (two fatal), and 4,045 ED visits in Colorado children. Total hospital charges and ED charges for vaccine-preventable diseases were over \$35 million, with over \$25 million due to influenza alone. The second most common vaccine-preventable cause of hospitalization or ED visits was pneumococcal disease, with total hospital and ED charges of \$8 million. Overall, the impact of vaccine preventable disease on Colorado’s economy is much greater if costs such as office visits, medication, lost wages, decreased productivity, and other societal costs are considered, as well as the total number of all cases for all ages (including both children and adults) reported to CDPHE in



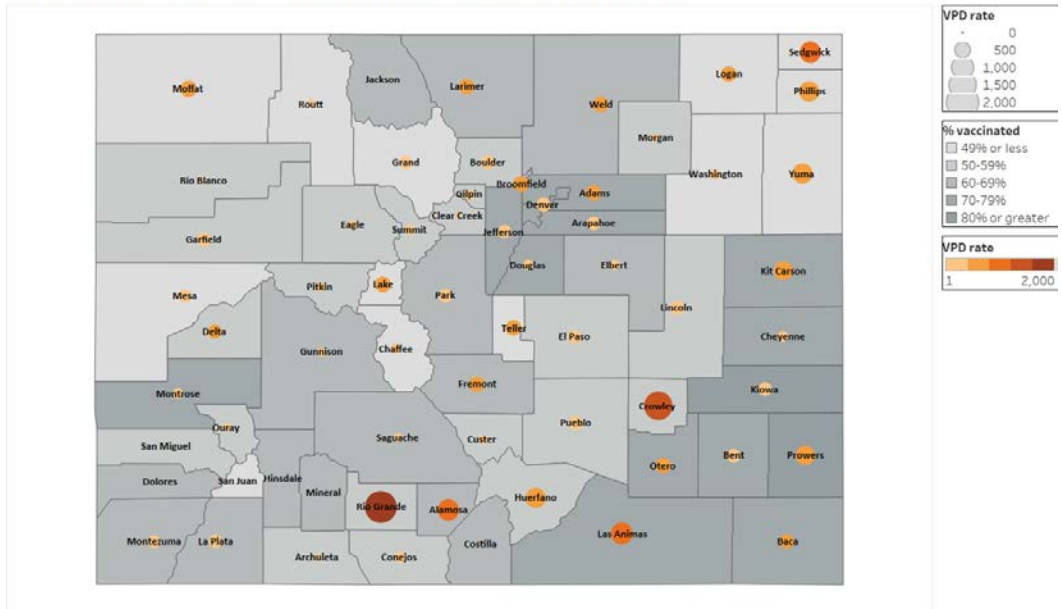
2015. (i.e. 1635 cases of hospitalized influenza; 916 cases of pertussis; 506 cases of invasive pneumococcal disease; one case of measles)

Many Colorado counties, both urban and rural, have low vaccination rates, and significant numbers of vulnerable children and vaccine-preventable disease.

As shown in Figure 4 and Table 3 (Appendix) the Colorado Department of Public Health and Environment has published county level immunization rates (4313314) for children 19 – 35 months of age in 2016.

As of June 2016, data from the Colorado Immunization Information System (CIIS) show as many as 49 counties (77%) in Colorado are below the national average of immunization rate.

Figure 4: County level immunization rates (4:3:1:3:3:1:4) per 100,000 of 19 – 35 months old children and Vaccine-preventable Disease rates per 100,00 of Colorado children 0-17 years of age.



Furthermore,

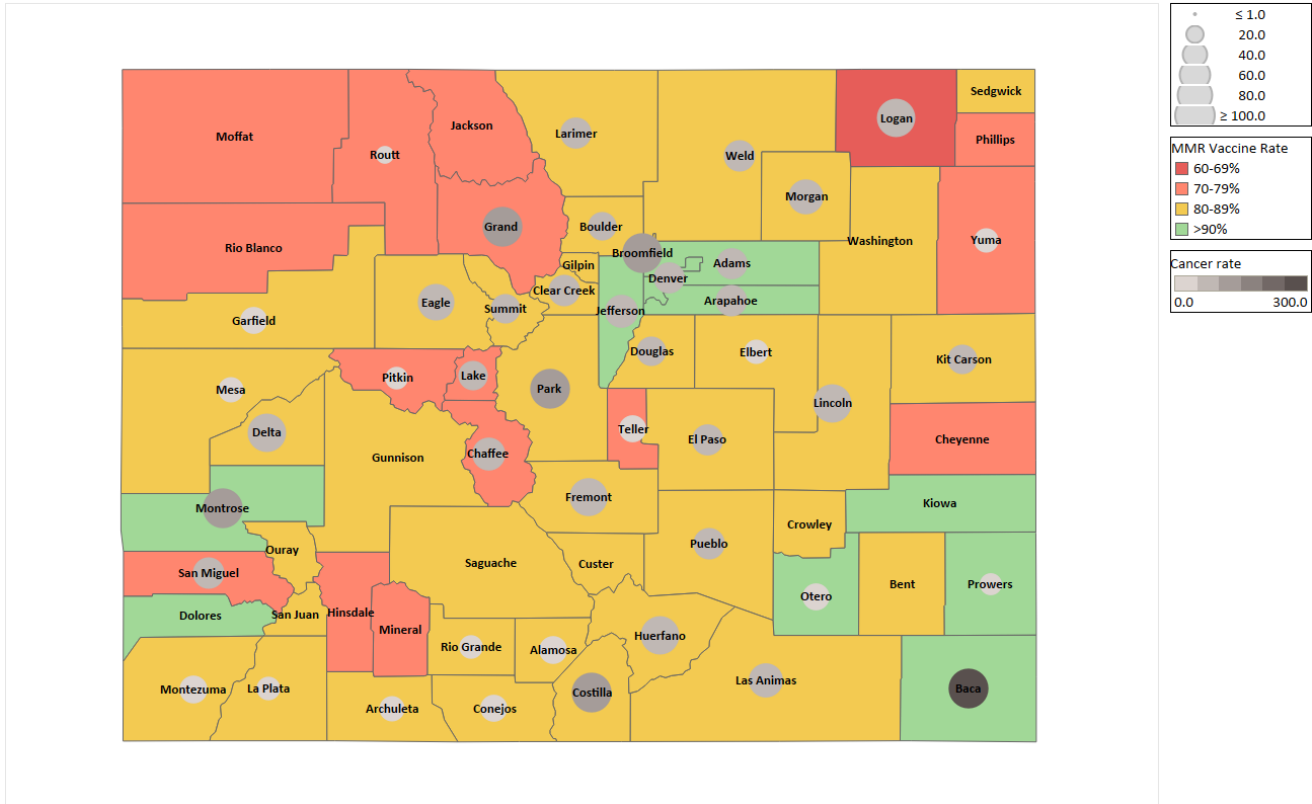
immunization coverage levels are less than 50% in 17 Colorado counties and currently only 5 counties achieve the Healthy People 2020 vaccination goal. Vaccine-preventable disease rates in Colorado children for ED and hospitalization visits are not focused in urban areas of Colorado but occur in counties throughout the state. Cumulative expenses from VPDs in most counties range from thousands to millions of dollars annually, with Adams (\$6.1million), Arapahoe (\$5.1million), Denver (\$4.7million) and El Paso (\$4.4million) counties accounting for about 58% of the \$35 million statewide hospital and ED charges.

Low levels of community protection due to unacceptable vaccination rates leave many vulnerable children at risk of deadly and serious infectious diseases.

Many children who have suffered from cancer and are undergoing chemotherapy or are in remission are at high risk of suffering the consequences of vaccine preventable diseases in Colorado. As an example, Figure 5 shows the statewide distribution by county of children diagnosed with cancer over the past 3 years and the respective MMR vaccination rates for 2015. All counties

have vulnerable children (children with cancer, cardiac disease, pulmonary disease, and immune deficiency, as well as transplant patients and infants too young or contraindicated to get certain vaccines) who are at risk of vaccine preventable diseases. If an outbreak of measles were to occur in some of the counties with MMR coverage below 90%, these children will be at even higher risk of serious complications or even death.

Figure 5: Rate per 100,000 of children 0-18 years of age with cancer diagnosed in Colorado counties from 2013- 2015 compared to MMR vaccination rate for 19-35 month children in 2015.

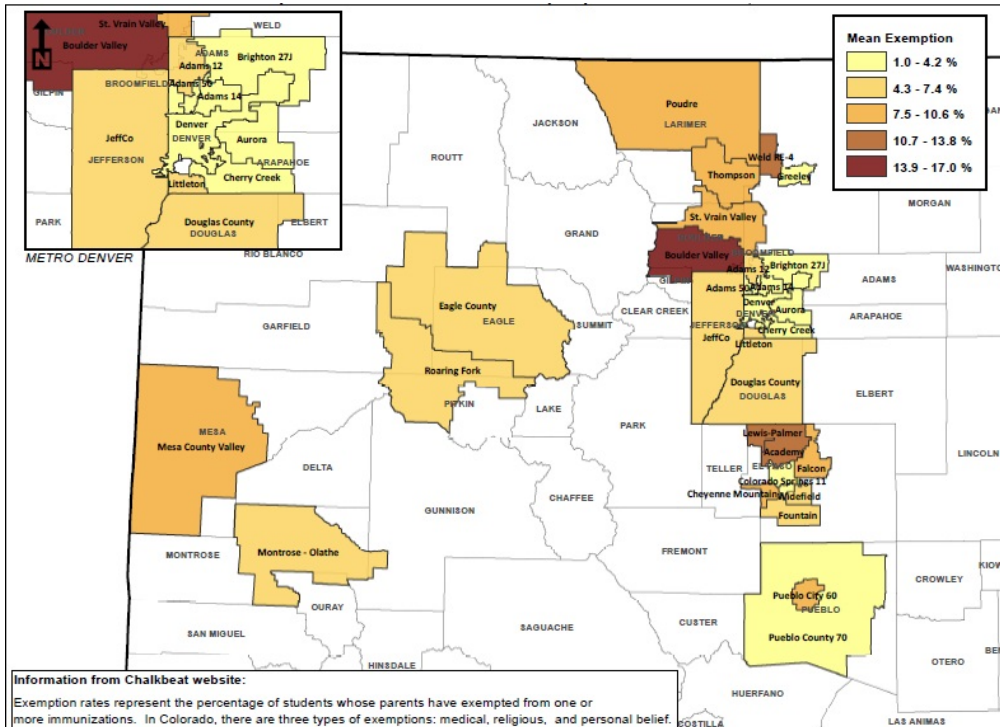


This risk that low vaccination rates poses to immune compromised children was highlighted in the media during the 2014-2015 US measles outbreak through the California family of Rhett Krawitt, a 6-year-old boy with leukemia. The Krawitt family spoke publicly in support of vaccination after the measles outbreak that originated at Disneyland theme parks in California placed their son, along with many others like him, at risk for severe complications. The measles outbreak ultimately sickened hundreds of people across 24 states and three countries.
<https://www.cdc.gov/measles/cases-outbreaks.html>

Exemptions to vaccination, especially personal exemptions, run high in some counties lowering the level of community protection and putting children and their families at risk.

Colorado is one of the states with more relaxed rules to claim an exemption to vaccination resulting in high numbers of under- and unvaccinated children in many school districts (Figure 6).

Figure 6: Mean immunization exemption rate data by school district as self-reported to Chalkbeat for Colorado’s 30 largest school districts for the 2015-2016 school year, published on June 29, 2016, Map created by CDPHE



While there are important reasons why some children could be exempt from getting immunized (e.g. medical exemptions), having a personal belief option to not vaccinate one’s child leaves too many children unprotected and their community at risk of having outbreaks of vaccine preventable diseases. Studies have shown that states with easy exemption processes, like Colorado, are associated with increased incidence of VPDs.¹

¹Omer, Saad B.; Pan, William K. Y.; Halsey, Neal A.; Stokley, Shannon; Moulton, Lawrence H.; Navar, Ann Marie et al. (2006): Nonmedical exemptions to school immunization requirements: secular trends and association of state policies with pertussis incidence. In *JAMA* 296 (14), pp. 1757–1763. DOI: 10.1001/jama.296.14.1757.

From January 2 to December 31, 2016, 70 people from 16 states (Alabama, Arizona, California, Colorado, Connecticut, Florida, Georgia, Hawaii, Illinois, Massachusetts, Minnesota, New York, North Carolina, Tennessee, Texas, and Utah) were reported to have measles.² For the 2015-2016 school year, Colorado had the lowest MMR coverage rate for kindergarteners (87.1%) and the 7th highest non-medical exemption rate of 4.3%, almost 3,000 kindergartners, in the US. Currently, Colorado is experiencing a mumps outbreak and an active flu season that has already claimed the lives of at least 20 children nationwide. In addition, Colorado is in the midst of a measles investigation due to one person with the disease who visited 18 locations including stores, clinics and a gym over the winter holidays. Even if such an exposure does not result in transmission of disease, the community costs of investigation and prevention can amount to tens of thousands of dollars per exposure. (See Highlight Box.)

❖ **A vaccine against cancer that could save millions of dollars and suffering for Coloradans**

The Human Papillomavirus(HPV) vaccine has proven very effective in preventing infections in adolescents and young adults. With time and increased vaccine use, as has been shown in other countries (UK, Australia, Canada, etc.), HPV immunization will lead to reduction in HPV-associated cancers (genital and oral). HPV is best known as the leading cause of cervical cancer but can also cause oropharyngeal cancer in men and women, along with vaginal, vulvar, penile, and anal cancers. In the US, it is estimated that taxpayers spend \$8 billion annually treating and preventing HPV in direct medical costs alone.

In 2013, there were 155 new cases of cervical cancer diagnosed in Colorado (2.9/100,000 people) and 700 new cases of oropharyngeal, vaginal, vulvar, penile, and anal cancer. We examined the number of new HPV-attributable cancer cases diagnosed in one year in Colorado and the estimated medical costs for each case. New cases of cancer caused by vaccine strains of HPV during one year led to over

Public Health Costs of Preventing an Outbreak of a Vaccine Preventable Disease

In July 2016, an unvaccinated child from the Denver Metro area tested positive for measles after developing a rash and fever after international travel. The child had visited many public locations while potentially contagious, including a learning center, two large grocery stores, a restaurant, and three health care settings (a pediatric office and two emergency departments) before being hospitalized. Tri-County Health Department conducted an investigation and contacted persons who could have been in contact with the child. High-risk contacts were provided measles vaccine or immune globulin (a medication to prevent infection). There were no secondary cases identified. Tri-County Health Department conducted a cost analysis including the time and effort of public health personnel, hospital personnel involved in the case investigation, and the cost of prophylactic medication and vaccine. The cost estimate associated with this measles case investigation was just under \$50,000 (Dr. Bernadette Albanese, Tri-County Health Department, personal communication). These costs do not include any direct medical costs for the care of the measles case.

² <https://www.cdc.gov/measles/cases-outbreaks.html>

\$23 million in medical costs in our state (Table 2). These estimates of direct medical costs do not include the costs of cervical cancer screening with pap smears and follow-up testing, which should also be reduced as HPV prevalence declines.

Table 2: Preventable medical costs of HPV-attributable cancers in Colorado 2013³

Type of cancer	Number of cases in Colorado in 2013	Percent attributable to HPV 16/18/31/33/45/52/58 (HPV 9-valent vaccine strains) ⁱ	Number attributable to HPV-9 vaccine strains	Cost per case (direct medical costs in 2010 USD)	Preventable Costs (2010 USD; cost per case * number of cases attributable to HPV-9 vaccine strains)
Cervical	155	81%	126	\$38,800	\$4,871,340
Vaginal	19	73%	14	\$27,100	\$375,877
Vulvar	71	63%	45	\$23,600	\$1,055,628
Penile	17	57%	10	\$19,800	\$191,862
Anal	81	88%	71	\$36,200	\$2,580,336
Oropharyngeal	512	66%	337	\$43,200	\$14,598,144
Total	855		603		\$23,673,187

The most powerful tool at our disposal to prevent these cancers, the HPV vaccine, was only given to 65% of our Colorado teens in 2015. Far fewer received the complete series of recommended HPV vaccine doses. For each year that Colorado remains below 100% vaccination, we miss the chance to reduce and prevent these infections, leading to more human suffering and healthcare costs.

❖ Conclusion

In conclusion, newly available data from the CIIS and other sources at the county and school levels demonstrate communities across Colorado have vaccination rates lower than the required levels of coverage to protect against vaccine preventable disease. This is especially concerning for Colorado’s most vulnerable children at greatest risk for complications if exposed to vaccine preventable disease and unimmunized children. Costs associated with ED visits, hospitalizations and outbreak prevention are significant and do not include indirect economic and societal costs. To prevent additional burden from vaccine preventable disease, Colorado needs continued support to improve access to vaccines, to strengthen its immunization delivery systems, and to ensure parents receive accurate information regarding the safety and benefits of childhood vaccination.

³ Table references: Markowitz LE, Liu G, Hariri S, Steinau M, Dunne EF, Unger ER. Prevalence of HPV after introduction of the vaccination program in the United States. *Pediatrics*. 2016;137(2):e20151968.

Chesson HW, Ekwueme DU, Saraiya M, Watson M, Lowy DR, Markowitz LE. Estimates of the annual direct medical costs of the prevention and treatment of disease associated with human papillomavirus in the United States. *Vaccine*. 2012 Sep 14;30(42):6016-9.

Colorado Central Cancer Registry. Colorado Health Information Dataset, CDPHE. Available at http://www.chd.dphe.state.co.us/cohid/topics.aspx?q=Cancer_Incidence_Data. Accessed January 8, 2016.

Viens LJ, Henley SJ, Watson M, Karkowitz LE, Thomas CC, et al. Human Papillomavirus-Associated Cancers- United States, 2008-2012. *MMWR Morb Mortal Wkly Rep*. 2016 Jul 8;65(26):661-6.

❖ What methods did we use for this report?

The National Immunization Survey (NIS) provides annual vaccination rate estimates. The NIS is a list-assisted, random-digit-dialing telephone survey conducted by the Centers for Disease Control and Prevention (CDC) followed by a mailed survey to the childrens' vaccination_providers. (www.cdc.gov/nchs/nis.htm).

Case counts of hospitalization, emergency department visits, and corresponding hospital charges due to vaccine-preventable disease (VPD) among Colorado children 0-17 years of age were calculated from the Colorado Hospital Association (CHA) Inpatient and Emergency Department databases for 2015. Data from 2016 will only be ready for analysis later in 2017. ICD-9 and ICD-10 codes for January-September and October-December, respectively, were used to obtain VPD diagnoses. Population estimates to calculate incidence rates by insurance type were obtained from the American Community Population Survey by way of the Colorado Health Institute, while county population estimates were obtained from the Colorado Department of Local Affairs. The Colorado Hospital Association is a consortium representing over 100 hospitals and health systems throughout the state, and provides hospital and emergency department utilization data from its online database program that collects monthly self-reported hospital and emergency department utilization and financial data from health care facilities. (www.cha.com/Resources/Colorado-Hospital-Utilization-Data.aspx)

The Colorado Department of Health and Environment (CDPHE) collects data on statewide reportable infectious diseases, which include all infections preventable by routine Colorado childhood vaccinations. https://www.colorado.gov/pacific/sites/default/files/DC_ComDis_Reports_Diag_Age_2015.pdf

Estimated vaccination rates (with thanks to Marianne Koshak, CDPHE) are based on information reported to CIIS. These are estimates with some limitations:

https://www.colorado.gov/pacific/sites/default/files/Imm_CIIS-County-Data-Child_1.pdf

Figure 6 was provided by the GIS & Mapping Services within the Health Statistics Branch at CDPHE using Chalkbeat Colorado data. Chalkbeat Colorado created a database of self-reported school-by-school immunization, exemption, and compliance rates for schools in Colorado's 30 largest districts which enroll more than 80% of students in CO. This database includes information for more than 1,200 public Colorado schools, but data may be missing for certain schools, charter schools in particular. The 2015-2016 data is available at: <http://www.chalkbeat.org/posts/co/2016/06/29/colorado-find-your-schools-2015-16-immunization-and-exemption-rates/>. Per Board of Health rules, Colorado schools are now required to report their immunization rate information annually to CDPHE.

Asthma visit ED and hospitalization rates for 2015 were obtained from the CHA database (above). New childhood cancer case numbers for 2013-2016 were obtained from the Children's Cancer Registry (Walters, M. Children Cancer Registry. Center for Cancer and Blood Disorders. Children's Hospital Colorado 2014-2016)

The authors would like to acknowledge Marianne Koshak, Vaccine Operations Program Manager at the Colorado Department of Public Health and Environment Immunization Branch for her assistance.

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Appendix

COUNTY	% Vaccinated, 19-35¹	% MMR Vaccine, 19-35	Asthma Visits/10	Cancer Cases/10	VPD rate/100K²	VPD charges³
Adams	70-79%	≥90%	386	62	454	\$6,060,482
Alamosa	60-69%	80-89%	610	43	829	\$88,886
Arapahoe	70-79%	≥90%	867	65	328	\$5,141,180
Archuleta	50-59%	80-89%	261	44	87	\$43,508
Baca	70-79%	≥90%	2,033	271	407	\$3,260
Bent	70-79%	80-89%	309	0	341	\$6,727
Boulder	50-59%	80-89%	426	52	363	\$1,263,281
Broomfield	60-69%	80-89%	720	103	435	\$411,019
Chaffee	<50%	70-79%	568	67	201	\$12,187
Cheyenne	70-79%	70-79%	214	0	214	\$393
Clear Creek	50-59%	80-89%	128	64	64	\$718
Conejos	50-59%	80-89%	138	46	229	\$4,455
Costilla	60-69%	80-89%	736	147	0	\$0
Crowley	50-59%	80-89%	760	0	1,520	\$31,515
Custer	50-59%	80-89%	154	0	154	\$5,040
Delta	50-59%	80-89%	514	36	402	\$108,704
Denver	70-79%	≥90%	1,172	58	368	\$4,743,657
Dolores	60-69%	≥90%	0	0	0	\$0
Douglas	70-79%	80-89%	306	56	193	\$1,961,183
Eagle	50-59%	80-89%	92	85	163	\$69,876
El Paso	50-59%	80-89%	615	61	358	\$4,377,586
Elbert	60-69%	80-89%	157	39	196	\$54,331
Fremont	60-69%	80-89%	430	31	457	\$83,249
Garfield	50-59%	80-89%	318	45	389	\$155,575
Gilpin	50-59%	80-89%	188	0	188	\$2,352
Grand	<50%	70-79%	433	108	288	\$73,971
Gunnison	60-69%	80-89%	295	0	131	\$3,369
Hinsdale	60-69%	70-79%	0	0	0	\$0
Huerfano	50-59%	80-89%	1,333	35	762	\$21,555
Jackson	60-69%	70-79%	403	0	0	\$0
Jefferson	70-79%	≥90%	628	63	364	\$3,346,342
Kiowa	≥80%	≥90%	712	0	356	\$694
Kit Carson	70-79%	80-89%	224	56	671	\$28,385
Lake	<50%	70-79%	445	56	500	\$15,311
La Plata	60-69%	80-89%	253	36	298	\$93,576
Larimer	60-69%	80-89%	575	62	446	\$1,373,854
Las Animas	70-79%	80-89%	743	74	831	\$55,529
Lincoln	50-59%	80-89%	743	34	375	\$2,062
Logan	<50%	60-69%	559	33	419	\$121,441
Meza	<50%	80-89%	419	41	320	\$290,880
Mineral	60-69%	70-79%	0	0	0	\$0
Moffat	<50%	70-79%	484	0	513	\$72,066
Montezuma	60-69%	80-89%	437	50	282	\$86,367
Montrose	70-79%	≥90%	338	127	201	\$139,342
Morgan	50-59%	80-89%	426	77	116	\$217,603
Otero	70-79%	≥90%	887	45	455	\$37,559
Oursay	50-59%	80-89%	0	0	131	\$824
Park	60-69%	80-89%	279	139	343	\$32,636
Phillips	<50%	70-79%	288	0	763	\$8,616
Pitkin	50-59%	70-79%	199	33	166	\$12,176
Prowers	≥80%	≥90%	851	32	634	\$78,054
Pueblo	50-59%	80-89%	1,253	66	370	\$1,168,452
Rio Blanco	50-59%	70-79%	581	0	65	\$954
Rio Grande	50-59%	80-89%	829	36	1,303	\$166,657
Routt	<50%	70-79%	63	21	126	\$2,715
Saguache	60-69%	80-89%	69	0	139	\$2,303
San Juan	<50%	80-89%	0	0	0	\$0
San Miguel	50-59%	70-79%	65	65	0	\$0
Sedgwick	<50%	80-89%	1,702	0	851	\$4,044
Summit	50-59%	80-89%	111	55	203	\$57,435
Teller	<50%	70-79%	468	47	444	\$41,641
Washington	<50%	80-89%	503	0	201	\$3,306
Weld	60-69%	80-89%	673	63	470	\$3,125,021
Yuma	<50%	70-79%	612	38	765	\$72,035
Colorado						\$35,395,539

¹ National Immunization Survey, 2015

² Children's Cancer Registry, 2013-2015

³ Colorado Hospital Association, 2015