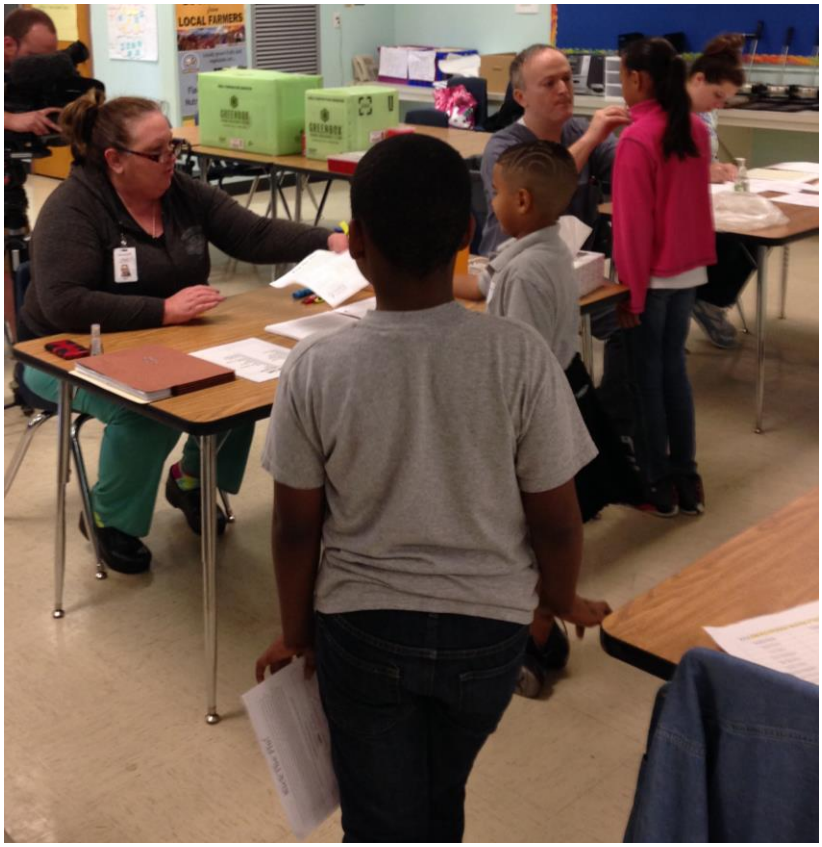
E3 ALLIANCE
EDUCATION EQUALS ECONOMICS

Efforts to Improve Attendance in Central Texas:

"Kick the Flu"

Flu Immunization Campaign Evaluation



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July 2017

Executive Summary

Overview

E3 Alliance determined in 2013 that a spike in absenteeism in schools across Central Texas was perfectly timed to a spike in flu cases in the region. An attempt to ameliorate this flu-related absenteeism led to a large scale "Kick the Flu" school-based immunization campaign in Central Texas. In the fall of 2016, the initiative provided vaccinations to 38,032 students in 262 elementary and middle schools across 15 Central Texas school districts. The purpose of this evaluation is to determine whether this school-based influenza vaccination program corresponded to improvements in school attendance during the peak weeks of the 2016-17 flu season.

Key Findings

- 87% of schools in the Central Texas immunization campaign (227 schools; 179 elementary and 48 middle schools) from 10 school districts schools participated in the evaluation
- Vaccination rates
    - At a majority (55%) of elementary schools, vaccination rates were 20-30% of students
    - Only 4% of elementary schools had vaccination rates of 40% or higher, close to the ~50% rate minimally needed to achieve *herd immunity* (where even non-vaccinated students are protected against the spread of flu)
    - No middle school had a vaccination rate of higher than 30%
- Absence spike due to flu
    - There was an overall detectable increase in absence rates during the peak weeks of flu season compared to the weeks earlier and later in flu season
- Effect of flu campaign
    - No effect found when all baseline (prior to flu season), flu season, and flu peak weeks included in analysis
    - When data limited to 2 baseline and 2 flu peak 'clean' weeks (i.e., weeks without holiday involvement), we found that as vaccination rates increased, absence rates decreased during the peak flu weeks, with the greatest improvement in schools that had the potential to achieve herd immunity.
    - Decrease in absence rates saved the schools an approximate combined $500,000 across the three peak weeks of flu season
    - If all schools reached a 40% vaccination rate, the projected savings would increase to $860,000. Vaccination rates beyond 40% would likely further increase savings at a potentially accelerated rate due to the effects of herd immunity.

Recommendations

- The flu immunization campaign showed positive effects on attendance in elementary schools. The campaign would benefit from efforts to increase schools' vaccination rates, so more schools could benefit from herd immunity and show even greater effects on attendance.
- The flu campaign had little effect on attendance in middle school because the vaccination rates were so low. The campaign would need to raise vaccination rates significantly to decrease absences in middle schools, or consider limiting to elementary schools.

Flu Immunization Campaign Evaluation

Background and Influenza Immunization Program

Student absenteeism negatively impacts both student learning and, in states such as Texas where school funding is largely based on student attendance, the financial resources available to school districts. Illness is a leading cause of missing school. In the winter of 2013, E3 Alliance determined that a spike in absenteeism in schools across Central Texas was perfectly timed to a spike in flu cases in the region. This finding led to a targeted effort to reduce flu-related absenteeism through school-based vaccination. The immunization program, having completed its third year in 2016-17, has grown to be the largest school-based immunization program in Texas and one of the largest in the country.

The purpose of this evaluation is to determine whether implementation of the school-based influenza vaccination program was associated with decreased absenteeism during peak flu season.

Prior Research on School-Based Influenza Vaccination

Effects on Elementary School Absences

Over the last decade, researchers have increasingly documented the positive effects of School-Located Influenza Vaccination (SLIV) programs for reducing student absences due to flu-like illness. In a recent review of the research literature, Hull and Ambrose (2011a, b) described SLIV campaigns as a legitimate means of reducing absences during flu season citing a broad range of prior research.[1] Subsequent studies reaffirm the efficacy of SLIVs in reducing the impact of influenza on student absence.

Graitcer et al. (2012) found that that increasing immunization coverage from the 10th to the 90th percentile—in their study from 38% coverage to 69% coverage—could reduce absences by as much as 8.2% (Graitcer et. al., 2012). Focusing on elementary schools in a predominantly Hispanic community, Keck, Ynalvez, Gonzalez, and Castillo (2012) found not only that the SLIV program led to reduced absences, but that the rate of absence to the SLIV vaccinated students was lower than those vaccinated independent of the program. In their study, Plaspohl et al., (2014) estimated that vaccinated students may have attended school almost a full day more, on average, than their unvaccinated peers.

[1] We provide a comprehensive list of SLIV-related research studies as an Appendix to this evaluation.

Herd Immunity

Pannaraj et al. (2014) sought to further confirm the impact of SLIVs on influenza-based absence by relying on laboratory tests to differentiate influenza-related from other type of illness. They found a 31% lower likelihood of illness due to influenza at schools hosting SLIV programs. Additionally, they found that when at least 50% of students were vaccinated at the school, absences were reduced for both vaccinated and unvaccinated students, implying an indirect effect on likelihood on illness from flu, known as herd immunity, for the students who were not vaccinated, whereas when 30% of students were vaccinated, they did not find a reduction in absences for unvaccinated students. Their result aligns with that of Longini et al. (2002) who used statistical models to determine that herd immunity for influenza is achieved at around a 50% vaccination rate.

Association of SLIV with Reduced Family Impacts of Flu

While much of the research on SLIVs, perhaps not surprisingly, focuses on the impact of vaccination on the student receiving the intervention, the research literature also provides evidence of broader impacts (i.e., spillover effects). King Jr. et al. (2005) found that households reported fewer influenza-like symptoms if a child in the home attended a school that hosted an immunization program. A follow-up study (King Jr. et al., 2006) also found that flu immunization benefitted the entire household if a child in the house attended a SLIV school. Taken together, these findings strongly supporting the hypothesis that immunizing schoolchildren may not only reduce absences, but could also exert indirect positive effects on individuals and households in the communities where those children live.[2]

Evaluation Method

Two hundred and sixty-two schools participated in the 2016 Kick the Flu school-located influenza vaccination program in Central Texas. The program was implemented by Healthy Schools, LLC with medical protocols and administrative support by Schoolhouse Pediatrics. A total of 227 schools (87%) participated in the evaluation, including 179 elementary and 48 middle schools from 10 major urban and suburban school districts in Central Texas. The districts included were Austin ISD, Del Valle ISD, Eanes ISD, Manor ISD, Hays CISD, Lake Travis ISD, Leander ISD, Pflugerville ISD, and Round Rock ISD. The schools included in the evaluation were representative of the range of income levels and ethnicities found across the region.[3]

Healthy Schools provided vaccinations (flu shots) from mid-September to mid-October 2016 to students with a signed parental consent form from. This early fall time period decreased the likelihood that children would have already received a flu shot outside of the school setting, thus increasing the likelihood that parents would avail themselves of the school-located program.

[2] Note, while the 2005 study found an impact on reported flu symptoms, this did not generalize to significantly fewer absences.

[3] School income level was operationalized as the percentage of students receiving free or reduced price lunch.

Importantly, the September/October time period was also before the start of flu season, based on data from the Austin/Travis County DHHS (ATCDHHS) Influenza Surveillance.

School districts provided aggregate daily absence data from the beginning of October 2016 (prior to flu season) through the end of March 2017 (near the end of flu season). Districts also provided enrollment data for this time period; six districts provided daily enrollment, 3 districts provided weekly enrollment, and one district with low student mobility provided monthly enrollment. These data were used to create daily absence rates by school, which were averaged to create weekly absence rates by school. Districts also provided the count of low income students at each school.

At the end of flu season, the Travis County Influenza Surveillance data compiled by Austin/Travis County Department of Health and Human Service (ATCDHHS) were examined to determine the peak weeks of flu season. The data were reported weekly by doctors in the flu reporting network in Travis County.[4] Multiple metrics, including the number of flu tests conducted, the percent positive for flu, and the percentage of doctor visits for influenza-like-illness (ILI), aligned, indicating a flu season that ran from December 12th, 2016 through mid-April, 2017 with a three weak peak period running from January 30th to February 17th, 2017. Absence data for the flu season were provided by participating districts as well as for a pre-flu season baseline (October 3rd to December 2nd, 2016).

The goal of the evaluation was first to assess whether a spike in absences could be detected at the peak of flu season, and second whether that spike could be mitigated for schools with higher vaccination rates, especially those with rates that might confer some level of herd immunity.

[4] Note that though this was only Travis County data and does not include flu reporting for Williamson or Hays counties, E3 Alliance's *Absence Reasons Study* (Wiseman and Dawson, 2015) found a simultaneous peak in absences in noncontiguous districts in Hays and northern Travis counties that aligned with a spike in doctor visits for ILI, suggested that Travis County data could be used regionally

Results and Discussion

Vaccination Rates

Vaccination rate histograms are reported in Figures 1 and 2. Elementary schools had higher rates of vaccination than middle schools. Considering these data in relation to herd immunity, where non-vaccinated students would be at decreased risk of flu because enough of the school population was vaccinated, only 4% of elementary schools (7 schools) were close to the vaccination rate needed for herd immunity, which is approximately 50% (Longini, et al. 2002; Pannaraj, et al., 2014), and only one school exceeded this threshold. No middle school was even close to reaching herd immunity, which meant there was little to no chance of finding an effect on absence rates for middle schools.

Figure 1. Vaccination rates for 179 Elementary Schools participating in School-located Influenza Vaccination Campaign, Central Texas, 2016-17.

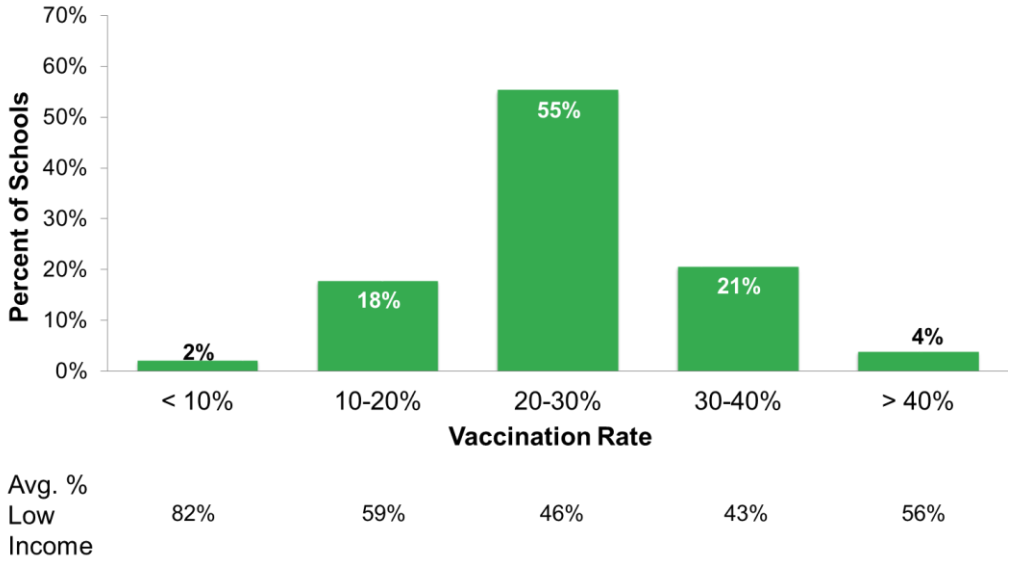
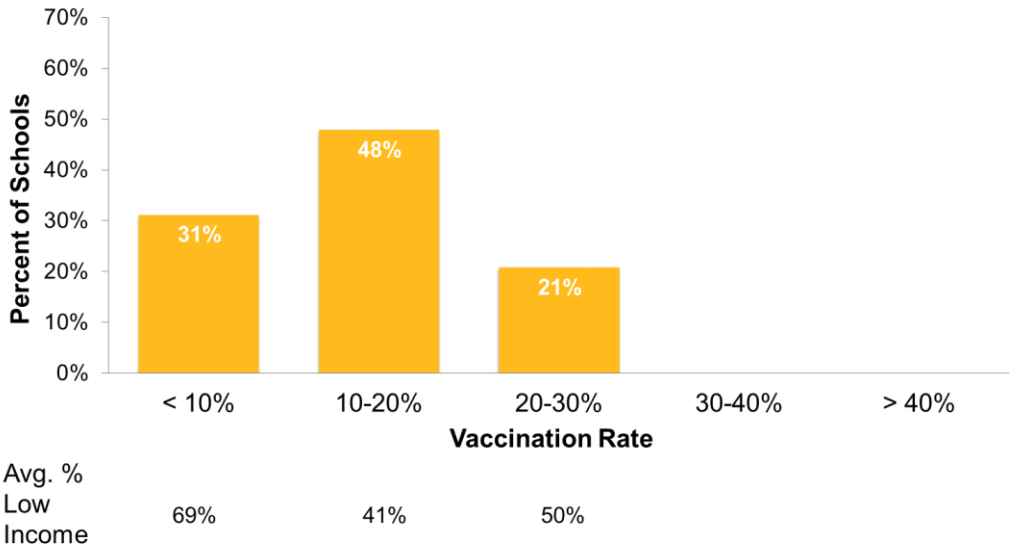


Figure 2. Vaccination rates for 48 Middle Schools participating in School-located Influenza Vaccination Campaign, Central Texas, 2016-17.



Why Absences Vary

To isolate the effects of the flu and vaccine on absences, it was necessary to control for other reasons why absence rates might vary between schools. A key explanatory variable is income status, as schools with significate populations of low income students have higher absence rates than schools with more non-low income students, so the percent of students with free and reduced price lunch at each school was a control variable in all analyses. Likewise, middle schools have more absences per pupil than elementary schools, so school level was included. Another source of that variation is that absences tend to increase across the school year. This was accounted for by factoring in the baseline attendance rate for schools into analyses. Additionally, there is absence variation within weeks of school, with clear increases in absenteeism on Mondays and Fridays. Absence rates were averaged across week for the evaluation to remove this variation and to match the flu surveillance data from ATCDHHS that was by week. Because of holidays, however, all weeks are not the same, especially with 10 separate school district calendars involved. In fact, an analysis of daily absences by district found that on the Friday or Monday before a holiday, there were even larger absence spikes than the typical weekly variation. Thus three additional variables were added to try to control for holiday absence spikes on different weeks by district.

Detecting Flu Peak Absence Spike

The first question was whether a spike in absences could be found during the peak of flu season that was higher than in weeks both prior to and after the peak season. The analysis was conducted both with and without the control variables, and in both cases, a spike in absences was found for the peak weeks of flu season that was higher than both pre and post flu season absences.

Means from the analysis that were adjusted for the control variables can be found in Table 1.

Table 1. Mean Absence Rate

Baseline	Early Flu Season	Peak Flu Season	Post Peak Flu Season
3.1%	3.4%	3.9%	3.6%

Crucially, the weeks after the flu peak showed a slight but statistically significant *decrease* in absences (0.3 percentage points), which is of particular note because overall absences *increase* across the school year. This seemingly small change in absence rate is ***equivalent to nearly 7,000 absences across the study schools during the three peak flu season weeks***.

Detecting Effect of Influenza Vaccine on Absence Rates

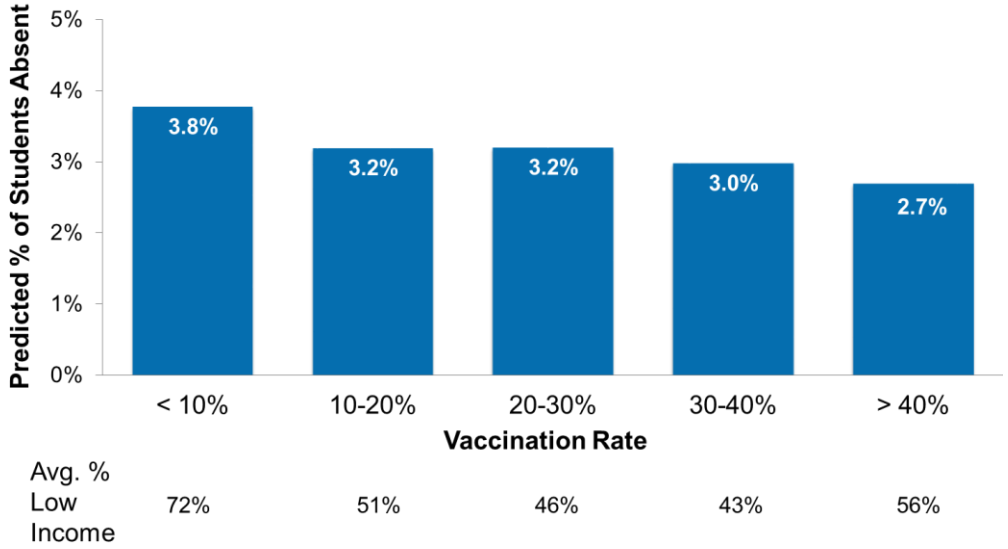
Though absence rates were highest overall during the peak of flu season, the crucial question for the evaluation was whether schools with higher vaccination rates would show reduced absence rates during the peak weeks compared to schools with lower vaccination rates. Of particular interest was the group of seven elementary schools with vaccination rates greater than 40%, which put them in the range of potential herd immunity.

A regression analysis was conducted to predict school absence rates during the flu peak weeks. The analysis included all of the control variables previously described and school vaccination rate broken into the quintiles shown in Figures 1 and 2. After controlling for other influences on the absence rate, there was a very small but statistically significant increase in absence rate as immunization rate increased. Basically, the absence rate got a bit worse. This finding was in the *opposite* direction of what would be expected if there were an effect of vaccination on absences.

We had a hypothesis that our attempt to control for other influences on absence rates, especially those related to holidays and the school districts' varied calendars, had been insufficient. Thus we set out to conduct a second analysis that limited the data only to weeks where school districts did not have a holiday before, during or after that could affect the absence rate. Because each of the 10 school districts calendars were unique, only two of eight baseline weeks did not have holidays issues and could be used. And, none of the flu peak weeks could be used until Leander ISD's 9 schools were removed from the analysis, which then allowed for two of the three peak season weeks to be used.

This regression analysis included all of the control variables as before, with the exception of the three variables that were intended to control for holidays, as these were no longer needed. Again the crucial variable used to predict absence rates was the school's vaccination rate quintile. In this analysis, as vaccination rate increased, absence rate showed a statistically significant decrease (see Figure 3), with over a percentage point decrease in absence rate for schools in the group with the highest vaccination rate compared to schools with little to no school-based vaccination.

Figure 3. Predicted Absence Rates Based on 218 Schools in School-Based Influenza Vaccination Campaign, Central Texas, 2016-17



The decrease in absence rate for the large group of schools in the 30-40% immunization range was a little more than for schools with less than 30% vaccination rate. This small additional decrease was probably due to the approximately third of students who were unlikely to come down with the flu. The largest decrease in absence rate overall and relative to the other vaccination groups occurred for schools in the 40%+ vaccination rate range, as one would expect based on nearly reaching a threshold for herd immunity in this group, such that more than the students who were vaccinated were likely protected. This pattern lends credence to the idea that under these more controlled circumstances (the few weeks without holiday issues), the result could be explained by vaccination rate and not some other factor we did not take into account.

For the schools with vaccination rates ranging between 10 and 56%, there was a ***combined savings of approximately $500,000*** across the three weeks of peak flu activity based on the decrease in absence rate compared to the rate at schools with very little vaccination (less than 10% of students). We were not expecting to find a statistically significant decrease in absence rates for schools in the 10-30% vaccination range, and it is possible that the drop we did see for these schools is partly due to factors that we could not take into account. Thus a more conservative estimate of savings based only on schools with vaccination rates of 30% or higher was $130,000. We consider this the lower bound on the immediate financial benefit of the flu campaign. Note that this figure includes only savings in school reimbursement rates, not savings from other illnesses from family members not in school, avoided lost work by parents, fewer doctor visits, pharmaceutical costs, etc.

We also considered what financial benefit the set of schools in the evaluation could expect if they were able to increase vaccination rates by 10 percentage points each. Using the same methodology as for the $500,000 calculation, the estimated benefit here would be $625,000.

This estimate is conservative, because as schools' vaccination rates go beyond the threshold for herd immunity, the absence rate should decrease even further, yielding greater savings.

We also considered the aspirational case where all schools in the evaluation achieve immunization rates of 40% or higher – the best rate we saw in the current data, yet barely achieving herd immunity. **The minimum estimate for the savings would be $860,000, with the likelihood of much greater savings due to decreased absenteeism from flu school-wide because of herd immunity and ancillary family/community savings.**

When compared to the decrease in absence rate in Graitcer et al. (2012), this was a modest effect, which is to be expected given that schools in their 10th percentile for vaccination rate (38%), were in approximately the 90th percentile for elementary schools in this sample. Furthermore, any ability to detect an effect here is impressive, when considering that only 7 schools achieved a vaccination rate possibly high enough to show herd immunity (Longini, et al. 2002; Pannaraj, et al., 2014). The generalizability of this effect does need to be considered with caution, however, because it is based on so few weeks of absence data. Nonetheless, with higher vaccination rates, a stronger and more generalizable effect on absences would be expected based both on the current finding and the prior research literature.

Recommendations

The recommendation from these results are two-fold. First, based on the low vaccination rates in middle schools, for the school-based immunization campaign in these schools to be effective, methods of obtaining parental consent and other processes would need to be re-evaluated. If these rates do not improve, especially when one considers that it is largely elementary age children who are the primary flu vectors, it may be appropriate to discontinue the immunization effort for middle schools.

In contrast, given the effect found for elementary schools, especially those seven schools with high enough vaccination rates, the immunization campaign provides direct health, attendance and financial benefit to elementary schools and their students. Based on prior studies (Davis et. al., 2008; King Jr. et. al, 2006) there may even be indirect benefits to these students' families that were beyond the scope of this study. The benefits would be enhanced and more widespread with a larger proportion of elementary schools achieving rates over 40% vaccination rates, and ideally schools achieving more than 50%. In 2017 and beyond, if the region could move the center of the distribution in Figure 1 so that it fell in the 40-50% range, then 25% of elementary schools participating in the school-based vaccination program would be expected to benefit from herd immunity, and another 55% may also benefit.

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Appendix – Summary of SLIV Related Outcome Studies

Article	Study Design	Coverage	Findings
Davis, M. M., King, Jr., J. C., Moag, L., Cummings, G., and Magder, L. S. (2008)	County level immunization campaign (Tx group); control consisted of prior years in same county as well as current and prior years in adjacent county (Ct group).	44%	• Decrease in absence for elementary and high school students
Graitcer, S. B., et al. (2012)	Regression analysis of mass immunization at school (elementary, middle, and high) level based on degree of participation	57%	• Decrease in absence related to increase in percentage vaccinated
Grijalva, C. G., Zhu, Y., and Griffin, M. R.	County-wide school-based vaccination campaign	41%, 48%[a]	• Lower relative risk of positive influenza test
Keck, P. C., Ynalvez, M. A., Gonzalez, H. F., and Castillo, K. D. (2013)	Twenty elementary schools within a district; regression analysis at the individual student level based on vaccination status.	13%-42%	• Decrease in absence rate among vaccinated students
King, Jr., J. C., Beckett, D., Snyder, J., Cummings, G. E., King, B. S., and Magder, L. S. (2012)	Regression analysis of mass immunization at county level based on degree of participation	3% to 46%	• Decrease in absence related to increase in percentage vaccinated
King Jr., J. C. et al. (2005)	Students one elementary school participated in vaccine program; comparison students drawn from two similar elementary schools served as the non-vaccination condition	40%	• Lower rate of child and adult medical visits in treatment group households • Lower rate of medication purchases • Lower rate of absence for all children in household • Lower rate of adult paid workdays lost
King, Jr., J. C., Lichenstein, R., Cummings, G. E., and Magder, L. S. (2010)	Regression analysis of mass immunization at county level based on degree of participation	3%-46%	• Decrease in medically attended acute respiratory illnesses among 5-11 and 19-49 age groups; increase among 50+ age group
King Jr, J. C. et al. (2006)	Eleven demographically similar clusters of elementary schools were selected with one school randomly assigned to vaccination program (Tx n=11; Ct n= 17)[b]	47%	• Lower rates of influenza-like symptoms for both adults and children • Lower rates of outpatient and inpatient care • No difference in ED or urgent care • Lower rate of medication use • No between school (Tx vs. Ct) differences in absence. Difference found between treated and untreated

			students within treatment schools. • Lower rate of days missed to care for sick child
Kjos, S. A., Irving, S. A., Meece, J. K., and Belongia, E. A. (2013)	Four elementary schools participated in study (2 received vaccinations; two served as controls).	52%[c]	• Absences in treatment group due to fever/cough lower in 7 of 12 surveillance weeks
Monto, A. S., Davenport, F. M., Napier, J. A., and Francis, Jr., T. (1970)	School-administered community-wide vaccination of students; comparison group was adjacent community	86%	• Decrease in absences • Decrease in flu measured in the community
Mears, C. J., Lawler, E. N., Sanders, L. D., and Katz, B. Z. (2009)	Within school comparison of vaccinated and non-vaccinated students within high school offering vaccination initiative	35%	• Lower rate of absence for students receiving one of two types of vaccine
Pannaraj, P. A., et al. (2014)	Eight elementary schools participated in study (4 received vaccinations; four served as controls).	27%-47%	• PCR test for influenza showed treatment students less likely to acquire influenza • Treatment students missed fewer days of school
Plaspohl, S. S., Dixon, B. T., Streater, J. A., Hausauer, E. T., Newman, C. P., and Vogel, R. L. (2013)	Comparison of pre- and post-program introduction at eight elementary schools	20%, 26%[a]	• Negative difference found in absence rates for pre-post comparison • Comparisons of pre against post-vaccinated and post-unvaccinated yielded positive results for absence • Comparison of vaccinated and unvaccinated students during program years found positive results on absence
Wiggs-Stayner, K. S. (2006)	Students from two elementary schools participated in immunization program; students from two similar schools served as controls.	57%	• Decrease in absence between treatment and control schools