The Impact of Improvements in Hygiene on Child Health: Evidence from Mexico

Jorge M. Agüero[a]
Trinidad Beleche[b]

March 11, 2013

Abstract

Diarrheal diseases are among the top causes of child deaths in developing countries. These diseases can be prevented by the simple act of handwashing. However, the current literature shows that only programs with high monitoring are effective in changing behavior and improving health outcomes. In this paper we exploit the spatial variation in the 2009 H1N1 influenza outbreak and show that areas with higher incidence of the swine flu observed substantial reductions in the number of diarrheal cases using hospital discharge data from Mexico. In particular, we find that for every 1,000 swine flu cases, there was a decrease of 20 percent in the number of hospital discharges and that most of the effects are found on children under six years of age. We validate the robustness of these estimates using cause-specific discharges as well as placebo tests before 2009. We present evidence suggesting that handwashing practices are behind these large effects. Overall, these findings are consistent with the literature of behavioral economics about the role of shocks on changing people risk perceptions.

[a] Department of Economics, University of California-Riverside, Riverside, CA 92521, United States. Tel.: +1 951 827 4108; fax: +1 951 827 5685. E-mail address: jorge.aguero@ucr.edu.

[b] Corresponding author. Food and Drug Administration, 10903 New Hampshire Ave, Building 32, Room 3237, Silver Spring, MD 20993, United States. Tel.: +1 301 796 8959. E-mail address: tbeleche@gmail.com. The findings, interpretations, and conclusions expressed in this paper are those of the authors, and they do not represent the views of the Food and Drug Administration.

Introduction

The World Health Organization (WHO) has estimated that diarrheal and acute respiratory diseases are responsible for two-thirds of child deaths.[1] Additionally, the occurrence of these diseases results in missed school days for children and lost wages for adults.

Handwashing with soap—especially after contact with feces and before handling food— is recommended by experts in order to reduce the incidence of diarrhea and respiratory infections. However, handwashing is not a widely adopted behavior in developing countries (Chase and Do, 2010). The World Bank (2005) reports that handwashing rates after defecation or cleaning up a child is between 0 and 35 percent. This low practice has triggered an increase in the number of studies that seek to change the factors behind handwashing behavior such as knowledge, beliefs and improvements in water access and soap. Ejemot-Nwadiaro et al (2008) review 14 randomized trials and find that handwashing promotion reduces diarrhea in children by 32 percent in developing countries. Included in that review is the article by Luby et al (2005) concluding that in Pakistan, children younger than five years living in households that received plain soap and handwashing promotion had a 50 percent lower incidence of pneumonia than the control households. However, these programs have high monitoring costs to ensure compliance and will be extremely difficult to replicate them at a large scale. For example, the Pakistani intervention required that fieldworkers visited treated households every week for an entire year.

Furthermore, the recent report of a large-scale intervention in Peru shows that a province-level mass media campaign alone was not effective in reaching the targeted population and did not improve the knowledge of mothers regarding handwashing

[1] See World Bank (2005), page 9.

(Galiani et al 2012). A more comprehensive district-level community treatment did improve knowledge. However, despite the gains in knowledge and self-reported practices there were no effects on health outcomes for children. Specifically, the intervention had no impact on diarrhea, anemia or nutrition in general. The combined results from localized and scaled-up interventions are puzzling. Why is it that knowledge alone—without high monitoring to ensure compliance—does not lead to health improvements for children? Our paper represents an attempt to answer this question.

This paper exploits the regional variation in the intensity of the H1N1 influenza (swine flu) epidemic that occurred in Mexico in 2009 and shows that states with higher incidence of the swine flu had a larger decline in the number of diarrheal cases relative to years preceding the outbreak. This main finding is clearly shown in Panel A of Figure 1. There we compare the number of hospital discharges related to diarrhea after the swine flu (2010-2011) with those prior to the epidemic (2007-2008) using data from Mexico's Ministry of Health (*Secretaria de Salud*). For each state, the (log) difference between these two periods is displayed against the number of cases of H1N1 flu in 2009 (in logs). Most of the points are below the zero axes which indicate that there was a decrease in the number of diarrheal cases after the 2009 epidemic.

We use hospital discharge data to construct a balanced panel of state-year observations. Our identification strategy controls for time and state fixed-effects to account for national trends and unobserved time-invariant characteristics at the state level. We further validate our empirical strategy using case-specific discharges. In Panel C of Figure 1 we show that hospital discharges related to injuries are not related with the incidence of the H1N1 flu at the state level. We expand our robustness checks by considering only the pre-swine flu period. Using variation in diarrhea related discharges between 2008 and 2007 we find no association with the 2009 flu cases (Figure 1, Panel B).

Our findings indicate that the incidence of the H1N1 epidemic led to an improvement in the health outcomes of the population with respect to diarrheal cases. We find that the bulk of the effect is concentrated in younger children (aged five or less). These effects are large. Every 1,000 cases of the swine flu reduced hospital discharges by 20 percent. We discuss the mechanisms behind the improvements and present evidence suggesting that handwashing might have a play a key role. These findings are consistent with recent models of behavioral economics where large health shocks alter the risk perceptions of individuals (e.g., Sloan, Smith and Taylor, 2003 and Cawley and Ruhm, 2012).

Mexico and the H1N1 Flu

In March and early April 2009, Mexico experienced an outbreak of respiratory illness which was later confirmed as the novel influenza H1N1 virus, or swine flu. The World Health Organization (WHO) declared this outbreak to be the first pandemic in 41 years. As of February 3, 2010, Mexico's Ministry of Health reported that there were more than 70,000 confirmed cases of swine flu in 2009, including 1,006 deaths (Gonzales-Canudas et al, 2011). Most of the cases in Mexico involved a relatively younger cohort than what is typically affected by the seasonal wave of influenza.

The Mexican government instituted several measures to slow disease transmission, including social distancing and mandatory closure of all schools, daycares, and non-essential businesses throughout the country. There was also an intense mass media campaign advocating the importance of respiratory hygiene/cough etiquette. Specifically, the goal of the campaign was to educate the public about frequent and proper handwashing technique, covering sneeze/cough, using facemasks and hand sanitizers, seeking care if ill, and discouraging self-medication. We will return to the health campain issue later in the discussion section.

Identification Strategy

All states in Mexico were affected by the swine flu outbreak, but there was variation in the frequency of cases across states.[2] Table 1 lists the number of identified cases reported across the states of Mexico in 2009 in descending order. Mexico City had the highest number of cases and the state of Campeche had the lowest. There were three waves of H1N1 outbreaks that occurred during 2009. The causes of the outbreaks are still unknown, although some hypothesize the first wave might have initiated after a large gathering that occurred during Easter in a place near Mexico City. During the first outbreak, states that were in close geographic proximity to Mexico City had a higher incidence of cases than states farther away. The second wave coincided with the summer school vacation period during which many travel to the Southern parts of Mexico. Finally, the fall wave coincided with the going back to school period for more than 30 million students from elementary school to university. Table 2 summarizes the variation across geographic areas for each of the waves that occurred in 2009.

A survey conducted Mexico City and two states where the incidence rate of the swine flu varied from 1.6 per 100,000 inhabitants (Queretaro) to 16.1 per 100,000

[2] The Federal District, or Mexico City, is not a state, but henceforth we refer to it as a state.

inhabitants (San Luis Potosi) at the time of the survey in mid-2009 showed that the top three mitigation efforts adopted to protect against the H1N1 virus included frequently washing of hands with soap, and use of a mask, and hand sanitizer (Aburto et al, 2010). Other studies indicate that mitigation measures such mandatory school closures and other social distancing measures were associated with a 29-37 percent reduction in H1N1 influenza transmission in Mexico (Chowell et al, 2011). According to Aburto et al's survey results, adherence to mitigation efforts was higher in the states with the higher incidence of swine flu. Table 3 shows that, for the surveyed states, high incidence of the swine flu is associated with higher adherence to mitigation efforts.

Data and Methods

Our study uses hospital discharge data from public hospitals in Mexico from 2007 to 2011, excluding the year of the outbreak (2009), as made available by Mexico's Ministry of Health (*Secretaria de Salud*). The data include all hospital discharges for which the initial diagnosis is gastroenteritis and colitis of infectious origin (or diarrhea) as specified by the International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) (code A09X). This code excludes non-infective diarrhea (K52.9) and intestinal infections due to bacterial, protozoal, viral and other specified infectious agents (A00-A08). Moreover, these data include morbidity and mortality cases. The nature of our data implies that we are concentrating on the extreme cases of diarrhea, that is, those leading to hospitalization.

Our study uses the variation in swine flu cases across states to examine effects on health outcomes such as diarreha that can also be prevented with improved hygiene behavior. This is formally presented in equation (1),

$$y_{st} = \alpha + \beta\ H1N1_s{*}Treat_{st} + \tau_t + \theta_s + e_{st} \qquad (1)$$

where y_{it} is the number of hospital discharges whose initial diagnosis was diarrhea (ICD-10 A09X) for state *s* in year *t*. Note that we consider only 2007-2008 and 2010-2011. Variable *H1N1* represents the number of swine flu cases (ICD-10 J09) reported in each of the states during 2009. *Treat* is an indicator equals to one if the hospital discharge occurred in the treatment period (post the 2009 H1N1 outbreak) and zero otherwise. Equation (1) controls for year, γ_t, and state, θ_s, fixed effects. The year fixed effects allow us to control for nationwide trends in diarrheal diseases while the state fixed effects accounts for time-invariant unobserved characteristics during the period of analysis at the state level, including income, population, attitudes towards hand washing and policies. If the outbreak induced changes in hygiene behavior, we would expect to observe a decrease in the incidence of diarrheal diseases of infectious origin that can be prevented by the mere act of handwashing. In other words, we would expect β to be negative and statistically significant.

Results

Table 4 presents the results from running the specification presented in equation (1) under two scenarios. In the first scenario, the treatment period pools 2010 and 2011 and the control period includes 2007 and 2008. In the second scenario the treatment period is only 2010, and the control period is 2008. The coefficient of interest in the first case is -

0.08 and it is statistically significant at the 10 percent level of significance (Table 5 Panel A, column 1). When we explore whether the effects vary by age groups we find that the observed effect is coming from the population under six and not for older ages groups (columns 2-6). Specifically, the coefficient of *H1N1*Treat* is -0.09 and it is statistically significant at the 5 percent level of significance. The effects for the other age groups are negligible and statistically insignificant. Given the average cases of hospitalization for the younger group (445 per year), the estimated effects are large: for every 1,000 cases of the swine flu we observe a 20 percent decline in diarrhea hospitalizations of children under five (=-.09/445*1,000.)

In Panel B of Table 4, we explore a sample that contains only the years immediately before and after the H1N1 outbreak (2008 and 2010). Our results do not change. We find that overall higher cases of swine flu are associated with fewer cases of diarrhea and that the effects are concentrated in the youngest population group.

Robustness Checks

A question that arises is whether we attribute changes to the outcome of interest to the intensity of H1N1 cases, rather than to pre-existing trends. To determine whether we have identified the effects separately from other confounding effects, we conduct the same empirical strategy but using injuries caused by external factors, e.g. accidents, as an outcome measure.[3] Because injuries should not be affected by the flu outbreak, we would expect to find statistically insignificant effects when we estimate equation (1) using injuries as an outcome.

[3] Injuries includes trauma to body, burns, poisoning due to external factors such as falls, traffic accidents, self-inflicted injuries, exposure to inanimate falling, thrown or projected objects, and aggressions.

Panel A of Table 5 reports the estimates of equation (1) where annual injuries caused by external factors is the dependent variable. Using the sample where the treatment period includes 2010 and 2011 and all age groups are pooled into one specification, the coefficient of interest is positive and marginally statistically significant (colunm 1). Although the coefficient of interest is significant at the 10 percent level, we note that the sign is positive, which goes against the negative effect that we found in the main specifications discussed above. Moreover, when we examine the specification separately by age groups we do not find any statistically significant evidence of trends affecting the population under 6 years of age, which is where we found the effects (column 2-6). When we narrow the sample to include only the year before and after the outbreak, none of the coefficients is statistically significant.

We conduct another falsification test by examining the impact of the intensity of the H1N1 outbreak on the period preceding 2009. If the intensity of the cases in 2009 only affected behavior post-2009 we should not find any effects or evidence of a decrease in diarrheal diseases if we run the same specification assuming that the control and the treatment occur in 2007 and 2008, respectively. The results of this specification are shown in Panel B of Table 5. The coefficient of interest for all age groups and for each of the age groups is close to zero and it is not statistically significant.

Conclusion and Discussion

Besides preventing respiratory diseases, diarrheal diseases can also be prevented by following good respiratory hygiene. Our results show robust evidence that the H1N1 outbreak led to a improvement in health outcomes. These health outcomes are related to extreme cases of diarrhea (those leading to hospitalizations) suggesting that the swine flu epidemic changed hygiene patterns. As part of the mitigation strategy Mexico implemented a media campaign aimed at educating the Mexican public about proper respiratory hygiene. Some evidence indicated the public interest in hand sanitizers remained high and that adherence to mitigation strategies was positively associated with incidence of the swine flu.

We present evidence that Mexicans became more aware of the need to have better hygiene practices. Panel A of Figure 2 shows the trend of public interest for hand sanitizers throughout 2009 as measured by the number of Google searches for the word "gel" as hand sanitizer is known in Mexico. We observe that interest in hand sanitizers remained relatively unchanged until around week 15 (early April) and it peaked at around week 19. Interest went down after week 20, but the post-outbreak trend remained at a level that was higher than the level prior to the outbreak.

In Panel B of Figure 2 we show the trends of Google searches for hand sanitizers for the years 2007, 2008, 2010 and 2011. We show that prior to 2009, the interest in hand-sanitizers was consistently around the same for 2007 and 2008—showing only spikes that appear to be seasonal. Even though the trends for 2010 and 2011 follow a pattern of seasonality similar to those of 2007 and 2008, the magnitude of the interest increased significantly and remained high throughout the post-2009 period.

The robust facts that the swine flu outbreak led to better health outcomes combined with the suggestive evidence that it also affected health practice is consistent with current findings in other health aspects. For example, Sloan, Smith and Taylor

(2003) show that adult smokers are more likely to stop smoking if they suffer from a health shock such as a heart attack compared to smokers who did not experience a negative shock and despite the facts that both groups had similar knowledge of the dangers of smoking. The evidence in this paper suggests that the changes in the perception of risk is not continous as suggested but recent literature in behavioral economics (Smith et al, 2001).

References

Aburto, N.J., E. Pevzner, R. Lopez-Ridaura, R. Rojas, H. Lopez-Gatell, E. Lazcano, et al. (2010) "Knowledge and Adoption of Community Mitigation Efforts in Mexico During the 2009 H1N1 Pandemic," *American Journal of Preventive Medicine,* Vol. 39, No. 5: 395-402. (doi: 10.1016/j.amepre.2010.07.011)

Cawley, J. and C. J. Ruhm. "The Economics of Risky Health Behaviors." Chapter 3 in: Thomas G. McGuire, Mark V. Pauly, and Pedro Pita Barros (editors), *Handbook of Health Economics*, Volume 2. (Elsevier: New York). pp. 95-199. 2012.

Chase, C. and Q.T. Do. Scaling Up Handwashing Behavior: Findings from the Impact Evaluation Baseline Survey in Vietnam. World Bank's Water and Sanitation Program. Technical Paper 58007, November 2010.

Chowell, G., S. Echevariia-Zuno, S., C. Viboud, L. Simonsen, J. Tamerius, M. A. Miller, and V. H. Borja-Aburto (2011) "Characterizing the Epidemiology of the 2009 Influenza A/H1N1 Pandemic in Mexico," *PLoS Med,* Vol. 8, No. 5: e10000436. doi:10.1371/journal.pmed.1000436. (www.plosmedicine.org)

Ejemot-Nwadiaro, R.I., J.E. Ehiri, M.M. Meremikwu, and J.A. Critchley (2008) "Hand washing for preventing diarrhoea". *Cochrane Database of Systematic Reviews*, Issue 1. Art. No.: CD004265.

Galiani, S., P. Gertler, and A. Orsola-Vidal (2012) "Promoting handwashing behavior in Peru : the effect of large-scale mass-media and community level interventions," Policy Research Working Paper Series 6257, The World Bank.

Gonzales-Canudas J., J.M. Iglesias, Y. Romero-Antonio, C., Chavez-Cortes, et al (2011). "Costo-efectividad en la deteccion de influenza H1N1: datos clinicos versus pruebas rapidas, " *Revista Panamericana de Salud Publica*, Vol. 29, No. 5: 1-8.

Luby, S.P., M. Agboatwalla, D. R. Feikin, et al. (2005) "Effect of Handwashing on Child Health: A Randomised Controlled Trial," *Lancet*, Vol. 366: 225-233.

Orsola-Vidal, A., and A. Yusuf. Scaling Up Handwashing Behavior: Findings from the Impact Evaluation Baseline Survey in Senegal. World Bank Water and Sanitation Program, Technical Paper, June 2011. (http://www.wsp.org/wsp/sites/wsp.org/files/publications/WSP-Senegal-Baseline-HWWS.pdf?)

Perez, E., H. H. Pyne, C. Amelink et al. Progress Report: Peru, Senegal, Tanzania, and Vietnam. World Bank Water and Sanitation Program. July 1-December 31, 2009. (http://water.worldbank.org/publications/progress-report-peru-senegal-tanzania-and-vietnam)

Sloan, F.A., V. K. Smith, and D. H. Taylor, Jr. (2003) *The Smoking Puzzle: Information, Risk Perception, and Choice*. Harvard University Press.

Smith, F., V. Kerry, D. H. Taylor and F. A. Sloan; F. Reed Johnson and William H. Desvousges (2001) “Do Smokers Respond To Health Shocks?,” *The Review of Economics and Statistics*, 83(4): 675-687, November.

The World Bank. 2005.The Handwashing Handbook. A Guide for Developing a Hygiene Promotion Program to Increase Handwashing with Soap. Washington D.C. (http://siteresources.worldbank.org/INTWSS/Publications/20389151/HandwashingHandbook.pdf)

Figure 1. Changes in Hospitalizations for Children under Five Years of Age

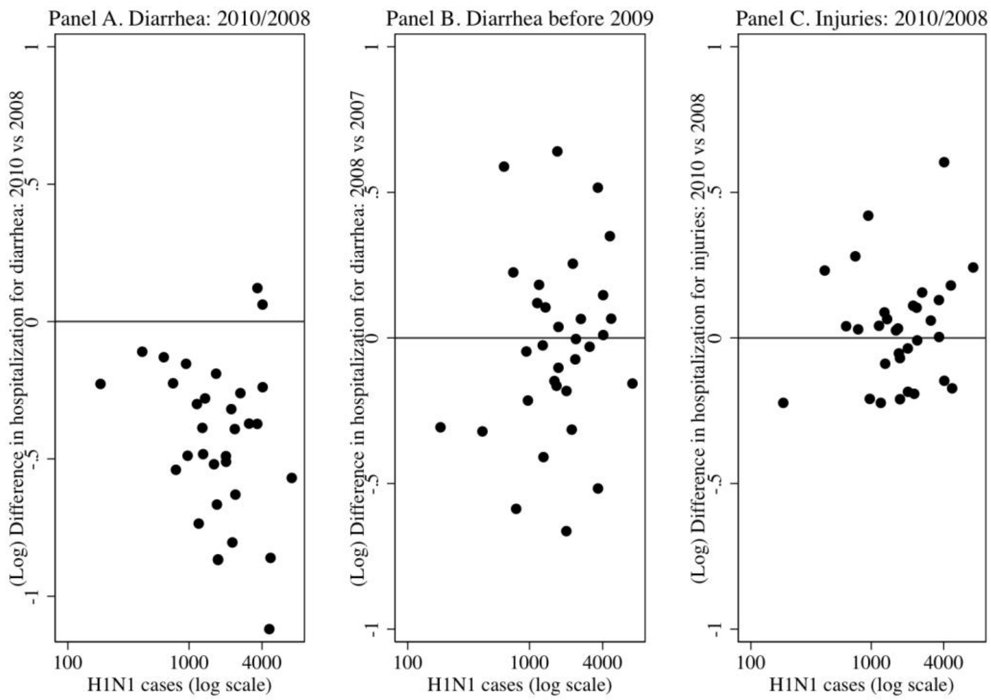
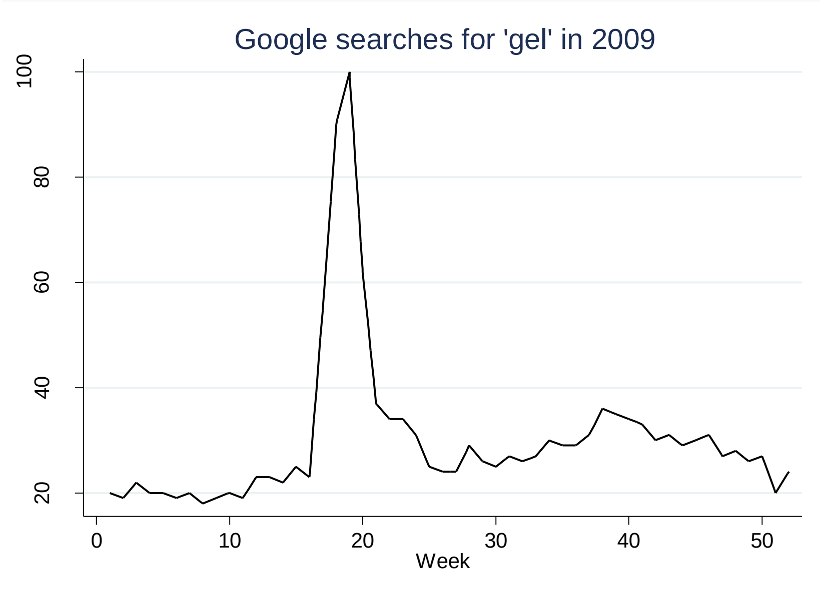


Figure 2. Google Searches for Hand Sanitizer Information

Panel A. Google Searches for “gel” in 2009



Pane B. Google Searches for “gel” pre- and post-2009.

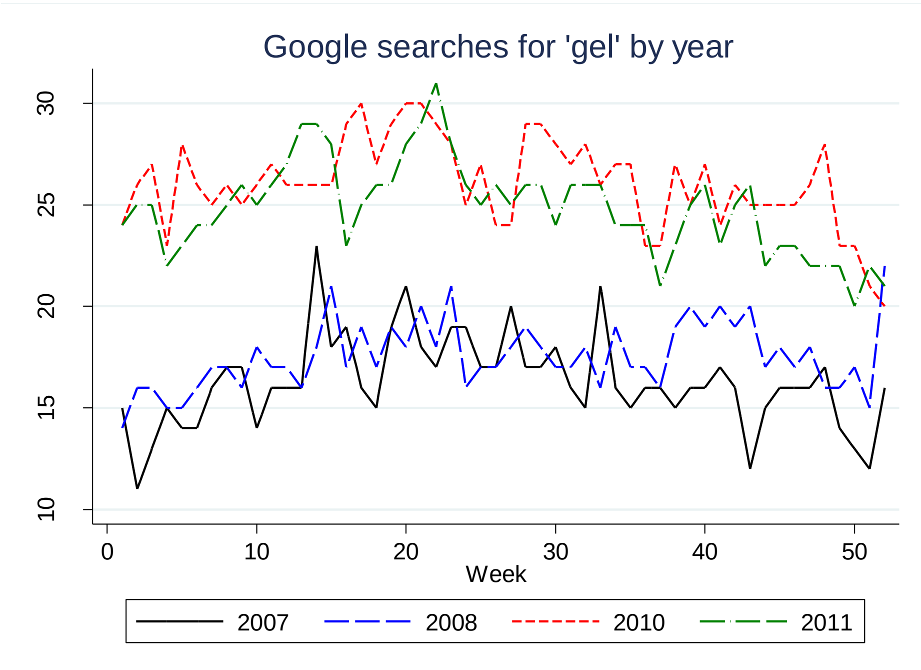


Table 1. Number of H1N1 Cases in Mexico, 2009

State	Total	State	Total	State	Total
Mexico City	7,032	Tamaulipas	2,276	Tabasco	1,306
Mexico	4,701	Hidalgo	2,230	Guanajuato	1,288
San Luis Potosi	4,589	Queretaro	2,019	Colima	1,201
Jalisco	4,047	Guerrero	2,014	Chihuahua	1,161
Nuevo Leon	4,037	Baja California	1,734	Zacatecas	973
Chiapas	3,662	Puebla	1,733	Baja California Sur	945
Yucatan	3,653	Aguascalientes	1,698	Morelos	779
Michoacan	3,128	Nayarit	1,671	Quintana Roo	738
Sonora	2,650	Tlaxcala	1,606	Sinaloa	619
Veracruz	2,412	Durango	1,356	Coahuila	411
Oaxaca	2,385	Tamaulipas	2,276	Campeche	186

Source: Secretaria de Salud.

Table 2. Variation in Areas Affected by H1N1 Outbreak in Mexico, 2009

Wave	States Most Affected	Region(s)
Spring	Mexico City, Jalisco, Mexico state, Puebla, San Luis Potosi, Guerrero, Hidalgo and Tlaxcala	Central
Summer	Veracruz, Yucatan, Quintana Roo, Chiapas, Oaxaca, Tabasco, and Campeche	Southeast
Fall	Baja California, Sonora, Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas	Central and Northern

Source: Chowell et al 2011.

Table 3. Reported Mitigation Efforts Adopted to Protect Against H1N1 in Mexico

Mitigation Activity	Mexico City (n=837)	San Luis Potosi (n=951)	Queretaro (n=878)
Frequently washing hands with soap/water	89.3	81.1	76.1
Using a mask	63.4	64.7	50.0
Using hand sanitizer/gel	30.1	30.3	16.0
Covering cough/sneeze with tissue or elbow	21.5	14.1	24.0
Avoiding crowds/public gatherings	19.5	29.5	14.8
Ventilating the home	19.9	17.3	18.6
Avoiding shaking hands/kissing when greeting	11.7	16.1	11.9
Avoiding close contact with symptomatic people	10.4	11.4	8.6
Incidence of H1N1 at time of survey (per 100,000 inhabitants)	14.1	16.1	1.6

Note: Number of observations represents the number of households surveyed.
Source: Adapted from Table 2 in Aburto et al (2010).

Table 4. Impact of H1N1 Incidence on Diarrheal Diseases

	Ages					
Treatment Period	All	0-5	6-14	15-21	22-44	45+
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Sample Includes 2007-2008 and 2010-2011						
H1N1*Treat	-0.080*	-0.088**	0.003	0.002	0.002	0.002
	(0.039)	(0.035)	(0.005)	(0.002)	(0.004)	(0.004)
Panel B: Sample Includes 2008 and 2010 Only						
H1N1*Treat	-0.078*	-0.081**	0.001	0.001	0.001	0.000
	(0.039)	(0.032)	(0.005)	(0.002)	(0.003)	(0.004)

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. Standard errors are clustered at the state level. Outcome variable is number of hospital discharges where the initial diagnosis was diarrhea. Each cell represents a separate regression. For the period 2007-2011, the indicator variable is equal to one when the discharge occurred in 2010 or 2011, and it is zero if it occurred in either 2007 or 2008. For the period 2008-2010, the indicator variable treat is equal to one if the discharge occurred in 2010 and zero if the discharge occurred in 2008. All regressions include time and state fixed effects.

Table 5. Robustness Checks

	Ages					
Treatment Period	All	0-5	6-14	15-21	22-44	45+
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Outcome is Annual Injuries Caused by External Factors						
2007-2011	0.549*	0.050	0.055	0.069*	0.181*	0.195*
	(0.30)	(0.03)	(0.04)	(0.04)	(0.09)	(0.11)
2008-2010	0.450	0.045	0.043	0.062	0.136	0.163
	(0.33)	(0.04)	(0.05)	(0.05)	(0.10)	(0.11)
Panel B. Outcome is Annual Diarrheal Diseases pre-2009						
2007-2008	-0.003	-0.008	0.003	0.000	-0.003	-0.008
	(0.03)	(0.02)	(0.00)	(0.00)	(0.03)	(0.02)

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses. Standard errors are clustered at the state level. Outcome variable is number of hospital discharges where the initial diagnosis was an injury due to external factors such as falls or accidents. Each cell represents a separate regression. For the period 2007-2011, the indicator variable is equal to one when the discharge occurred in 2010 or 2011, and it is zero if it occurred in either 2007 or 2008. For the period 2008-2010, the indicator variable treat is equal to one if the discharge occurred in 2010 and zero if the discharge occurred in 2008. All regressions include time and state fixed effects.