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Influenza vaccination coverage among US-Mexico land border crossers: 2009 H1N1 pandemic and 2011–2012 influenza season

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Abstract

Background: The high volume of US-Mexico land border crossings can facilitate international dissemination of influenza viruses.

Methods: We surveyed adult pedestrians crossing into the United States at two international land ports of entry to assess vaccination coverage during the 2009H1N1 influenza pandemic and 2011–2012 influenza season.

Results: Of 559 participants in 2010, 23.4% reported receipt of the 2009H1N1 vaccine. Of 1423 participants in 2012, 33.7% received the 2011–2012 influenza vaccine. Both years, those crossing the border 8 times per month had lower vaccination coverage than those crossing less frequently. US-border residents had lower H1N1 coverage than those in other locations. Vaccination coverage was higher for persons age ≥65 years and, in 2010 only, those with less than high school education. Although most participants believed it is important to get vaccinated, only half believed the influenza vaccine was safe and effective. The main reasons for not receiving the influenza vaccine were beliefs of low risk of disease, time constraints, and concerns about vaccine safety (in 2010) or efficacy (in 2012).

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Author contributions

SW and AR conceived and designed the study. AR and CD analyzed and interpreted the data. AR drafted the manuscript. All authors critically revised the manuscript for important intellectual content. SW supervised the study.

Conflict of interest declaration

The authors state that they have no conflicts of interest to declare.

Conclusions: International land border crossers are a large and unique category of travelers that require targeted binational strategies for influenza vaccination and education.

Keywords

Influenza A virus; H1N1 subtype; Vaccination; US-Mexico border; Border crossers

1. Introduction

In 2016, 237 million individuals crossed into the United States from Mexico and Canada through official land border ports of entry (POEs), more than double the total number of international arrivals by air [1]. The 2000-mile US-Mexico land border is considered the world's busiest international boundary, with 185 million northbound crossings through the 26 POEs in 2016 [2]. The majority of crossings are by Mexican and US residents of the border region traveling regularly to shop, work, or visit family and friends in sister cities across the border [3]. Other entrants include tourists and individuals traveling from Mexico or other countries to live, work, or seek asylum in the United States [3,4]. The majority of crossings are via private vehicles, followed by pedestrians and, least commonly, by commercial buses and trains [2]. In addition to authorized border crossers, an estimated 170,000 entrants crossed by land into the United States in 2016 without authorization through areas other than official POEs [5].

The bidirectional flow across the US-Mexico border brings economic, social, and cultural benefits to the border region and beyond [3]. However, similarly to air travelers, this international movement can facilitate infectious disease dissemination between countries of origin, transit, and destination [3]. In addition, frequent border crossers may have close social ties in both countries that may increase the risk of cross-border exposure and transmission of communicable diseases, such as influenza [6].

Influenza is the most frequent vaccine-preventable disease reported among international travelers [7] and creates substantial morbidity and mortality through yearly seasonal outbreaks [8]. Novel strains of influenza virus can also cause pandemics, such as the 2009 influenza A (H1N1) pandemic which, although first detected in a California Southern border town, originated in Mexico, and then rapidly spread worldwide, infecting over 200 million people [8,9]. Vaccination is the first line of defense against influenza illness and transmission [8]. Land border crossers are a population for which the United States and Mexico have common interest in ensuring appropriate vaccination levels. Yet published information on vaccine uptake in that population is limited. We assessed influenza vaccination coverage and attitudes among pedestrian border crossers at US-Mexico land POEs during the 2009H1N1 influenza pandemic and 2011–2012 influenza season.

2. Methods

2.1. Study population and sampling design

We conducted two in-person surveys of adult (18 years and older) pedestrians crossing from Mexico into the United States at the two busiest land POEs: 1) 2010 survey (March 23–27

and April 27–May 10) at San Ysidro (California) and Paso del Norte (Texas) POEs; and 2) 2012 survey (April 10–23) at San Ysidro POE only. The study protocols were approved by the Texas Department of State Health Services, County of San Diego Health and Human Services Agency, and US Customs and Border Protection officials. Both surveys received a non-research exemption by the US Centers for Disease Control and Prevention.

Systematic random sampling was used to select participants while they waited in line to be cleared by US immigration authorities. After an initial “starting person” was randomly selected, the interviewer approached each fifth or tenth person in line to confirm age eligibility and obtain verbal informed consent. This process allowed interviewers to adjust to fluctuations in the length and speed of the pedestrian line and avoid interrupting the processing of individuals by immigration authorities. Interviewers were trained bilingual public health workers in 2010, and bilingual private survey company staff in 2012. The interviews took about 6 min and were conducted in the participant’s preferred language (English or Spanish). Recruitment took place at varying times of the day and days of the week to capture variations in border crossing flows and characteristics of border crossers. The sample size was based on an estimated vaccination coverage of 30%, desired precision of $\pm 4\%$, and a 95% confidence level, with a goal of a minimum of 505 participants each year.

2.2. Data collection tool

In both years, we used a structured survey instrument, which included questions on demographics, residence, border crossing frequency, and primary sources of influenza prevention information. The 2012 survey had six additional questions on attitudes about seasonal influenza and vaccination. Influenza vaccination status was assessed by asking: “Have you received a vaccine for H1N1 or swine flu?” (2010 survey) or “Did you happen to get a flu shot sometime between August 2011 and today?” (2012 survey). No personally identifiable information was collected from respondents. Border region residence (United States or Mexico) was defined as living within 62.5 miles north or south of the international boundary line [10]. Bilingual staff translated the survey to Spanish. Before use, the questionnaires were pilot-tested with members of the target community.

2.3. Data handling and analysis

Data were entered into a database and analyzed using SAS 9.2 (SAS Institute, Cary, NC, USA). Chi-square statistical tests were used to assess differences in vaccination coverage between the 2010 and 2012 surveys. Extended Mantel-Haenszel chi-square test for linear trend was used to assess significant trends in vaccination coverage for ordinal variables (i.e., age, education, and border crossing frequency). A p value of < 0.05 was considered statistically significant.

3. Results

3.1. Participants

Of 877 pedestrian border crossers approached in 2010, 559 (63.7%) completed the survey (282 in Texas and 277 in California); and of 2875 approached in California in 2012, 1423

(49.5%) completed the survey. Both years most interviews were completed in Spanish, and the majority of participants reported living in the border region, primarily on the Mexican side, and crossing the border four or more times a month (Table 1). Compared with 2010, a significantly higher percentage of participants in 2012 were 18–37 years old (54.3% vs. 38.3%, $p < 0.001$), male (49.4% vs. 41.1%, $p < 0.05$), and completed at least high school education (70.0% vs. 42.5%, $p < 0.001$).

3.2. Influenza vaccination coverage

In 2010, 23.4% of participants reported having received the H1N1 vaccine (Table 2). Of those, 72.7% were vaccinated in Mexico and 27.3% in the United States. In 2012, 33.7% of participants reported having received the seasonal influenza vaccine, a significantly higher ($p < 0.001$) percentage than the H1N1 vaccination rate in 2010. Location of vaccination was not collected in the 2012 survey. In 2010, vaccination coverage significantly increased among participants as frequency of border crossings decreased ($p < 0.05$). Participants living in the US border region had significantly lower H1N1 vaccination coverage than those residing on the Mexican side or in non-border locations (18.2% vs. 32.5% vs. 33.7%, respectively; $p < 0.05$). In 2012, participants crossing more than 8 times had significantly lower vaccination coverage than those crossing 4–7 times per month ($p < 0.05$), and lower (but not significantly) than those crossing less frequently.

Both years, vaccination coverage significantly increased with age of participants ($p < 0.05$). In 2010, higher levels of education completed were significantly associated with lower vaccination coverage ($p < 0.05$), while no significant differences were identified in 2012. The most frequently reported primary reason for not having received the influenza vaccine varied by survey year. In 2010, “time constraints” was the most frequent reason (17.5%) for not being vaccinated against H1N1, followed by believing themselves “not to be at risk for influenza illness” (15.0%), concerns about vaccine safety (9.8%), and not being in the recommended group for vaccination (7.5%). In 2012, the most frequently reported reasons for not having received the seasonal influenza vaccine were believing themselves “not to be at risk for influenza illness” (26.8%), concerns about vaccine efficacy (12.5%), “time constraints” (4.1%), and cost or not having health insurance (3.3%).

3.3. Sources of information on influenza prevention

Both years, the majority of participants reported mass media, mainly television and radio from Mexico, as their primary source of influenza prevention information (Table 3). In 2012, compared to 2010, a significantly ($p < 0.001$) higher percentage of participants received influenza information from a doctor (59.5% vs. 14.7%), or from a friend or family member (40.5% vs. 4.8%), or saw influenza health messages at a POE (23.0% vs. 5.7%). Also, a higher percentage of participants reported not having seen or heard any influenza prevention messages in 2012 than in 2010 (35.6% vs. 4.4%).

3.4. Attitudes about seasonal influenza disease and vaccination

In 2012 the majority of participants agreed that seasonal influenza disease is “dangerous” (66.9%) and that they (70.6%) or others (81.3%) were likely to catch the disease. Most also agreed that it is important to prevent catching (89.7%) and spreading (91.9%) the disease

and to get the seasonal influenza vaccine (80.9%). At the same time, fewer participants agreed with the statements that the influenza vaccine is safe (50.4%) and prevents catching (43.4%) or spreading the influenza virus (50.4%).

4. Discussion

We have shown evidence of influenza vaccination coverage gaps among adults crossing the US-Mexico land border. Both the 2009H1N1 and 2011–2012 influenza season had vaccination coverages well below the Healthy People 2020 targets at the time of the surveys (80% for persons aged 18–64 years and 90% for those aged ≥ 65 years) [11]. The H1N1 vaccination coverage among border crossers (23.4%) was not significantly different from rates reported for non-Hispanic white adults in the United States (23.5%, $p > 0.05$) [12] and for the general population in Mexico (24.8%, $p < 0.05$) in 2010 [13]. On the other hand, although higher than the H1N1 vaccination rate, the 2011–2012 influenza vaccination coverage for border crossers (33.7%) was significantly lower than that for adult non-Hispanic whites (41.9%, $p < 0.05$), but higher than coverage for Hispanics (29.4%, $p < 0.05$) in the United States [14]. The finding that for both years vaccination coverages were lower for the most frequent crossers is of concern because they represented the largest category of participants and may have larger cross-border social networks.

In both years the most frequently reported reasons for not receiving the influenza vaccine were beliefs of low risk of disease, time constraints, and concerns about the vaccine safety (in 2010) or efficacy (in 2012). Low perception of susceptibility to influenza infection and negative beliefs about the vaccine's efficacy and safety have been previously reported, among other factors, as significantly associated with lower receipt of the vaccine [15]. In 2012, a majority of respondents agreed with the importance of vaccination to prevent getting and spreading influenza. However, only half or fewer participants believed that the influenza vaccine was effective or safe, a smaller percentage than US adults reporting the belief that the influenza vaccine is effective (86.6%) or safe (89.3%) [16]. Also, over one-third of participants in 2012 reported not having seen or heard any information about seasonal influenza prevention.

These findings need to be interpreted keeping in mind the different periods and contexts in which the two surveys took place: a) during the last months of an influenza pandemic, and b) at the end of an influenza season that was short and mild compared to previous seasons. During the H1N1 pandemic, the United States and Mexico launched extraordinary media campaigns and other public health interventions to limit the spread of illness [9,17]. However, both countries experienced H1N1 vaccine shortages, which were greater in Mexico, and different distribution strategies [18]. There were also delays in availability of the H1N1 vaccine (October 2009 for the United States and for December 2009 for Mexico), with the vaccine being available for the general public when the pandemic was well underway [13,16,18]. At the beginning of the pandemic, both countries prioritized similar high-risk groups for vaccination, such as pregnant women, infants, the elderly, health care personnel, and individuals with chronic diseases. However, during the last months of the pandemic, the United States encouraged all residents to get vaccinated, while Mexico maintained its priority groups [9,13,19]. In Mexico, the H1N1 vaccine was available for free,

mainly at federal government vaccination centers; while in the United States, vaccine distribution varied by state and private providers may have collected payments from insured patients [18]. Also, for seasonal influenza vaccination, Mexico's recommendations include only prioritized risk groups [19], while in the United States, starting in 2010, vaccination is recommended for all individuals more than 6 months old [14]. Our finding of higher H1N1 vaccination coverage among Mexican border region residents compared to those in the US border region, was unexpected, and might have been due to differences between both countries in their immunization program strategies and access to vaccinations at the local level, and that Mexicans reportedly tended to consider the H1N1 pandemic influenza a more serious health threat than US residents did [18].

4.1. Strengths and limitations

The strengths of this assessment included a systematic random sampling of border crossers, and data collection by experienced bilingual interviewers, which offered the best chance of providing valid findings. The assessment has several limitations. First, lack of information on those who refused to participate may have biased our findings if those who chose not to participate were systematically different from participants. All information was self-reported and thus subject to recall and social desirability bias. Although the surveys were anonymous, we do not know whether conducting interviews in an immigration building may have influenced participation or responses. The setting allowed for only short questionnaires, and thus information on additional factors that may affect vaccination coverage, was not collected. Particularly, differences in access to health care and vaccination cost between Mexico and the United States, at the national and local levels, may have affected this study findings and should be further explored. Differences in the characteristics of crossers between 2010 and 2012 and between POEs may have affected the comparability of results. The surveys' findings may not be generalizable to individuals crossing at other land POEs, using other transportation modes, or crossing without authorization. In a survey of Mexican and other Latin American immigrants planning to cross by land into the United States from Tijuana, Mexico, with or without authorization, for work or change of residence, 19% reported having received the influenza vaccine in 2013 [20].

4.2. Potential interventions

The land POEs offer efficient locations to implement and evaluate public health interventions targeting border crossers, including vaccinations. Stronger collaboration between US and Mexican federal and local agencies could enhance land border crossers' access to vaccination and health education. Differences between the countries in influenza vaccination recommendations and accessibility would need to be considered. Influenza prevention messages can be provided before or after crossing the border and at transportation hubs in border towns, for example through large posters and electronic boards, or by bilingual health educators or community health workers (or promotoras) [20–22]. This can be complemented by expanded influenza communication campaigns, in Spanish and English, across the border region, using primarily television and radio, plus other channels, such as social media, and health care providers.

Public health interventions might be more effective if tailored to land border crossers' unique characteristics, which differentiate them from international air travelers arriving in the United States. These differences include: a) different patterns of travel, such as higher frequency, shorter duration, and shorter distance traveled; b) primary purposes for travel being most frequently shopping or working (versus tourism or recreation for international air travelers); c) closer binational ties, including social networks and frequent exposure to media messages in both sides of the border [23–25].

5. Conclusions

Influenza vaccination is an important preventive strategy for travelers in general, whether they are crossing nearby borders or visiting other continents [26]. Most international travelers arrive to the United States by land, rather than by air or sea [1]. International land border crossers are a large and unique category of travelers with high relevance to US-Mexico and global health, because they can connect remote areas of the world with disparate infectious disease burdens [3]. Findings from this assessment suggest the need for further implementation and evaluation of targeted public health interventions to address the influenza vaccination and information gaps found in this population. Additional assessments could provide a better understanding of mobility patterns, health status, access to health information, and health-related practices of border crossers along the US-Mexico border. Given the transnational nature of border crossers, both countries would benefit from enhanced binational collaboration to more effectively protect the health of this population and that of communities on both sides of the border. These findings are relevant to other land border areas of the world, as demonstrated by the 2014–2015 Ebola outbreak in West Africa, when disease spread regionally mostly via ground movement of sick persons across porous international land borders [27].

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Table 1

Sociodemographic characteristics of pedestrians crossing international land ports of entry at the US-Mexico border, 2010 and 2012.

	2010 survey, N in sample (%)	2012 survey, N in sample (%)
Total	559 (100%)	1423 (100%)
Language of interview		
Spanish	505 (90.3)	1316 (92.5)
English	54 (9.7)	107 (7.5)
Sex*		
Female	329 (58.9)	720 (50.6)
Male	230 (41.1)	703 (49.4)
Age*		
18–39 years	214 (38.3)	773 (54.3)
40–64 years	298 (53.1)	588 (41.3)
65+ years	47 (8.4)	62 (4.4)
Education completed*		
Less than high school	320 (57.4)	426 (29.9)
High school	113 (20.3)	501 (35.2)
Some college	74 (13.3)	192 (13.5)
College degree or more	50 (8.9)	304 (21.3)
Residence*		
US border region ^a	141 (25.2)	258 (18.1)
Mexican border region ^a	295 (52.8)	1003 (70.5)
Other	123 (22.0)	162 (11.4)
Border crossing frequency per month		
8 or more times	231 (41.3)	615 (44.5)
4–7 times	108 (19.3)	260 (18.8)
1–3 times	130 (23.3)	304 (21.9)
Less than 1 time	87 (15.6)	204 (14.8)

* $p < 0.05$ by chi-square test for comparisons between 2010 and 2012.

^a Border region defined as within 62.5 miles north (United States) or south (Mexico) of the international boundary.

Table 2

2009H1N1 pandemic influenza and 2011–2012 seasonal influenza vaccination coverage among pedestrians crossing international land ports of entry at the US-Mexico border, 2010 and 2012*.

	2009 H1N1 influenza vaccination coverage, 2010		2011–2012 seasonal influenza vaccination coverage, 2012	
	N in sample	Vaccination coverage % (95% CI)	N in sample	Vaccination coverage % (95% CI)
Total*	559	23.4 (20.1–27.1)	1423	33.7 (31.2–36.1)
Language of interview				
Spanish	505	29.9 (25.5–34.4) (ref.)	1316	33.7 (31.2–36.3) (ref.)
English	54	22.7 (10.3–35.2)	107	32.7 (23.8–41.6)
Sex*				
Male	230	23.4 (17.1–29.7) (ref.)	720	32.2 (28.7–35.6) (ref.)
Female	329	32.7 (27.1–38.3)	703	35.1 (31.6–38.6)
Age*				
18–39 years	214	22.3 (16.4–28.3) (ref.)	773	30.4 (27.1–33.6) (ref.)
40–64 years	298	31.9 (25.8–37.9) ^a	588	36.4 (32.5–40.3)
65+ years	47	50.0 (33.1–66.9) ^a	62	48.4 (35.9–60.8)
Education completed*				
Less than high school	320	34.0 (28.1–39.9) (ref.)	426	39.7 (35.0–44.3) (ref.)
High school	113	31.5 (21.8–41.1) ^a	501	29.5 (25.5–33.5)
Some college	74	19.4 (9.9–28.9) ^a	192	30.7 (24.2–37.3)
College degree or more	50	13.0 (3.3–22.8) ^a	304	33.9 (28.6–39.2)
Residence*				
US border region ^b	141	18.2 (10.9–25.4) (ref.)	258	37.9 (32.1–43.9) (ref.)
Mexican border region ^b	295	32.5 (26.5–38.4) ^a	1003	32.2 (29.1–35.1)
Other	123	33.7 (24.3–43.1) ^a	162	35.8 (28.4–43.2)
Border crossing frequency per month				
8 or more times	231	21.4 (15.5–27.3) (ref.)	615	28.6 (25.0–32.0) (ref.)
4–7 times	108	28.9 (19.1–38.7) ^a	260	39.6 (33.7–45.6) ^a
1–3 times	130	35.9 (26.6–45.2) ^a	304	34.9 (29.5–40.2)
Less than 1 time	87	39.2 (28.0–50.4) ^a	204	38.7 (32.0–45.4)

* $p < 0.05$ by chi-square test for comparisons between 2010 and 2012 for each covariate.

^a $p < 0.05$ by chi-square test for comparisons for categories in each variable with the reference group (ref.).

^b Border region defined as within 62.5 miles north (United States) or south (Mexico) of the international boundary.

Table 3

Sources of influenza prevention information among pedestrians crossing international land ports of entry at the US-Mexico border, 2010 and 2012^a.

Source ^b	2010 survey, All respondents (N = 559) N (%)	2012 survey, All respondents (N = 1423) N (%)
Mass media (television, radio, printed)	476 (85.1)	916 (64.4)
Friends or family	27 (4.8)	576 (40.5)
Health care provider	82 (14.7)	847 (59.5)
Port of entry	32 (5.7)	255 (23.0)
None	24 (4.4)	507 (35.6)

^aSurvey respondents could select more than one source of influenza prevention information.

^bp < 0.05 by chi-square test for comparisons between 2010 and 2012.