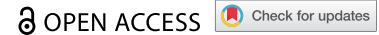


SHORT REPORT



Effect of Hurricane Maria on HPV, Tdap, and meningococcal conjugate vaccination rates in Puerto Rico, 2015–2019

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ABSTRACT

In September 2017, Hurricane Maria devastated the Caribbean region, among them the US territory of Puerto Rico (PR). Vaccination distribution and uptake suffered from the impact. This study evaluated the trends in monthly vaccination initiation rates for human papilloma virus (HPV), Tdap and meningococcal conjugate (MenACWY) adolescent vaccines from 2015 to 2019, during which it was possible to observe and analyze the impact of Hurricane Maria on vaccine initiation. Monthly initiation rates were estimated. Age-standardized initiation rate ratio (SRR) and 95% CI were estimated. The analysis included 85,340 adolescents; 52.3% were male, and 47.7% were females. September 2017 showed HPV vaccine initiation had the lower rates of all the studied vaccines, with a rate of 75% after the disaster (from a rate of almost 90% in July 2017). Tdap and MenACWY vaccines rates remained above 90% in the same period. The SRR of HPV vaccine for September and October 2017 showed an estimated reduction of 5% and 8% in vaccine initiation rates, respectively for each month, when 2016 was the reference year ($p > .05$). The SRR of Tdap and MenACWY vaccines for November 2017 showed significant reductions when 2015 and 2016 were reference years ($p < .05$). HPV vaccine initiation rate was the most severely affected by the Hurricane Maria. Post-natural disaster protocols should strengthen existing programs for facilitate immunization access.

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Introduction

In September 2017, Hurricane Maria devastated the Caribbean region, among them the US territory of Puerto Rico (PR), with an estimated 2,975 excess deaths after six months of the disaster.¹ Scientific efforts have documented the impact of Hurricane Maria on mental health,² interruption and delay of treatment in vulnerable populations (such as cancer patients), challenges encountered in healthcare access and treatment during the disaster.³ Other studies have reflected on the lessons learned concerning the preparedness,⁴ emergency, and response protocols at different levels of the healthcare delivery system,⁵ all this with the expectation of implementing better emergency response practices in the face of future catastrophes.

Vaccination delivery distribution and uptake undoubtedly suffered from the impact of Hurricane Maria. A report from the National Center for Immunization and Respiratory Diseases⁶ acknowledged the significant disruption of immunization services and vaccine losses due to widespread infrastructure and electrical grid damage and resulting cold chain failures. An estimated 5% of the clinics were fully operational ten days after the disaster.⁶ In October 2017, staff from the Centers for Disease Control and Prevention (CDC) and the Puerto Rico Department of Health worked together to make an average of 10 visits per week to these clinics. These visits were to identify what the clinic needed to be operational and whether it could receive vaccine

shipment. The restoration took months, given the airport's working capacity, limited telecommunication, need for generators, adequate storage, and a dilated power restoration. In May 2017, 86% of the clinics were operational.⁶ Besides documenting the impact that this disaster had on the program, it is also important to document the reduction in immunization rates and the time until restatement of those rates at a population level. The disruption to the uptake of human papilloma virus (HPV), Tdap and meningococcal conjugate (MenACWY) vaccines was explored in this study. The HPV vaccine is an important adolescent's vaccines to monitor. In the last decade, the HPV vaccine has led to an outstanding partnership among academic, clinical, and community-based organizations,⁷ intending to promote vaccine uptake due to the disparate burden of cervical and other HPV-related cancers in the island.⁸ Since 2006, the Advisory Committee on Immunization Practices (ACIP) recommended as part of the routine vaccination for girls aged 11–12 years, later in 2009 included in guidelines the use of this vaccine in males.⁹ The Tdap and MenACWY vaccines also have the same age-range recommended to initiate vaccine series according ACIP.^{10,11} Also, these three vaccines are required for the school entry in Puerto Rico.¹² Therefore, since HPV vaccine uptake has been observed to be below the uptake of other recommended vaccines for adolescents,¹³ we also aim to evaluate monthly Tdap and meningococcal conjugate (MenACWY) vaccine. Using data from the PR Immunization

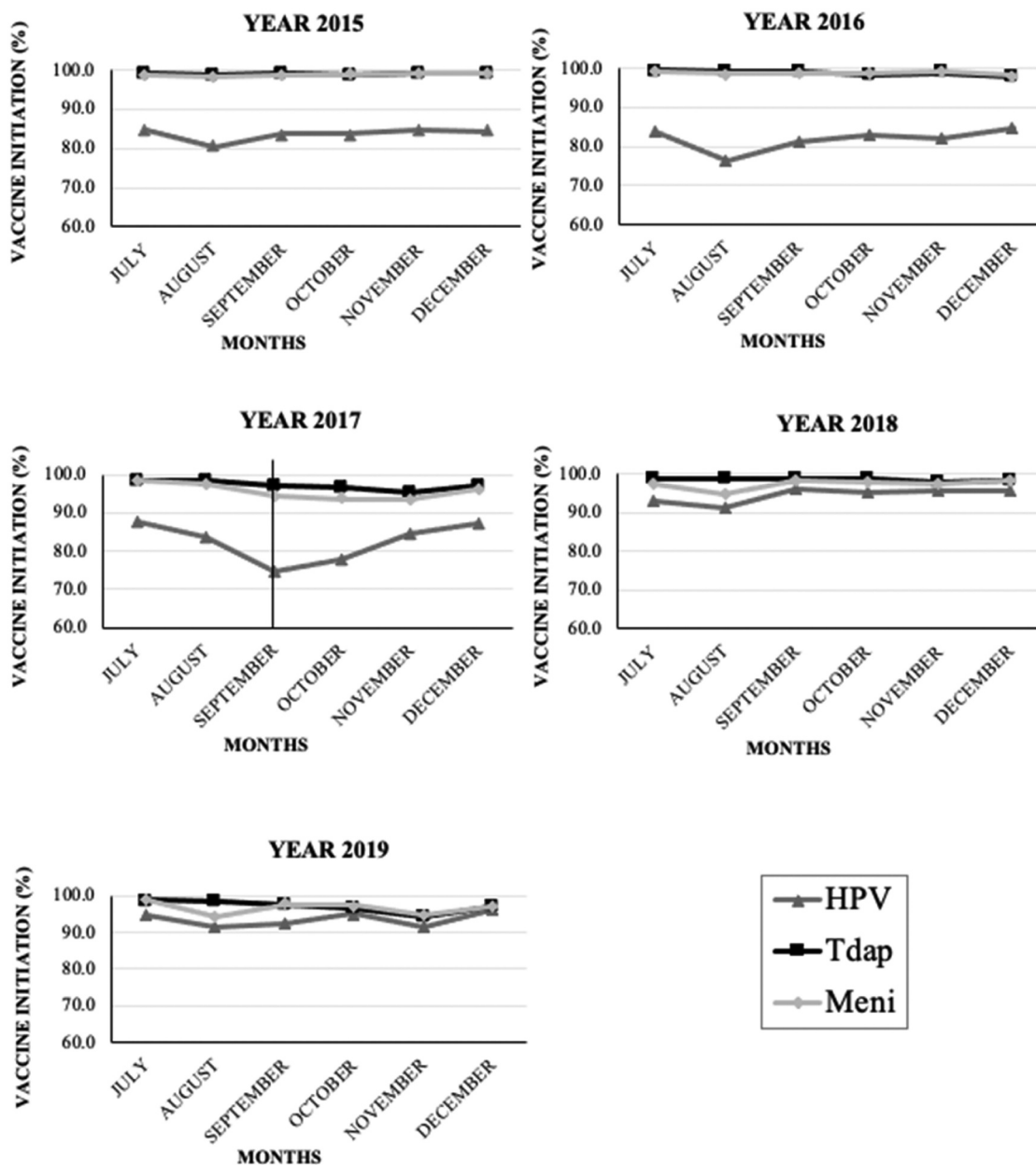


Figure 1. HPV, Tdap and meningococcal monthly initiation vaccine rates (July–December) among adolescents 11 to 17 years old: Puerto Rico 2015–2019.

Registry (PRIR), this report assessed the impact of Hurricane Maria on monthly adolescent's vaccine initiation rates from 2015 to 2019.

Materials and methods

Data source

The PRIR was an immunization information system (IIS) funded by the CDC. The main purpose of this IIS was to record administered vaccines, including demographic information, and to determine vaccination coverage at a population level. Data from the PRIR represent 87% of the Puerto Rican population.¹⁴ By Law No. 169 of December 12, 2019, vaccine providers are obliged to report administered vaccines.¹⁵

Target population

Adolescents within the ages of 11–17 registered in the PRIR from 2015 to 2019 that were immunized with HPV, influenza (flu), influenza A (H1N1), tetanus, Td (Tetanus, Diphtheria), Tdap, MenACWY, serogroup B meningococcal (MenB) vaccines.

Statistical analysis

Monthly initiation rates were estimated as follows:

$$\text{Initiation Rate} = \frac{\text{Number of adolescents who had at least the first dose of the evaluated vaccine}}{\text{Number of adolescents who administered the first dose of any of the evaluated vaccines during the study period}}$$

Age-standardized rates (ASR) of vaccines initiation (per 100 individuals) were estimated with 95% CI using the direct-standardization method with the US 2000 census

data distribution as the reference population. In order to control the effect of the high migration in PR for the last years, the age-standardized initiation rate ratio (SRR) was estimated with 95% CI to compare the age-standardized initiation rate before and after the hurricane Maria as follows:¹⁶

$$SRR_{2017\text{vs}.k} = \frac{ASR_{2017}}{ASR_k}$$

where ASR_k indicates the age-standardized initiation rate in any other different than 2017.

If $SRR > 1$, this indicates the ASR_{2017} was higher than ASR_k ; in this condition, we will refer to this as an excess in the initiation rate. If $SRR < 1$, this indicates that ASR_{2017} was lower than ASR_k ; in this condition, we will refer to this as a reduction in the initiation rate. The statistical analyses were conducted using Stata version 13 (USA: StataCorp LLC).

Results

The analytical sample size was 85,340 adolescents, 52.3% were male adolescents, and 47.7% were females. Of this total, 76.8% of adolescents initiated the HPV vaccine series between 11 and 12 years old, 86.9% initiated the MenACWY vaccine series, and 88.8% were vaccinated against Tdap in the same age range. While 23.2%, 13.1% and 11.2% were between 13 and 17 years old when they initiated the series of HPV and MenACWY vaccines, and received the Tdap vaccine, respectively.

Trends of initiation rates

Figure 1 shows the trends of monthly initiation rates for each vaccine. During these periods, the HPV vaccine initiation rates were higher in 2018 and 2019; however, 2017 showed the lower rates. For the other vaccines, the trend was almost flat in the

studied years. Regardless of any variation in Tdap and MenACWY vaccines rates, these remained above 90% in the entire period.

Standardized initiation rate ratios

When we compare the ASR's of HPV in 2017 against previous years, we observe that September and October showed a reduction of 6 and 9% in HPV vaccine initiation rates when the reference year was 2015 (SRR: 0.94, 95% CI: 0.80, 1.09) and (SRR: 1.04, 95% CI: 0.98, 1.10), for each month respectively (see Table 1). The same months showed a reduction of 5% and 8% in HPV initiation rates when the reference year was 2016 (SRR: 0.95, 95% CI: 0.81, 1.12) and (SRR: 0.92, 95% CI: 0.79, 1.08), for each month, respectively. However, these reductions were not significant ($p > .05$) (Table 1).

ASR's for Tdap in 2017 against previous years showed in November a reduction of 17% in Tdap vaccination when the reference year was 2015 (SRR: 0.83, 95% CI: 0.70, 0.99). Similarly, an 18% reduction in MenACWY vaccine initiation was observed when the reference year was 2016 (SRR: 0.82, 95% CI: 0.70, 0.97). Both reductions were significant ($p < .05$).

Discussion

Results from this study showed the impact of Hurricane Maria on adolescent vaccination. The HPV vaccine was the most severely affected, showing a rate of 75% after the disaster (from a rate of almost 90% in July 2017). Parents have rapidly accepted the MenACWY and Tdap vaccines as part of the vaccination schedule, and despite the disaster, rates were maintained at over 90%. The pattern observed in HPV vaccine rates might be explained by a 'lagged effect' from parents, this means parents immunized their children with Tdap and MenACWY vaccines but many postponed HPV vaccination. The decision to vaccinate their children may have been delayed with the hurricane revoking the decision to initiate the HPV vaccine series.

Table 1. Standardized initiation rate ratio (SRR) for HPV, Tdap, and meningococcal vaccination among adolescents 11–17 years, by months (July to December) of years 2015 to 2019.

Years	Standardized Risk Ratio ^b					
	July	August	September	October	November	December
HPV						
2017 vs 2015 ^a	1.03 (0.97–1.10)	1.04 (0.98–1.10)	0.94 (0.80–1.09)	0.91 (0.78–1.07)	0.97 (0.86–1.09)	0.99 (0.87–1.12)
2017 vs 2016 ^a	1.04 (0.97–1.11)	1.08 (1.02–1.15) *	0.95 (0.81–1.12)	0.92 (0.79–1.08)	0.99 (0.87–1.12)	1.04 (0.92–1.19)
2017 vs 2018 ^a	0.95 (0.89–1.01)	0.94 (0.89–0.99) *	0.84 (0.71–0.98) *	0.83 (0.70–0.97) *	0.89 (0.78–1.01)	0.92 (0.80–1.07)
2017 vs 2019 ^a	0.94 (0.87–1.02)	0.94 (0.87–1.01)	0.85 (0.71–1.02)	0.83 (0.70–0.99) *	0.92 (0.78–1.08)	0.90 (0.74–1.11)
Tdap						
2017 vs 2015 ^a	0.97 (0.88–1.07)	0.98 (0.91–1.06)	0.97 (0.78–1.19)	0.91 (0.74–1.12)	0.83 (0.70–0.99) *	0.91 (0.75–1.10)
2017 vs 2016 ^a	0.97 (0.87–1.08)	0.98 (0.91–1.06)	0.97 (0.78–1.20)	0.93 (0.75–1.14)	0.84 (0.70–1.00) *	0.94 (0.77–1.15)
2017 vs 2018 ^a	1.00 (0.89–1.12)	0.99 (0.91–1.07)	0.98 (0.78–1.24)	0.91 (0.73–1.13)	0.85 (0.68–1.06)	0.93 (0.71–1.22)
2017 vs 2019 ^a	1.00 (0.87–1.15)	0.98 (0.88–1.10)	1.01 (0.76–1.33)	0.96 (0.75–1.25)	0.88 (0.68–1.15)	0.93 (0.64–1.40)
Meningococcal						
2017 vs 2015 ^a	0.98 (0.90–1.07)	0.99 (0.92–1.06)	0.92 (0.75–1.13)	0.87 (0.72–1.08)	0.82 (0.70–0.97) *	0.90 (0.75–1.07)
2017 vs 2016 ^a	0.97 (0.87–1.07)	0.98 (0.92–1.06)	0.91 (0.74–1.12)	0.89 (0.72–1.08)	0.82 (0.69–0.97) *	0.94 (0.78–1.12)
2017 vs 2018 ^a	1.00 (0.90–1.11)	1.03 (0.95–1.11)	0.92 (0.73–1.15)	0.89 (0.71–1.10)	0.85 (0.69–1.06)	0.92 (0.73–1.17)
2017 vs 2019 ^a	0.98 (0.86–1.11)	1.04 (0.94–1.16)	0.92 (0.71–1.19)	0.90 (0.71–1.15)	0.92 (0.71–1.19)	0.93 (0.65–1.35)

^aReference year.

^bThe ratio of two ASR with 95% confidence interval between parentheses.

* P -value $< .05$.

According to the data analyzed, it took the PRIR system three months to restate the HPV initiation estimates observed in July 2017 when compared to the previous year. This fast catch-up in vaccination might be attributed in part to the efforts conducted before the disaster. In June 2017, the Secretary of Health announced that the vaccine was going to be required for school entry for children aged 11–12 years for the fall of 2018; the official requirement was implemented in August 2018⁷. The establishment of this public policy could have lessened the effect. Moreover, resources provided as part of the national emergency⁶ (e.g., school nurses), helped catch up on HPV vaccination as well.

Limitations should be considered. PRIR depends on the data entry of vaccine providers and schools. Potential data entry errors could occur. However, PRIR has a data quality control protocol, and our team performed an extensive data quality before the analyses. Another limitation to consider is that data for this study includes adolescents immunized with vaccines against HPV, influenza (flu), influenza A (H1N1), tetanus, Td (tetanus, diphtheria), Tdap, MenACWY, and meningococcal serogroup B (MenB). This may have induced an estimation bias in the analysis if additional types of vaccines had been included in the analysis, a greater number of adolescents could also have been included in the denominator of rates thus affecting the specific value of these rates. However, this possibility would not affect the rate per year trend found in this study. Anticipating the impact that disasters can have on immunization, post-natural disaster protocols should strengthen existing programs for immediate response and health system recovery. Facilitating access and the opportunity for bundling immunization for adolescent vaccines, including COVID-19 and HPV vaccination in the near future, must be a priority.

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Author contributions

VCL was conceptualization, funding acquisition, methodology, validation, and writing – original draft. OLDM’s contribution was conceptualization, formal analysis, visualization, writing – original draft. DTML’s contribution was writing – review and editing. RSA’s contribution was writing – review and editing. IVJ’s contribution was writing – review and editing. APOM’s contribution was writing – review and editing. ELSP’s contribution was methodology, validation, writing – review and editing.

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