

FACTORS ASSOCIATED WITH HPV VACCINE ADHERENCE AMONG LATINO/A ADOLESCENTS IN A RURAL, TEXAS-MEXICO BORDER COUNTY

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Objective: Completion of human papillomavirus (HPV) vaccine series among Texas Hispanic adolescents is low compared to national data. We examined the association between HPV vaccine initiation and completion among Hispanic adolescents in a rural, Texas-Mexico border county and specific individual and neighborhood-level characteristics.

Design: Cross-sectional analysis of data from a broader cancer prevention program.

Setting: Underserved *colonias* communities in a Texas-Mexico border county.

Participants: Hispanic mothers or caregivers (n=712) and adolescents aged 11-17 years (n=1120) linked to publicly available data about their neighborhood.

Methods: Logit and multi-level mixed-effects logistic regression of individual- and neighborhood-level data.

Main Outcome Measures: HPV vaccine adherence (ie, initiation and completion) as reported in either the Texas Immunization Registry or adolescents' electronic medical records, measured at the end of the cancer prevention program.

Results: Factors associated with HPV vaccine initiation and completion were female gender (P<.01), adolescent insurance status (P<.001), and receipt of required vaccines (P<.001). After controlling for neighborhood-level characteristics, only receipt of required vaccines remained significant (P<.001).

Conclusions: Findings indicate a relationship between Hispanic adolescents' receiving the required vaccine series for school admission and HPV vaccine initiation and completion. In resource-limited settings like

INTRODUCTION

There are geographical disparities in human papillomavirus (HPV) vaccination rates¹ and cervical cancer,² as exemplified among residents of South Texas. For example, the Texas age-adjusted cervical cancer mortality rate for 2013-2017 was 3.4 per 100,000 Hispanic women compared to 2.9 per 100,000 White women.³ In Hidalgo, a border county, the disparity in the age-adjusted cervical cancer mortality rate among Hispanics was 4.3 per 100,000 compared to 1.7 per 100,000 among non-Hispanic White women from 1990-2018.³ Adolescent HPV vaccination is an effective, evidenced-based strategy to reduce HPV-associated cancer incidence.^{4,5} Given its proven effectiveness, the Advisory Committee on Immunization Practices (ACIP)

has endorsed vaccination for male and female adolescents (aged 11-17 years).^{4,5} Despite these recommendations and extensive availability of the vaccine, uptake is suboptimal.⁶

HPV vaccine adherence is defined as receiving all HPV vaccine doses according to ACIP dosing guidelines and most research on adherence has focused on individual (eg, parental) factors.⁷⁻¹⁰ Hispanic parents are the main decision makers with regard to their adolescent receiving the HPV vaccine, and are more likely to report willingness to vaccinate if they: have higher knowledge levels, believe the vaccine prevents cancer and is safe, and perceive few barriers to accessing the vaccine.¹¹⁻¹⁵ Despite evidence that Hispanic parents are more accepting of the HPV vaccine than non-Hispanic parents,¹⁶ vaccination rates in Texas are lower than most states, ranking

federally qualified health centers, further efforts should focus on implementing best practices at both the provider level (eg, education on bundled vaccine recommendation) and practice-level (eg, outreach and support by trained immunization navigators). *Ethn Dis.* 2022;32(4):275-284; doi:10.18865/ed.32.4.275

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31st nationwide.⁶ Completion rates of the HPV vaccine series among Texas Hispanic adolescents (45%) is lower than the national completion rate (54%).¹⁷ However, for required vaccinations Texas Hispanic adolescents had high completion rates that are similar to national data, highlighting differences between required and recommended vaccinations.¹⁷ Also of note, the percentage of HPV vaccine series completion among Hispanic

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adolescents is below the *Healthy People 2030* target¹⁸ (80%) and the Texas Cancer Plan target (45%-60%) for adolescents aged 13-17 years.¹⁹

Prior research focused on geographic or neighborhood-level factors influencing HPV vaccination has shown mixed results.^{1,20-25} Henry et al²⁰ reported that girls living in high poverty and predominantly Hispanic or mixed-race communities were more likely to initiate the vaccine series. These researchers²³ also

found that HPV vaccine initiation and completion among boys living in urban, low income, majority Hispanic areas was higher than HPV vaccination rates among boys residing in rural, affluent, non-Hispanic White or non-Hispanic Black communities. Tsui and colleagues²¹ reported higher initiation rates among girls from more impoverished neighborhoods in Los Angeles County, but the finding was not significant after controlling for individual level factors. Using national survey data, Pruitt et al¹ examined individual, county, and state-level indicators of HPV vaccination and reported no ethnic/racial disparities in HPV vaccination. They reported girls living in high poverty states were less likely to be vaccinated, but girls living in poor counties were more likely to be vaccinated. In their examination of the association with vaccine initiation, neighborhood income, and race/ethnic composition, Chao et al²² found higher frequencies of vaccine initiation among girls from higher-income neighborhoods compared to girls from low-income neighborhoods. Furthermore, Hispanic girls aged 9-12 years were more likely to receive the vaccine, whereas young Hispanic women aged 18-26 years were less likely to receive it.²² Mansfield et al²⁴ reported the odds of HPV vaccination were higher among adolescents who lived in low-deprivation areas compared to higher ranked areas. Similarly, Kurani et al²⁵ found, in a study conducted in the Midwest of the United States, that those living in areas of highest deprivation were less likely to initiate or complete the HPV vaccine series.

Given the disparities in both cer-

vical cancer incidence and mortality and HPV vaccination, and current gaps in the literature related to individual- and neighborhood-level factors and rural Hispanic adolescents, the aim of this study was to examine HPV vaccine initiation and completion among Hispanic adolescents in a rural, Texas-Mexico border county. We hypothesized that HPV vaccine adherence would be associated with both individual and neighborhood level factors. Ecological systems theory provided the theoretical framework for the research, which posits that behavior is affected by interactions across sociodemographic factors (individual-level), health care providers (interpersonal-level), and neighborhood factors (community-level).²⁶

METHODS

Data sources for this secondary analysis included individual-level data from participants of the *Entre Familia*²⁷ program conducted from 2015-2018. This cancer prevention education and navigation program, led by community health workers (CHWs), focused on Hispanic mothers or female caregivers, (hereafter referred to as caregivers). The program aimed to increase HPV vaccine initiation and completion rates among Hispanic adolescents. The lead author (DMC) of this article led the evaluation of the program, which used a single group, pre-posttest design. Researchers from UT Health San Antonio partnered with the Texas A&M University Colonias program and a local federally qualified health center (FQHC) to offer the *Entre Familia* (EF) program

to Hidalgo County residents in community and clinic settings. Caregivers who identified as Hispanic, had an unvaccinated or partially vaccinated adolescents aged 11–17 years, and resided in Hidalgo County were eligible for the program. Given the primary program goal was to improve both HPV vaccination initiation and completion rates, unvaccinated and partially vaccinated adolescents were eligible to enroll. CHWs recruited adult caregivers at community events, community resources centers, and clinics. Between February 2015 and June 2016, two trained CHWs screened and enrolled eligible participants and their unvaccinated or partially vaccinated adolescents aged 11–17 years into the program. During enrollment, caregivers provided their address and adolescents' names, which allowed for geocoding.

The research roles of the CHWs included: administering the baseline survey; providing brief HPV vaccine education accompanied by a brochure; offering navigation support;

administering a follow-up survey and providing a local clinic resource handout that included hours of operation. At a minimum, all caregivers received brief education using brochure and a clinic resource sheet. Caregivers who accepted CHW navigation support received a referral to the FQHC for HPV vaccinations and reminder calls for each remaining dose. All surveys, education, and handouts were offered in Spanish or English, although most caregivers requested the Spanish version. Details of the educational content, referrals, and navigation support are available elsewhere.²⁸

Vaccine Adherence Data

Trained program staff recorded the dates adolescents received the following vaccines from either the Texas Immunization Registry (ImmTrac) or electronic medical record (EMR): HPV, Tdap (tetanus, diphtheria, and acellular pertussis) and MenACWY (Meningococcal) vaccines. The state of Texas requires Tdap and MenAC-

WY vaccinations for adolescents to enroll in school.^{29,30} The UT Health San Antonio Institutional Review Board (IRB) deemed the study exempt (category 2). Based on this exemption, UT Health San Antonio IRB waived informed consent for all participants. All procedures were in accordance with the ethical standards of the institutional review boards and with the Helsinki Declaration of 1975, as revised in 2000.

Neighborhood-Level Data

We geocoded participants' addresses to their respective census tracts using ESRI ArcMap to obtain neighborhood-level characteristics. We gathered neighborhood-level characteristics from census-tract level data from the US Census Bureau's 2011-2015 American Community Survey (ACS).³¹ Census-tract level neighborhood data provide sensitive measures of neighborhood health disparities and are easily linkable to other datasets that also provide inequality measurements at the census tract level.³²

Table 1. HPV vaccine uptake descriptive statistics, N = 890

Level	Variable	Study Group			Hidalgo County
		Boys	Girls	Both	
Individual	% Initiated vaccine	49.0	51.2	50.0	
	% Completed vaccine	7.0	8.2	7.5	
	% Gender	54.8	45.2	100	
	Child's age (M)	13.7	13.8	13.8	
	% Has insurance	58.8	56.0	57.5	70.3
	% Received Tdap	68.0	64.2	66.3	
	% Received MCV4	69.5	66.0	67.9	
	% Received HPV education	87.9	86.8	87.4	
	Parent's age (M)	38.7	38.7	38.7	
	Parent % foreign born			90.2	27.3
Neighborhood	% Minority (M)	--	--	95.1	95% CI [94.8- 95.4]
	% Unemployed (M)	--	--	10.6	95% CI [10.4- 10.8]
	% Poverty (M)	--	--	40.9	95% CI [40.2- 41.7]
	% Personal vehicle (M)	--	--	79.0	95% CI [78.6- 79.4]
					93.8

Individual-Level Data

EF participants predominantly resided in rural colonias, neighborhoods that lack essential public services such as water, electricity, trash service, and safe paved roads.³³ The current study used data from caregivers (n=712) and adolescents (n=1120) enrolled in the EF program to examine the relationship vaccine adherence (initiation and completion) has with individual- and neighborhood-level factors using logit and multi-level mixed-effects logistic regression. Table 1 describes the study group, composed of more boys (54.8%) than girls (45.2%) and an average age of 13.8 years. At the end of the program, half (50%) of adolescents initiated the HPV vaccine and 7.5% completed the vaccine series. Caregivers in our sample were majority foreign-born (90.2%), and slightly more than half (57.5%) had health insurance.

Measures

Measures included individual-level characteristics of caregivers and adolescents (provided by each caregiver), and neighborhood level factors associated with the residential location (Table 2). We computed HPV vaccine initiation and HPV vaccine completion (two dependent HPV vaccine status variables) using the adolescent's HPV vaccination dates from the Texas ImmTrac or EMR. We coded HPV Vaccine Initiation (0/1), the code one indicates the adolescent received the first dose of the HPV vaccine. We coded HPV Vaccine Completion (0/1); code one indicates the adolescent completed the HPV vaccine series, including three doses. At the

time of this study, the HPV vaccination guidelines recommended a three-dose schedule for females aged 11-26 years and males aged 11-21.³⁴

Other measures included the adolescent's age and sex, insurance status, mandatory vaccine uptake, and the parent's age. Both the adolescent's age and parent's age are continuous, calculated from their recorded date of birth to the date of study enrollment. Adolescent insurance status (0/1) measured whether the adolescent had health insurance. Mandatory vaccine uptake (0/1) indicated whether the adolescent received both required vaccinations (Tdap and MenACWY) after they turned 11 years old. We also controlled for HPV education group. This variable, HPV education group (0/1), indicated whether the adolescent's caregiver *only* received brief education with a brochure about the HPV vaccine (0) or received the brief education and brochure *plus* navigation support (1). We included several neighborhood factors based on previously defined measures related to neighborhood influence on HPV vaccination at the census tract level. These included percent minority, percent unemployed, percent in poverty, and percent who own a functional personal vehicle.

Statistical Analysis

We conducted initial descriptive statistics to compare the study sample's mean statistics with the Hidalgo County population. We then examined the relationship between the individual-level factors and HPV vaccine initiation and completion using logit regression. Given the binary na-

ture of the dependent variables, the more frequently used OLS regression would have been inappropriate in these circumstances. For ease of interpretation, we transformed the logit coefficients into odds ratios and furthered the single-level analysis by computing the predicted probabilities for each model. We examined the relationship between the individual-level and neighborhood-level characteristics by performing a multilevel regression analysis. Since the dependent variable and several independent variables are binary, we employed a multilevel fixed-effects logistic regression. As in the single-level analysis, we transformed the coefficients to odds ratios in STATA 15.1 and performed neighborhood analysis using ArcGIS 10.6.1.

RESULTS

Sample Neighborhood Characteristics Compared to Hidalgo County

Table 1 shows neighborhood factors of the study sample compared to Hidalgo County. An average of 19.17 participants (range: 1–100) were clustered within each Hidalgo County census tract (ie, 82 unique neighborhoods for the 890 individual participants). Study participants' neighborhoods were 95.1% minority compared to Hidalgo County (93.8%), meaning predominantly Hispanic. In contrast to the entire county population, study participants' neighborhoods had a lower percent that owned a functional personal vehicle (79.0% vs 93.2%) and higher percent of poverty (40.9% vs 29.5%).

Table 2. Logit regression examining HPV vaccine uptake with selected individual-level characteristics

	Initiation			Completion		
	Boys	Girls	Both	Boys	Girls	Both
Child's age	.962	.864 ^a	.918 ^a	.874	.759 ^a	.817 ^b
Child's insurance status	1.562 ^a	.819	1.168	1.967	1.847	1.846 ^a
Mandatory vaccine uptake	5.586 ^c	7.513 ^c	6.279 ^c	4.805 ^b	6.432 ^c	5.435 ^c
HPV education	1.099	1.056	1.075	5.344	.996	1.909
Parent's age	.992	.994	.993	1.005	.988	.998
Constant	.526	3.196	1.196	.016	.938	.141

Odds ratios reported
a. P<.05; b. P<.01; c. P<.001

Regression Analysis

The analyses began with the single-level logit regression analysis. Subsequently, we examined the relationship between HPV vaccine uptake and individual characteristics by sex, and then on the sample as a whole. The adolescent's age was significantly associated with HPV vaccine initiation (Table 2). As adolescents aged, they were less likely to initiate the HPV vaccine (OR=.92, P<.05), and female adolescents had a lower odds ratio (OR=.86, P<.05). For males, the adolescent's insurance status was positively associ-

ated with HPV vaccine initiation (OR=1.562, P<.05), whereas for females the association was positive but not statistically significant. Receiving both mandatory vaccines, (ie, Tdap and MenACWY) was the strongest, positive, and statistically significant relationship (Table 2). For both males (OR=5.586, P<.001) and females (OR=7.513, P<.001), receipt of mandatory vaccinations increased the likelihood of initiating the HPV vaccine.

The relationships between HPV vaccine completion and individual-level variables were similar to HPV

vaccine initiation. The adolescent's age was statistically significant and negatively associated with HPV vaccine completion (OR=.817, P<.01), with female adolescents having a lower odds ratio (OR=.76, p<.05). Adolescent's insurance status was statistically significant and positively associated with HPV completion (OR=1.85, P<.05) and there were no differences found by gender. Having received mandatory vaccines was the strongest, positive, and most significant relationship with HPV vaccine completion (OR=5.44, P<.001).

Table 3. Multi-level fixed effect logit regression examining HPV vaccine uptake

		Initiation			Completion		
		Boys	Girls	Both	Boys	Girls	Both
Individual factors	Child's age	.959	.854 ^a	.912 ^a	.868	.750 ^a	.820 ^a
	Child's insurance status	1.700 ^a	.832	1.222	1.953	1.787	1.913 ^a
	Mandatory vaccine uptake	6.104 ^b	8.252 ^c	6.769 ^c	4.727 ^b	6.472 ^c	5.386 ^c
	HPV education	1.251	1.003	1.113	5.630	.982	1.953
	Parent's age	.996	.994	.996	1.004	.994	.998
Neighborhood factors	% Minority	.983	.994	.990	1.031	.961	.998
	% Unemployed	1.026	.974	1.004	.921	1.008	.966
	% in poverty	1.013	.994	1.005	1.019	1.010	1.013
	% Personal transportation	1.050 ^a	.983	1.024	1.049	1.048	1.046
	ICC	.048	.061	.057	.000	.006	.000

Odds ratios reported
a. P<.05; b. P<.01; c. P<.001

Multilevel Fixed Effects Logit Regression

The multilevel fixed effects logit regression analyses confirmed the relationships found in the single-level logit regression (Table 3). The only neighborhood-level variable to reach significance was the percentage of households with access to personal transportation, which occurred in the HPV initiation model for male adolescents. Although significant, the relationship was weak, and the intraclass correlation coefficient was very low. Across all fixed effect logit regression models, we found that HPV initiation and completion to be either not correlated, or only slightly correlated, within each neighborhood, meaning that the neighborhood effects compose between 0% and 6% of the total residual variance.

DISCUSSION

These findings indicated that neighborhood-level factors, at the census tract level, were not associated with the HPV vaccine initiation and completion after accounting for individual level factors. Although Tsui et al²¹ reported similar findings that HPV vaccine initiation was not significantly associated with neighborhood factors, our findings are not consistent with those reported by others.^{1,20,22-25} The lack of a significant association between HPV vaccine initiation or completion and neighborhood factors may be related to the situations of study sample caregivers and adolescents and their neighborhoods. Study participants resided in areas that had more/higher

negative characteristics compared to the general population of Hidalgo County. For adolescents, neighborhood context may play a lesser role than other factors such as caregivers' beliefs about vaccine safety and effectiveness and their provider's endorsement of the HPV vaccine. Also, the neighborhoods represented in sample were relatively homogenous, and thus there was little variability across neighborhood-level factors. Had the study sample been more varied the neighborhood-level results may have indicated greater differences.

Another finding was that adolescents who received mandatory vaccinations for school entry were five times more likely to initiate and complete the HPV vaccine series, which is contrary to other previously published research. For example, Chao et al²² reported the receipt of other adolescent vaccines with the HPV vaccine were non-significant using clinical billing data of 9- to 18-year-olds, predominantly White girls. One of our previous studies, a qualitative examination of South Texas providers in South Texas serving Hispanic adolescent patients,³⁵ provides some context for these findings. We found that required vaccines for school entry facilitated providers' recommendation for and adolescent receipt of the HPV vaccine in their practices. Butterfield et al³⁶ also showed that a strong HPV vaccine recommendation from a provider to parents increased the rate of vaccine acceptance, which could be what occurred in our study group. Szilagui et al³⁷ reported less than a quarter of their sample of US parents did not believe the HPV vaccine was beneficial for

their adolescent, protected against HPV-related cancers, or was effective; thus, it may be our sample believed in the benefits of the vaccine.

The significant association between adolescent age and vaccine initiation, with older adolescents being less likely to initiate the HPV vaccine, is also important to note. Furthermore, in our study sample, female adolescents were less likely to initiate and complete the HPV vaccine as age increased. This finding contradicts prior indications of higher vaccine initiation rates among older adolescents.³⁸ Differences in the samples between Kessel et al³⁸ and this study may account for the discrepancy. Given the ACIP recommendation to vaccinate adolescents at the age of 11 or 12 years, before the onset of sexual activity, this finding may be indicative that our sample is complying and not delaying vaccination. As we have reported previously,³⁵ providers describe some parents as deferring HPV vaccination for a child until he/she is old enough to make the decision personally. Delayed vaccination is problematic because it could result in adolescents not receiving the full benefits of protection from HPV and associated cancers. Additional efforts are needed to understand barriers for initiation and completion among older adolescents, especially females.

Insurance status was also associated with HPV vaccine initiation (specifically for boys) and completion for adolescents, overall. Mixed results from a systematic review³⁸ indicated either no association or a positive association between HPV vaccine initiation and having health insurance, and a positive association

between vaccine completion and having health insurance. Among a sample of low-income, urban girls, Tsui et al²¹ also found positive relationship between HPV vaccine initiation and having public health insurance. Access to health insurance coverage not only increases the likelihood of adolescents receiving required vaccines but also recommended vaccines like

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HPV, particularly when receiving services from FQHCs that typically provide preventative care to this population.²¹ The difference we found between HPV vaccine initiation and its association with insurance status among boys may be explained by gender biases in Hispanic culture, with broader acceptance of early sexual maturity and sexual initiation among boys, in contrast to similar behaviors considered to be taboo among girls.³⁹

Prior research has shown parents are more willing to vaccinate their sons compared to their daughters with the HPV vaccine.^{40,41} Public health efforts train providers to emphasize the HPV vaccine as cancer prevention to parents and to vaccinate early at 11 or 12 years old before the adolescent engages in any activity that may put them at risk.⁴²

Given the low vaccination rates among Hispanic adolescents, a strength of this study is the specific focus on rural, low-income Hispanics living along the Texas/Mexico border who experience cancer disparities. Thus, this research directly addresses a prior gap in the HPV vaccine literature. We collected data from low-income, rural Hispanics and identified an association between HPV vaccine uptake and mandatory vaccine uptake. Recognized limitations to the research include the limited variability in the study sample, operationalization of insurance status as yes or no, and the lack of data on provider recommendation or parents HPV vaccination beliefs. Given that female caregivers voluntarily enrolled into the program, the findings may not apply to less motivated caregivers or those with mistrust of vaccinations. The study sample (individual and neighborhood level) was fairly homogenous and may differ from a more diverse group of participants. Insurance status was operationalized as a yes or no question and was self-reported, a less reliable measure than inquiring if insurance was private or public or using billing data.³⁸ We also did not inquire if female caregivers had received a provider recommendation for the HPV vaccination or probe their

personal beliefs about the vaccine.

These findings indicate that bundling required vaccines with HPV vaccine among rural, Hispanic adolescents is potentially an effective strategy to increase the likelihood of initiation and completion of the HPV vaccine series. However, low HPV vaccination rates persist across the state of Texas. There is existing evidence that providers giving parents an HPV vaccine recommendation increases initiation and completion rates,^{9,10} future research is needed to explore what other factors are contributing to these low rates in our study sample. Given some study participants were recruited through our FQHC partner and FQHCs provide vaccination services to populations with disparities, future studies should also focus on factors influencing implementation of HPV vaccine interventions in these resource-limited settings.^{43,44}

IMPLICATIONS FOR GLOBAL POPULATIONS

These results can inform the development and implementation of HPV vaccination interventions designed to increase uptake in global settings. The findings show several factors that increased rates of HPV vaccine initiation and completion: Hispanic adolescents receiving mandatory vaccinations for school admission; adolescents being of younger age; and adolescents having insurance coverage. This research clearly supports the importance of policy level initiatives related to having vaccination requirements that may also be beneficial for increasing timely uptake globally. We

can assume that adolescents with insurance (private or public) were able to cover the costs of well-child visits and vaccines. However, there are underinsured or uninsured adolescents who would not be able to cover these costs in the United States if not for the Vaccines for Children's Program.⁴⁵ Through this program, the US government uses federal funds to cover vaccine costs. To ensure vaccination coverage globally, governments would need to consider how to cover costs for their populations. In addition, the difference we found between HPV vaccine initiation and its association with insurance status among boys also suggests potential for biases related to cultural gender roles. There clearly is a need for further examination of cultural influences and gender norms on HPV vaccination among girls and for global efforts, to understand gender role beliefs and if and how these play a role in HPV vaccine uptake. Efforts directed at understanding the local community context of those who are the focus of global vaccination programs and including them in the planning and implementation process, will likely increase the success and sustainability of these programs.

CONCLUSIONS

This study fills a gap in the literature by examining the association between neighborhood characteristics and HPV vaccine initiation and completion among Hispanic adolescents living in a rural, US/Mexico border county. The findings indicated the positive impact of receipt of the required HPV vaccine

series for school admission among residents of an impoverished, homogenous neighborhood on the US/Mexico border. Further efforts should focus on provider- and practice-level changes in resource-limited settings like FQHCs that provide vaccination services to Hispanic adolescents.

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CONFLICT OF INTEREST

No conflicts of interest to report.

AUTHOR CONTRIBUTIONS

Research concept and design: Morales-Campos, Flores, Parra-Medina; Acquisition of data: Morales-Campos, Parra-Medina; Data analysis and interpretation: McDaniel, Amaro; Manuscript draft: Morales-Campos, McDaniel, Flores, Parra-Medina; Statistical expertise: Amaro; Acquisition of funding: Morales-Campos, Parra-Medina; Administrative: Morales-Campos, McDaniel, Flores, Parra-Medina; Supervision: Morales-Campos, Parra-Medina

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