HHS Public Access

Author manuscript

Ethn Health. Author manuscript; available in PMC 2019 January 02.

Published in final edited form as:

Ethn Health. 2017 December ; 22(6): 585–595. doi:10.1080/13557858.2016.1244744.

Rotavirus vaccination rate disparities seen among infants with acute gastroenteritis in Georgia

Trisha C. Parker[a,f], **Anaam Mohammed**[b], **Traci Leong**[c], **Shelley Mays**[e], **Shabnam Jain**[d,e], **Victoria Churchill**[a], **Fatima Ali**[a], and **Lilly C. Immergluck**[a,d]

[a]Departments of Pediatrics and Microbiology/Biochemistry/Immunology, Morehouse School of Medicine, Atlanta, GA, USA

[b]Pediatric Emergency Medicine Associates, Atlanta, GA, USA

[c]Department of Biostatistics and Bioinformatics, Rollins School of Public Health, Emory University, Atlanta, GA, USA

[d]Departments of Pediatrics and Medicine, Emory University, Atlanta, GA, USA

[e]Children's Healthcare of Atlanta, Atlanta, GA, USA

[f]Postgraduate Medical Institute Clinical Trials Unit, Anglia Ruskin University, Chelmsford, UK

Abstract

Objective: Rotavirus (RV) is one of the most common diarrheal diseases affecting children less than 5 years of age. RV vaccines have greatly reduced this burden in the United States. The purpose of this study was to determine possible disparities and socio-economic differences in RV vaccination rates.

Design: Children with acute gastroenteritis were enrolled. Stool was tested for presence of rotavirus using an enzyme immunoassay kit. Vaccination records were abstracted from the state immunization registry and healthcare providers to examine complete and incomplete vaccination status. Cases were identified as children receiving a complete RV dose series and controls were identified as children with incomplete RV doses. A logistic regression model was used to determine disparities seen amongst children with incomplete vaccination status.

Results: Racial differences between Black and white infants for RV vaccination rates were not significant when controlling for covariates (OR 1.15, 95% CI 0.74–1.78); however ethnicity (*p*-value .0230), age at onset of illness (*p*-value .0004), birth year (*p*-value < .0001), and DTaP vaccination status (*p*-value < .0001) were all significant in determining vaccination status for children.

Conclusions: Racial disparities and socio-economic differences are not determinants in rotavirus vaccination rates; however, age and ethnicity have an effect on RV vaccine status.

CONTACT Trisha C Parker trishabchan@gmail.com.

Disclosure statement

No potential conflict of interest was reported by the authors.

Keywords

Rotavirus; gastroenteritis; immunization; rotavirus vaccine; disparities; health inequities

1. Introduction

Before the wide scale implementation of rotavirus (RV) vaccines, RV remained the leading cause of severe diarrhea in children in the United States (US) (Cortese and Parashar 2006). In 2006, RotaTeq® (Merck & Co., Inc.; RV5), a live, oral pentavalent three-dose vaccine was licensed for use in the US. Rotarix® (GlaxoSmithKline Biologicals; RV1), a human, live attenuated two-dose vaccine was later introduced and licensed in the US in 2008. Although national introduction of RV vaccine has caused an overall decline in rotavirus related gastroenteritis hospitalizations in children of all races, disparities in Black children and children under public insurance observed in pre-vaccine years in the US still persist in post licensure times (Fischer et al. 2007; Ma, El Khoury, and Itzler 2009; Pont et al. 2009).

During its first 6 months of availability (August 2006 through January 2007), an analysis of RV5 reported that a significant portion of children from Pennsylvania's immunization registry were being excluded, due to age, from receiving any RV5 doses and from completing the three dose regimen series (Daskalaki et al. 2008). However, a large prospective cohort study conducted in 2009 found that 84.3% of all patients completed a full RV vaccine series. More children in the RV1 cohort were fully immunized than in the RV5 cohort, due to either missed dosing or incorrect dose timing (91.0% vs. 83.4%; $p < .001$) (Krishnarajah et al. 2012).

Previous studies in the US have reported that children who are under-immunized, defined as those who have received some vaccines but have not completed all of the recommended doses, are more likely to be Black and come from a low socio-economic background than fully immunized children. Conversely, children who are unimmunized, or those who had parents who refused vaccines, tend to be White and from higher income households (Omer et al. 2006; Glanz et al. 2009). Identifying disparities that might exist for RV vaccines can have a major impact on the types of vaccine programs and the populations they target. Health inequities associated with RV vaccine rates have not been determined or examined in previous studies.

The purpose of this study was to determine if racial, ethnic, socio-economic status, and insurance status inequities exist in completion rates for RV vaccine using secondary analysis from primary surveillance conducted at three pediatric hospitals in southeastern US. This study seeks to identify whether previously reported disparities in rotavirus-related disease and immunizations are also associated with incomplete RV vaccination status.

2. Materials and methods

This was a secondary analysis of a large case control study to determine possible disparities in RV vaccination status. Data was collected from active surveillance conducted during three rotavirus seasons from 1 January 2010 to 30 June 2010, 1 January 2011 to 30 June 2011, and

1 January 2013 to 30 June 2013. Pediatric patients who were seen at any of the three pediatric hospital sites (Hughes Spalding Children's Hospital, Egleston Children's Hospital, and Scottish Rite Children's Hospital), which cover the metro Atlanta area, were eligible for enrollment if they were: (1) diagnosed with acute gastroenteritis (AGE) defined as ≥3 looser than normal stools within a 24-hour period and diarrhea <10 days at time of enrollment; (2) managed as an emergency department (ED) patient, short-stay patient, or inpatient; (3) had no immunocompromising condition (e.g. malignancy, HIV infection); (4) had a stool sample collected from the patient within 14 days of presentation of illness with results available from a rotavirus antigen immunoassay; (5) eligible to have received at least 1 RV vaccine dose≥14 days before presentation according to birth date; (6) born on or after 1 March 2009 and age at evaluation≥56 days; and (7) lived in the usual catchment area of the hospital.

Parents of children who met all of the criteria listed above were approached, and once an informed consent was obtained, a standardized parent questionnaire was administered. The questionnaire collected demographic data, medical history of the underlying symptoms, household information, and names and addresses of the child's immunization providers. Presence of rotavirus in stool samples was conducted at the Centers for Disease Control and Prevention (CDC) using a commercial enzyme immunoassay (EIA) kit (Rotaclone) to categorize children as either rotavirus test positive (cases) or rotavirus test negative (controls). Immunization records were obtained from the Georgia Registry of Immunization Transactions and Services (GRITS), which is maintained by the department of public health and contains up-to-date immunization records. Immunization providers that were identified by parents or guardians during enrollment were also contacted to obtain immunization records and verify GRITS. The study was approved by the institutional review boards at the CDC and the hospital.

2.1. Vaccination status

Immunization records were used to determine RV vaccination status and diphtheria-tetanus-acellular pertussis (DTaP) vaccination status. RV vaccination status was defined as complete or incomplete at the onset of illness. A child was considered to have complete RV vaccination status if he or she met one of the following criteria: (1) the child received three doses of RV5 or two doses of RV1 at the time of enrollment; (2) the child received one dose of RV1 and two doses of RV5 by 8 months 0 days of age; (3) the child was younger than 8 months 0 days of age and had the recommended Advisory Committee on Immunization Practices (ACIP) number of doses for that particular age at time of enrollment. If a child did not have doses administered at the recommended scheduled time, but had time to complete the series and was within the recommended guidelines, the child was considered complete (Table 1). Children who did not meet the above criteria were considered to have incomplete rotavirus vaccination status.

DTaP vaccine was used for comparison with rotavirus vaccination status because the vaccine follows a similar schedule to the rotavirus schedule for the first three doses of administration and has been shown to be commonly accepted vaccine among parents compared to other vaccines (Kroger et al. 2011; Robison, Groom, and Young 2012).

2.2. Statistical analyses

Descriptive characteristics of the cohort were conducted to summarize the general characteristics of those used in this analysis, as well as to determine the distribution of characteristics for vaccination status. Significant differences in demographics were determined by chi square tests and possible associations between vaccination status and covariates were determined by odds ratios and 95% confidence intervals. Variables that were identified as possible covariates included race, ethnicity, insurance status, age at visit, birth year, caretaker's highest educational degree level, daycare status, household size, and DTaP vaccine status. Multivariable regression analysis was also performed to determine the association between vaccination status and possible covariates. The data analyses were generated using SAS Software, Version 9.2 © 2002–2008 SAS Institute Inc., Cary, NC, USA.

3. Results

From three different rotavirus seasons in January to June of 2010, 2011, and 2013, 1127 eligible patients were approached at all 3 pediatric hospital sites in the ED and inpatient floors. Of the 1127 eligible patients, 226 parents refused participation into the study. Of the 901 patients who were successfully enrolled into the study, 708 valid stool samples were collected and tested over the course of each season. Ten stool samples were later withdrawn due to data collection errors. Of the 698 samples that were used, 6 of those children's RV vaccine status could not be determined to be complete or incomplete, and they were therefore, removed from the analysis. Overall, 692 children were included in this secondary analysis, with 379 children having complete RV status and 313 having incomplete status (Figure 1).

Most children were enrolled from the hospital ED 84.5% (585/692) and were not admitted into the hospital for management of their AGE illness. The majority of participants were Black 60.1% (405/692), non-Hispanic 80.7% (556/692), rotavirus test negative 68.9% (477/692), more than 8 months of age 71.5% (495/692), born in 2009 or 2010 73.7% (510/692), male 58.5% (405/692), and had public health insurance 79.2% (533/692).

Almost half of the study participants had incomplete RV vaccine status (45.2%) at the time that they presented to the hospital with AGE symptoms. Of those who were incomplete, the majority of children, 65.8% (202/307), identified themselves as Black and non-Hispanic (87.2%, 272/312). More than 40% of children with incomplete status were test positive for RV, compared to only 20.6% test positive for children with complete status (p-value < .0001). In addition, children with incomplete vaccination status had a higher percentage of being admitted into the hospital and staying between 1 and 5 days in the hospital compared to complete RV vaccine status children (Table 2).

Lastly, 27.8% (87/313) of incomplete RV vaccine children were incomplete for DTaP vaccine, whereas only 2.4% of complete RV vaccine children were incomplete for DTaP vaccine (p-value < .0001).

3.1. Univariate analysis

Possible risk factors associated with incomplete RV vaccination status were examined. Children with incomplete vaccination status were more likely to be Black, compared to complete vaccine status children (OR 1.63, 95% CI 1.15–2.32). Those who were Non-Hispanic were more likely to have an incomplete vaccination status (OR 1.63, 95% CI 1.24–2.14). Daycare attendance was less likely to be associated with incomplete vaccination status (OR 0.84, 95% CI 0.72–0.99). Children who were >8 months of age were also more likely to have incomplete vaccine status, compared to children ≤8 months (OR 1.24, 95% CI 1.08–1.42). Children born in 2012 were more likely to have complete RV vaccine status compared to children born in 2009 (OR 3.51, 95% CI 2.07–5.96). Being incomplete for DTaP vaccine also increased a child's likelihood of being incomplete for RV vaccine (OR 2.39, 95% CI 2.12–2.70) (Table 3).

3.2. Multivariable analysis

Multivariable logistic regression analysis was performed to investigate the relationship between a risk factor identified in the univariate analysis and incomplete RV vaccine status after controlling for other possible risk factors. Children who were >8 months of age remained a significant predictor and were twice as likely as children younger than 8 months to have incomplete RV vaccination status in this cohort (OR 2.11, 95% CI 1.39–3.18) and older children (born in 2009) continued to have higher risk of incomplete RV vaccine status (OR 4.86, 95% CI 2.56–9.25). Children who were non-Hispanic continued to be at a higher risk for being incomplete for RV vaccines (OR 1.89, 95% CI 1.09–3.34). DTaP vaccine status was also significant in predicting RV vaccine completion status (OR 21.90, 95% CI 9.91–48.36) (Table 4).

4. Discussion

Previous studies have confirmed that RV1 and RV5 vaccines are both effective in deterring rotavirus disease and sustaining protection in the first 2 years of life; however, the highest vaccine effectiveness from RV vaccines is consistently related to receipt of a complete course of vaccines (Cortese et al. 2011, 2013; Dennehy et al. 2011; Wang et al. 2013). This secondary analysis study confirms the previous studies' analyses for rotavirus vaccine effectiveness in that children with complete vaccination status were less likely to be positive for rotavirus compared to those with incomplete status at onset of AGE illness. Incomplete RV vaccine children also seemed to have higher severity in their illness.

Through this analysis, disparities associated with rotavirus disease and other immunizations that were evident in earlier studies, specifically race and insurance status, were not apparent (Dominguez et al. 2004; Fischer et al. 2007). Although racial disparities were seen in the univariate analysis, controlling for other covariates in the multivariable analysis showed a non-significant association between race and vaccination status. Children with no RV vaccines were examined in further analysis to determine if those that had no RV vaccines had different characteristics from those that had partial RV vaccines; however, racial differences were not evident when separating incomplete RV vaccination status in this way (data not shown). These findings might suggest that racial disparities associated with

immunizations are diminishing; however, this study only examined children covering a small part of Georgia, mainly the metro Atlanta area, and may not be reflective to other areas in the US. Insurance status was never found to have a significant association to vaccination status, and completion rates in this analysis were lower for both types of insurance when comparing other studies looking at compliance rates with public and privately insured children in multiple states using insurance claims data. Despite this, Panozzo et al found a larger proportion of privately insured children to have completed the RV vaccine series compared to other studies looking at publically insured children (Krishnarajah et al. 2012; Panozzo et al. 2013; Calnan et al. 2016). The results from those studies, though, were limited to insurance claims data and looked at only one type of insurance, whereas these results could have been limited due to the small number of children reporting private insurance and limited to the state of Georgia. A larger sample using various methods of obtaining demographic and insurance information is needed to fully understand the relationship between socioeconomic and vaccination status as well as state coverage differences.

There was a significant difference in vaccine status for Hispanics compared to non-Hispanics. Hispanics were more likely to have complete coverage of rotavirus. This analysis seems to show an improvement in vaccination rates for Hispanic children from the pre-rotavirus vaccine period, where disparities existed between Hispanic children to non-Hispanic white children for other vaccines (Walker, Smith, and Kolasa 2014). To date, it appears that ethnic disparities have not been reported for RV vaccine status.

The RV vaccines have a unique age restriction compared to other recommended vaccines for routine use. Few vaccines have an upper age limit of such a short time span as the RV vaccines, which might affect children from receiving a full dose of RV vaccine. Secondly, RV vaccines are the only vaccines that are recommended with age limits counted in weeks. This might cause confusion for providers, as well as put more stringent age restrictions on RV vaccines compared to other vaccines (Daskalaki et al. 2008). Since these two vaccines have two different dosing schedules, RV5 might seem more difficult to achieve complete vaccination status, which has been noted in a large prospective cohort study (Krishnarajah et al. 2012). This analysis showed similar issues in regard to complete vaccination status and between RV5 and RV1 completion. The comparison for ages was between children less than 8 months of age to those that were greater than 8 months of age. This comparison was used due to the age limits set by the ACIP and American Academy of Pediatrics (AAP) (Centers for Disease Control and Prevention 2009). The age at onset of illness affected the likelihood of a child having complete vaccination status, which seems to signify the importance for timely vaccinations.

Other vaccines, such as DTaP, seem to be a predictor in determining if a child will receive RV. Although children lacking a complete course of DTaP vaccination are seven times more likely to not receive the RV vaccine, further analysis needs to be done to determine why 46.9% of children that were complete for DTaP were incomplete for RV vaccine. The age of visit might play a role into why there were a high number of children that were incomplete for RV vaccine but complete for the other DTaP vaccine because DTaP has a less stringent age dose criteria.

Birth year was examined and it was evident that there was an upward trend for RV vaccine uptake for children born in later years. This could be an indication for RV vaccines requiring time for adoption, considering that recommendations for these vaccines did not occur until 2006 and 2008. When analyzing DTaP, there was no significant differences between completion vaccination rates at birth year. Because DTaP was introduced as a recommended vaccine in 1998, this factor could contribute to the increased adoption for this vaccine compared to RV vaccines. Continual analysis on current young children is needed to establish if coverage can continue to increase for RV vaccines to the level of DTaP, which could help clarify if the age restriction is a key barrier for children's RV vaccination status. Nonetheless, the completion rates between RV vaccines and DTaP clearly indicates missed opportunities for many children in achieving complete vaccination status for all vaccine types.

5. Limitations

There were several limitations to this secondary analysis study. Because this dataset was originally used to examine the vaccine effectiveness of RV1 and RV5, some questions that could have facilitated the analysis were not asked. Therefore, reasons for why certain risk factors exist or do not exist were more difficult to examine. Household size was used as a proxy for household crowding, but it might not truly reflect crowding. In addition, risk factors that remained significant, including age at onset of illness, ethnicity, and DTaP vaccine status, had somewhat larger confidence intervals, which indicates that there might be variability within our study cohort.

This analysis only included a cohort of children that covered the metro Atlanta area and might not reflect other populations outside of metro Atlanta or nationally. The catchment area was primarily children with public insurance and Blacks, which might have made it difficult to determine associations with vaccination status. Disparities not shown in this analysis might still persist in other parts of the country. Further analysis needs to be performed to include a larger sample size.

6. Conclusions

RV vaccines have proven to be effective vaccines for combating severe rotavirus disease. It has been demonstrated that these vaccines have continued protection for children in the first 2 years of life; however, complete vaccinations are imperative in order for these vaccines to sustain its efficacy. Due to age restrictions of these RV vaccines, timely vaccinations are important to complete these vaccines. Advisory committees should consider examining the potential efficacy for children that are given the RV vaccine after 8 months of age and adjusting the recommended age accordingly. Routinely recommended vaccines, specifically DTaP, are associated with determining RV vaccine status, which reinforces the need for timely vaccinations for all vaccine types.

Certain disparities, specifically race and insurance, which had been previously demonstrated to be associated with incomplete vaccination status were not shown as being statistically significant; however, other disparities and social determinants, age and ethnicity, seem to

influence vaccination status. Additional studies should be conducted to examine the necessity for age requirements and the differences in vaccine compliance in different ethnicities to reduce the variation of vaccination status in age and ethnic groups.

Acknowledgements

We would like to thank Dr. Margaret Cortese, Ms. Slavica Mijatovic-Rustemapasic, Dr. Jacqueline Tate, and Dr. Michael D. Bowen at the Centers for Disease Control and Prevention. We would like to thank Dr. Monica Farley and staff of Georgia's Emerging Infections Program. We would like to thank Ms. Elham Laghaie, Dr. Saadia Khizer, and Mr. Kevin Thornton, Emergency staff at Scottish Rite Children's Hospital, Egleston Children's Hospital, and Hughes Spalding Children's Hospital, and the Clinical Microbiology staff of Children's Healthcare of Atlanta (especially, Mr. Charles Ash, Dr. Robert Jerris and Ms. Theresa Stanley).

Funding

This work was funded through Centers for Disease Control and Prevention-Emerging Infections Program grants U01CI0000307–05 and U0I000312B; Georgia Emerging Infections Program Cooperative Agreement U50CK000196; PHS Grant UL1 RR025008 from the Clinical and Translational Science Award program, National Institute of Health, as part of the Atlanta Clinical and Translational Science Institute; Grant Number 2R25RR017694–06A1; and Grant Number G12-RR03034, a component of the National Institutes of Health.

References

Calnan M, Krishnarajah G, Duh MS, Haider BA, Yermakov S, and Davis M. 2016 "Rotavirus Vaccination in a Medicaid Infant Population from Four US States: Compliance, Vaccination Completion Rate, and Predictors of Compliance." Human Vaccines & Immunotherapeutics 12 (5): 1235–1248. [PubMed: 26900728]

Centers for Disease Control and Prevention. 2009 "Prevention of Rotavirus Gastroenteritis among Infants and Children: Recommendations of the Advisory Committee on Immunization Practices (ACIP)." *MMWR Recommendations Reports* 58 (RR-2): 16–18.

Cortese MM, Immergluck LC, Held M, Jain S, Chan T, Grizas AP, Khizer S et al. 2013 "Effectiveness of Monovalent and Pentavalent Rotavirus Vaccine." Pediatrics 132 (1): e25–e33. doi:10.1542/peds.2012-3804. [PubMed: 23776114]

Cortese MM, Leblanc J, White KE, Stinchfield P, Preston KL, Meek J, Odofin L et al. 2011 "Leveraging State Immunization Information Systems to Measure the Effectiveness of Rotavirus Vaccine." Pediatrics 128 (6): e1474–e1481. doi:10.1542/peds.2011-1006. [PubMed: 22084328]

Cortese MM, and Parashar U. 2006 "Prevention of Rotavirus Gastroenteritis among Infants and Children: Recommendations of the Advisory Committee on Immunization Practices (ACIP)." *MMWR Recommendations Reports* 55 (RR1–2): 1–13. http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5802a1.htm.

Daskalaki I, Spain CV, Long SS, and Watson B. 2008 "Implementation of Rotavirus Immunization in Philadelphia, Pennsylvania: High Levels of Vaccine Ineligibility and Off-label Use." Pediatrics 122 (1): e33–e38. doi:10.1542/peds.2007-2464. [PubMed: 18595974]

Dennehy PH, Vesikari T, Matson DO, Itzler RF, Dallas MJ, Goveia MG, DiNubile MJ, Heaton PM, and Ciarlet M. 2011 "Efficacy of the Pentavalent Rotavirus Vaccine, RotaTeq® (RV5), Between Doses of a 3-Dose Series and With Less Than 3 Doses (Incomplete Regimen)." Human Vaccines 7 (5): 563–568. [PubMed: 21441783]

Dominguez SR, Parrott JS, Lauderdale DS, and Daum RS. 2004 "On-time Immunization Rates among Children Who Enter Chicago Public Schools." Pediatrics 114 (6): e741–e747. [PubMed: 15574606]

Fischer TK, Viboud C, Parashar U, Malek M, Steiner C, Glass R, and Simonsen L. 2007 "Hospitalizations and Deaths from Diarrhea and Rotavirus among Children <5 Years of Age in the United States, 1993–2003." Journal of Infectious Diseases 195 (8): 1117–1125. [PubMed: 17357047]

Glanz JM, McClure DL, Magid DJ, Daley MF, France EK, Salmon DA, and Hambidge SJ. 2009 "Parental Refusal of Pertussis Vaccination is Associated with an Increased Risk of Pertussis

Infection in Children." Pediatrics 123 (6): 1446–1451. doi:10.1542/peds.2008-2150. [PubMed: 19482753]

Krishnarajah G, Davis EJ, Fan Y, Standaert BA, and Buikema AR. 2012 "Rotavirus Vaccine Series Completion and Adherence to Vaccination Schedules among Infants in Managed Care in the United States." Vaccine 30 (24): 3717–3722. doi:10.1016/j.vaccine.2011.12.077. [PubMed: 22214886]

Kroger AT, Sumaya CV, Pickering LK, and Atkinson WL. 2011 "General Recommendations on Immunization Recommendations of the Advisory Committee on Immunization Practices (ACIP)." *MMWR Recommendations and Reports* 60 (RR02): 1–60. http://www.cdc.gov/mmwr/preview/mmwrhtml/rr6002a1.htm.

Ma L, El Khoury AC, and Itzler RF. 2009 "The Burden of Rotavirus Hospitalizations among Medicaid and Non-medicaid Children Younger than 5 Years Old." American Journal of Public Health 99 (S2): S398–S404. doi:10.2105/AJPH.2008.148494. [PubMed: 19797754]

Omer SB, Pan WK, Halsey NA, Stokley S, Moulton LH, Navar AM, Pierce M, and Salmon DA. 2006 "Nonmedical Exemptions to School Immunization Requirements." JAMA: The Journal of the American Medical Association 296 (14): 1757–1763. doi:10.1001/jama.296.14.1757. [PubMed: 17032989]

Panozzo CA, Becker-Dreps S, Pate V, Funk MJ, Sturmer T, Weber DJ, and Brookhart MA. 2013 "Patterns of Rotavirus Vaccine Uptake and Use in Privately-insured US Infants, 2006–2010." Plos One 8: e73825. doi:10.1371/journal.pone.0073825. [PubMed: 24066076]

Pont SJ, Grijalva CG, Griffin MR, Scott TA, and Cooper WO. 2009 "National Rates of Diarrhea-associated Ambulatory Visits in Children." The Journal of Pediatrics 155 (1): 56–61. doi:10.1016/j.jpeds.2009.01.075. [PubMed: 19394047]

Robison SG, Groom H, and Young C. 2012 "Frequency of Alternative Immunization Schedule Use in a Metropolitan Are." Pediatrics 130 (1): 32–38. doi:10.1542/peds.2011-3154. [PubMed: 22711719]

Walker AT, Smith PJ, and Kolasa M. 2014 "Reduction of Racial/Ethnic Disparities in Vaccination Coverage, 1995–2011." Morbidity and Mortality Weekly Report 63 (01): 7–12.

Wang FT, Mast TC, Glass RJ, Loughlin J, and Seeger JD. 2013 "Effectiveness of an Incomplete RotaTeq (RV5) Vaccination Regimen in Preventing Rotavirus Gastroenteritis in the United States." The Pediatric Infectious Disease Journal 32 (3): 278–283. doi:10.1097/INF.0b013e318275328f. [PubMed: 23014356]

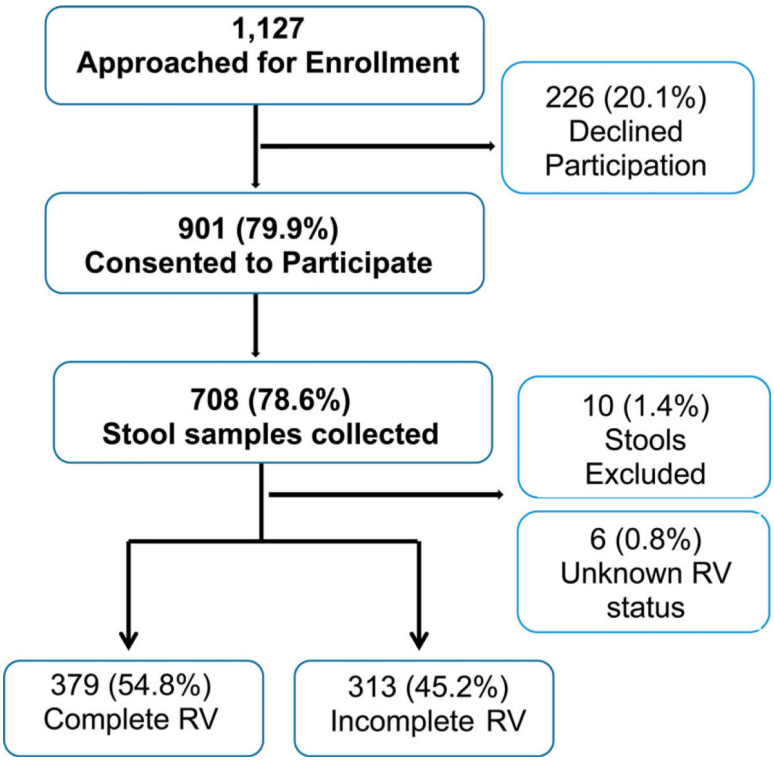

Figure 1.

Enrollment schema for patients enrolled in study. From the 708 patients whose stool samples were collected, 10 individuals were excluded analysis due to not meeting enrollment criteria: One patient was younger than 55 days, three individuals had stool samples that were collected more than 14 days after enrollment, two patients had previously been enrolled in the study, and one patient was a twin whose twin sibling had been previously enrolled; three additional patients were excluded for not being in the state immunization registry and no provider vaccine record was provided.

Table 1.

ACIP schedule guidelines.

RV dose	ACIP guideline
Minimum age for first dose	6 weeks
Maximum age for first dose	14 weeks and 6 days
Maximum age for any dose	8 months and 0 days
Dose 1	6 weeks through 2 months
Dose 2	4 months and ≥4 weeks after previous dose
Dose 3 (if required)	6 months and ≥4 weeks after previous dose

Table 2.

Population characteristics.

Variable	Total number *N* = 692 (%)	Rotavirus vaccine doses		*p*-Value
		Incomplete *N* = 313 (%)	Complete *N* = 379 (%)	
Race[a]				
White	190 (28.2)	72 (23.5)	118 (32.2)	.0183
Black	405 (60.1)	202 (65.8)	203 (55.3)	
Other	79 (11.7)	33 (10.8)	46 (12.5)	
Ethnicity[b]				
Hispanic	133 (19.3)	40 (12.8)	93 (24.7)	<.0001
Non-Hispanic	556 (80.7)	272 (87.2)	284 (75.3)	
Sex				
Male	405 (58.5)	181 (57.8)	224 (59.1)	.7346
Female	287 (41.5)	132 (42.2)	155 (40.9)	
Rotavirus cases				
Positive	215 (31.1)	137 (43.8)	78 (20.6)	<.0001
Negative	477 (68.9)	176 (56.2)	301 (79.4)	
Age at visit				
<=3 months	26 (3.8)	16 (5.1)	10 (2.6)	.0002
3–6 months	92 (13.3)	24 (7.7)	68 (17.9)	
6–8 months	79 (11.4)	32 (10.2)	47 (12.4)	
>8 months	495 (71.5)	241 (77.0)	254 (67.0)	
Age at visit (8 months)				
<=8 months	197 (28.5)	72 (23.0)	125 (33.0)	.0038
>8 months	495 (71.5)	241 (77.0)	254 (67.0)	
Birth year[c]				
2009	287 (41.5)	159 (50.8)	128 (33.8)	<.0001
2010	223 (32.2)	102 (32.6)	121 (31.9)	
2011	88 (12.7)	26 (8.3)	62 (16.4)	
2012	88 (12.7)	23 (7.4)	65 (17.2)	
Hospital duration				
Not admitted	586 (84.7)	252 (80.5)	334 (88.1)	.0109
1–5 days	94 (13.6)	56 (17.9)	38 (10.0)	
>5 days	12 (1.7)	5 (1.6)	7 (1.9)	
Billing category				
ED or clinic	585 (84.5)	252 (80.5)	333 (87.9)	.0078
Hospital Adm/Obs	107 (15.5)	61 (19.5)	46 (12.1)	
Insurance status				
None	55 (8.2)	26 (8.7)	29 (7.8)	.3873
Private	85 (12.6)	32 (10.7)	53 (14.2)	
Public	533 (79.2)	241 (80.6)	292 (78.1)	

Variable	Total number *N* = 692 (%)	Rotavirus vaccine doses		*p*-Value
		Incomplete *N* = 313 (%)	Complete *N* = 379 (%)	
DTaP vaccine				
Complete	596 (86.1)	226 (72.2)	370 (97.6)	<.0001
Incomplete	96 (13.9)	87 (27.8)	9 (2.4)	
Household size				
<=4	373 (54.2)	160 (48.7)	213 (56.7)	.1595
>4	315 (45.8)	152 (51.3)	163 (43.4)	
Attend daycare				
No	447 (64.7)	190 (60.7)	257 (68.0)	.046
Yes	244 (35.3)	123 (39.3)	121 (32.0)	
Caretaker degree				
None	133 (19.6)	56 (18.1)	77 (20.8)	.7703
High School/GED	377 (55.4)	173 (55.8)	204 (55.1)	
College	117 (17.2)	57 (18.4)	60 (16.2)	
Graduate	53 (7.8)	24 (7.7)	29 (7.8)	
Hospital site				
Egleston	174 (25.1)	81 (25.9)	93 (24.5)	
Scottish Rite	280 (40.5)	112 (35.8)	168 (44.3)	.055
Hughes Spalding	238 (34.4)	120 (38.3)	118 (31.3)	

[a] 18 unknown race status.

[b] 3 unknown ethnicity status.

[c] 6 born in 2013 (data not shown).

Table 3.

Univariate analysis of incomplete RV vaccination status.

	Incomplete status		
Variables	**Odds ratio**	**95% CI**	***p*-Value**
Race			
White	1.00	Referent	
Black	1.63	(1.15–2.32)	.0065*
Other	1.18	(0.69–2.01)	.5529
Ethnicity			
Hispanic	1.00	Referent	
Non-Hispanic	1.63	(1.24–2.14)	<.0001*
Insurance status			
Private	1.00	Referent	
Public	1.37	(0.85–2.19)	.1931
None	1.49	(0.75–2.95)	.2597
Caretaker degree			
None	1.00	Referent	
High School/GED	1.17	(0.78–1.74)	.4509
College	1.31	(0.79–2.15)	.2949
Graduate	1.14	(0.60–2.16)	.6928
Daycare			
Yes	1.00	Referent	
No	0.84	(0.72–0.99)	.0460*
Age at visit			
<=8 montds	1.00	Referent	
> 8 montds	1.24	(1.08–1.42)	.0038*
Birth year			
2012	1.00	Referent	
2011	1.19	(0.61–2.29)	.6141
2010	2.38	(1.38–4.10)	.0017*
2009	3.51	(2.07–5.96)	<.0001*
Household size			
<=4	1.00	Referent	
>4	1.24	(0.918–1.678)	.1595
DTaP vaccine			
Complete	1.00	Referent	
Incomplete	2.39	(2.12–2.70)	<.0001

Table 4.

Multivariable analysis of the relationship between vaccination status and risk factors.

Risk factor			
	Odds ratio	**95% CI**	***p*-Value**
Race			
White	1.00	Referent	
Black	1.15	(0.74–1.78)	.8592
Other	1.42	(0.78–2.59)	.3204
Ethnicity			
Hispanic	1.00	Referent	
Non-Hispanic	1.91	(1.09–3.34)	.0230
Daycare			
Yes	1.00	Referent	
No	0.85	(0.58–1.23)	.3869
Age at visit			
< = 8 months	1.00	Referent	
>8 months	2.11	(1.39–3.18)	.0004
Birth year			
2012	1.00	Referent	
2011	1.25	(0.57–2.72)	.0270
2010	2.73	(1.42–5.27)	.0501
2009	4.86	(2.56–9.25)	<.0001
DTaP vaccine			
Complete	1.00	Referent	
Incomplete	21.90	(9.91–48.36)	<.0001