POPULATION SCIENCE

Demographic and socioeconomic factors associated with HPV vaccination in Georgia's South Central Health District

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ABSTRACT

Background: Human Papillomavirus (HPV) subtypes are the primary cause of cervical cancer. Despite introduction of the HPV vaccine in 2006, vaccination percentages remain low across Georgia counties. The primary objective of this research was to conduct a descriptive epidemiological study of HPV vaccination coverage among individuals in the South Central Health District (SCHD) to provide guidance for targeted vaccination campaigns aimed at adolescents residing in rural communities.

Methods: Data from the Georgia Registry of Immunization Transactions and Services and AEGIS.net, Inc. were used to analyze demographic and socioeconomic factors associated with HPV vaccine uptake among individuals visiting county health departments in the SCHD from 2007-2014. Descriptive statistics were used to evaluate the relationship between sex, age at first vaccination, county of vaccine administration, race, and insurance status to vaccine series completion.

Results: In the SCHD, Johnson County had the highest completion percentage (50%); Montgomery County had the lowest (20%). However, Montgomery County had the fastest time to completion (334 days). Throughout the district, males were fully vaccinated at much lower percentages than females ($p < 0.001$). Race was a significant variable ($p=0.011$) for vaccine completion. Compared to other racial groups, more White individuals completed the HPV vaccine. Absolute counts of HPV vaccine doses peaked in the study population during 2010 (n=507).

Conclusions: Due to overall low rates, community-based intervention methods should be considered to increase HPV vaccine uptake across the SCHD. School-based programs may be useful in targeting at-risk populations and increasing rates of HPV vaccine initiation and completion. Expanded efforts are needed to determine the best structure for effective school-based programs.

Key Words: human papillomavirus (HPV); HPV vaccine; HPV vaccine completion; adolescent; HPV vaccine initiation; rural health

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INTRODUCTION

An association between human papillomavirus (HPV) and cervical cancer has been established. Two HPV-subtypes, 16 and 18, contribute to most cervical cancer cases (Doorbar, Quint, Banks, et al., 2012; Walboomers, Jacobs, Manos, et al., 1999). These subtypes are also the cause of penile, vaginal, vulvar, oropharyngeal and anal cancers (Bonafide, Vanable, 2015; Backes, Kurman, Pimenta, et al., 2009). Despite introduction of an HPV vaccine in 2006, average vaccination percentages remain low. Nationally, only 37.6% of female and 13.9% of male adolescents aged 13-17 years received greater than or equal to 3 doses of the HPV vaccine (CDC, 2014).

Both the bivalent (HPV2) and quadrivalent (HPV4) vaccines have received positive safety profile reviews with the most common complaint being pain at the injection site, which resolves shortly after injection (Denny, International Federation of Gynecology and Obstetrics, 2013). Safety of the HPV2 vaccine has been monitored largely by the PATRICIA trial (Lehtinen, Paavonen, Wheeler, et al., 2012) and the Costa Rica vaccine trial (Herrero, Hildesheim, Rodríguez, et al., 2008); the HPV4 vaccine has been assessed by the FUTURE I and FUTURE II trials (McCormack, 2014), all with results suggesting adequate vaccine safety (De Vincenzo, Conte, Ricci, et al., 2014). The efficacy of the HPV2 and HPV4 vaccines has also been assessed in trials. Both prevent 90-100% of new HPV 16 and 18 infections and associated grade 2 or higher cervical intraepithelial neoplasia, which are potentially premalignant transformations, in women not already infected with HPV 16 or 18 at the time of vaccination (Herrero, González, Markowitz, 2015). Antibodies have remained at consistently

high levels for nearly 10 years, indicating that the vaccines remain effective for long periods (McCormack, 2014; Naud, Roteli-Martins, De Carvalho, et al., 2014). Despite evidence that the HPV vaccine is safe, effective, and long lasting, vaccination percentages remain low (CDC, 2014).

Safety, effectiveness, and duration of the vaccine, as well as uncertainty about when to return for subsequent doses, were commonly cited as reasons not to receive the vaccine (Krawczyk, Perez, King, et al., 2015; Moore, Crosby, Young, et al., 2010; Printz, 2013). Further, participants who did not intend to receive the HPV vaccine cited vaccine safety and low perceived need as their motivating reasons; those intending to receive the vaccine cited practical concerns, such as cost, as barriers to receiving vaccination (Gerend, Shepherd, Shepherd, 2013). One study consistent with the Information-Motivation-Behavioral Skills model suggested that well-informed individuals who were motivated to act on their knowledge of the HPV vaccine and possess the behavioral skills necessary to overcome the barriers of vaccination would complete the HPV vaccine series (Fisher, Fisher, Harman, 2003; Fisher, 2012). In alignment with the Health Belief Model, HPV vaccine acceptability was higher when people believed that the vaccine was effective, a physician recommended it, and HPV infection was likely (Becker, 1974; Brewer, Fazekas, 2007).

Though these generalized determinants of HPV vaccination have been helpful, a more in-depth analysis at the county-level is needed in order to understand disparities in HPV vaccine uptake and to identify specific populations who are at risk for not receiving the vaccine. Within the state of Georgia, only 33.2% of female and 15.3% of male adolescents aged 13-17 years received greater than or equal to 3 doses of the HPV vaccine (CDC, 2014). This finding reveals that female vaccination in Georgia falls below the national average of 37.6%, and that male vaccination is slightly greater than the national average of 13.9% (CDC, 2014). The impact of low vaccination rates is seen through health disparities related to the higher incidence of cervical cancer in southern states, including Georgia, compared to other states (Markowitz, Dunne, Saraiya, et al., 2007). Health disparities, particularly in rural areas of the state, may be explained by a combination of culture, economy, and geographical location (Thomas, DiClemente, Snell, 2014). Furthermore, a lack of information about sexual and reproductive health in rural communities can lead to parental mistrust and further healthcare disparities (Thomas, Strickland, Diclemente, et al. 2013).

The focus of the present study was on the South Central Health District (SCHD) of Georgia, a rural public health district comprised of 10 counties. The objective was to conduct a descriptive epidemiological study of HPV vaccination coverage among individuals in the SCHD to provide guidance for targeted vaccination campaigns aimed at adolescents residing in rural communities. This study examined the relationship between demographic and socioeconomic factors to completion of HPV vaccination.

METHODS

Data Sources

Information from the AEGIS.net, Inc. (AEGIS) and the Georgia Registry of Immunization Transactions and Services (GRITS) databases from 2007-2014 were utilized. AEGIS is an intergovernmental health information database that documents health records of clients who sought services provided by the SCHD county health departments. GRITS, a registry managed by the Georgia Department of Public Health, includes complete and current vaccination records from across the state. Clients who received at least one dose of HPV vaccine from a county health department in the SCHD during this time frame were identified from AEGIS. GRITS was then used to measure vaccine series completion of the SCHD clients in case vaccine doses were administered outside of the SCHD. The Augusta University Institutional Review Board approved this study.

Data Variables

By use of AEGIS and GRITS, this research examined age, race, sex, and insurance status as key independent variables of HPV vaccine uptake due to their acknowledged relevance (CDC, 2014) and their availability in the administrative databases. The following variables were evaluated: reported county of HPV vaccine administration in the SCHD (Bleckley/ Dodge/ Johnson/ Laurens/ Montgomery/ Pulaski/ Telfair/ Treutlen/ Wheeler/ Wilcox), age at first vaccination, race (Asian/Black/Native Hawaiian and Other Pacific Islander/Multiracial/American Indian and Alaska Native/Unknown/White), sex (male/female/unknown), and insurance status at the most recent visit to the SCHD (yes/no/unknown). Anyone who received at least one HPV vaccine dose in the SCHD was recorded and completion was defined as having received at least three HPV vaccine doses.

Data Analysis

The data provided by AEGIS and GRITS were used to examine vaccine completion percentages, defined as receiving all three injections in the series, among SCHD clients over time and across counties. A chi-square test for independence analyzed the relationships between categorical variables when each category had at least 5 values; otherwise; a Fisher's exact test was employed. For the continuous variable, age at first vaccination, a t-test was utilized. Counts and percentages were displayed where appropriate. All analyses were conducted using Stata (StataCorp, 2007) with a p-value of $\leq$ 0.05 level of significance.

RESULTS

From 2007 to 2014, county health departments within the SCHD provided at least one dose of vaccine in the HPV series to 2,362 clients throughout the district. Overall, 945 (40%) completed the entire HPV vaccine series. Table 1 shows demographic and socioeconomic characteristics of clients who received at least one dose of HPV vaccine through a health department in the SCHD during this time period. Similar to statewide data, the proportion of females

who completed the HPV vaccine series was significantly greater than that for males ($p < 0.001$). Additionally, the distribution across counties was significantly different ($p < 0.001$) in regard to completion status. In the SCHD data, race was a significant variable in regard to vaccine series completion (p=0.011) with a larger proportion of white clients completing the series compared to other racial groups. The presence or absence of insurance was not significantly associated with vaccine series completion (p=0.441).

Table 1. Demographic and socioeconomic factors associated with completion of the HPV vaccine in the SCHD of Georgia (AEGIS, GRITS 2007-2014)

Variable	Series Incomplete (1417, 60%)		Series Complete (945, 40%)		p-value
	Mean	Std. Dev.	Mean	Std. Dev.	
Age at 1st Vaccination*	12.0	0.1	12.0	0.1	0.054
	Number	Percentage	Number	Percentage	
Sex					
Male	280	19.8	85	9.0	< 0.001
Female	1133	80.0	858	91.0	
Unknown	4	0.3	2	0.2	
County					
Bleckley	71	5.0	61	6.5	< 0.001
Dodge	67	4.7	39	4.1	
Johnson	170	12.0	174	18.4	
Laurens	321	22.7	185	19.6	
Montgomery	222	15.7	49	5.2	
Pulaski	76	5.4	30	3.2	
Telfair	262	18.5	248	26.2	
Treutlen	54	3.8	45	4.8	
Wheeler	64	4.5	47	5.0	
Wilcox	110	7.8	67	7.1	
Race					
Asian	9	0.6	2	0.2	0.011
Black	696	49.1	417	44.1	
Native Hawaiian/Other Pacific Islander	0	0.0	1	0.1	
Multiracial					
American Indian/Alaska Native	10	0.7	14	1.5	
Unknown	4	0.3	0	0.0	
White	6	0.4	3	0.3	
	692	48.8	508	53.8	
Insurance					
Yes	1092	77.1	747	79.1	0.441
No	62	4.4	42	4.4	
Unknown	263	18.6	156	16.5	

*All unknown or missing values for age were removed resulting in n=2339.

Table 2. Number of HPV vaccine doses received by sex in the SCHD (AEGIS, GRITS 2007-2014)

Number of HPV Vaccines Received	Males (n=365)		Females (n=1,991)	
	Number	Percentage	Number	Percentage
1	191	52.3	663	33.3
2	89	24.4	470	23.6
3	85	23.3	858	43.1

After excluding six subjects with unknown sex status, the association between sex and number of HPV vaccine doses received was determined (Table 2). Data relating to the number of subjects who did not receive HPV vaccination in the SCHD were not available. Among those who received at least one HPV vaccine dose in a SCHD county health department, females were more likely to receive all three HPV vaccine doses (43.1%) compared to males, who were more likely to receive only one (52.3%) (p-value < 0.001).

The number of individuals in the SCHD who received their 1st vaccine dose from 2007-2014 is shown in Figure 1. Four individuals were excluded due to receiving their first vaccine dose outside of the evaluation period according to the GRITS database. A peak in initial HPV vaccinations was evident for 2010. However, initial HPV vaccinations in the study population declined in 2011 and remained low.

Figure 1. Individuals in the South Central Health District who initiated the HPV vaccine series by year (AEGIS, GRITS 2007-2014)

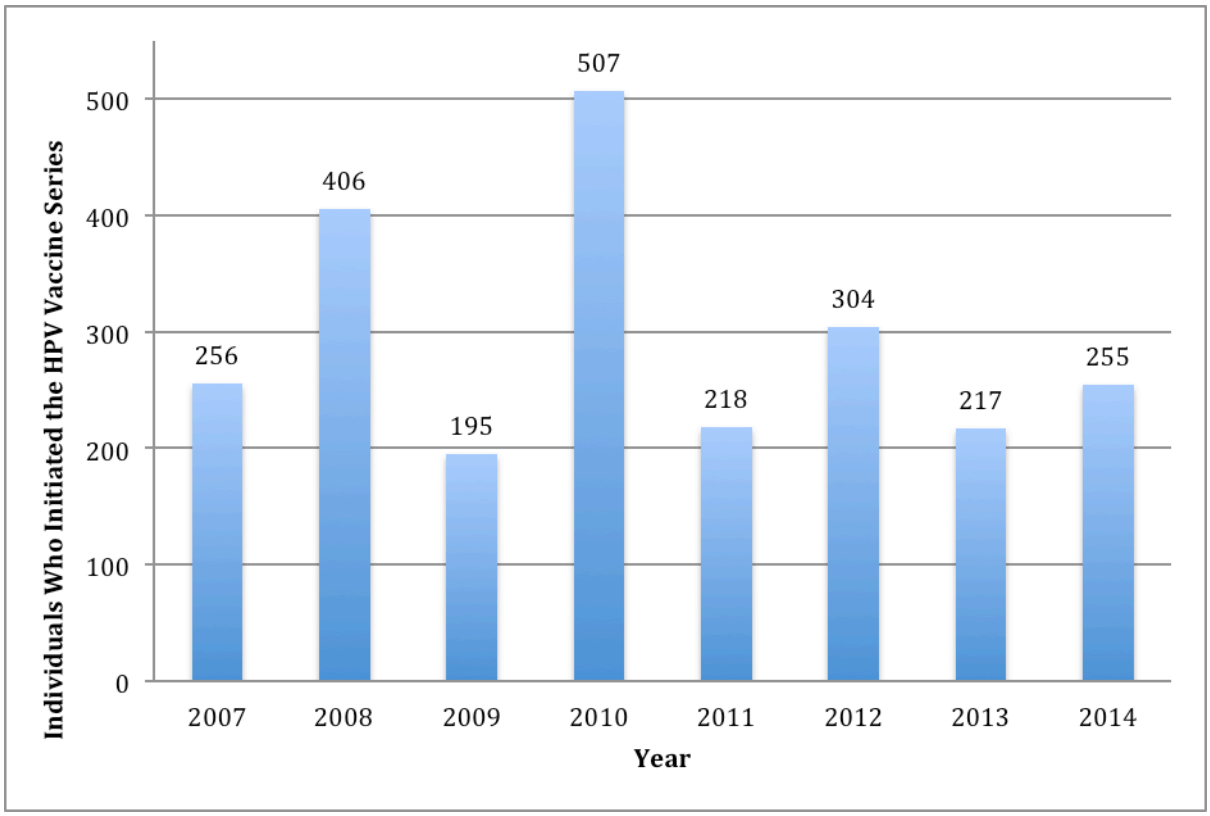
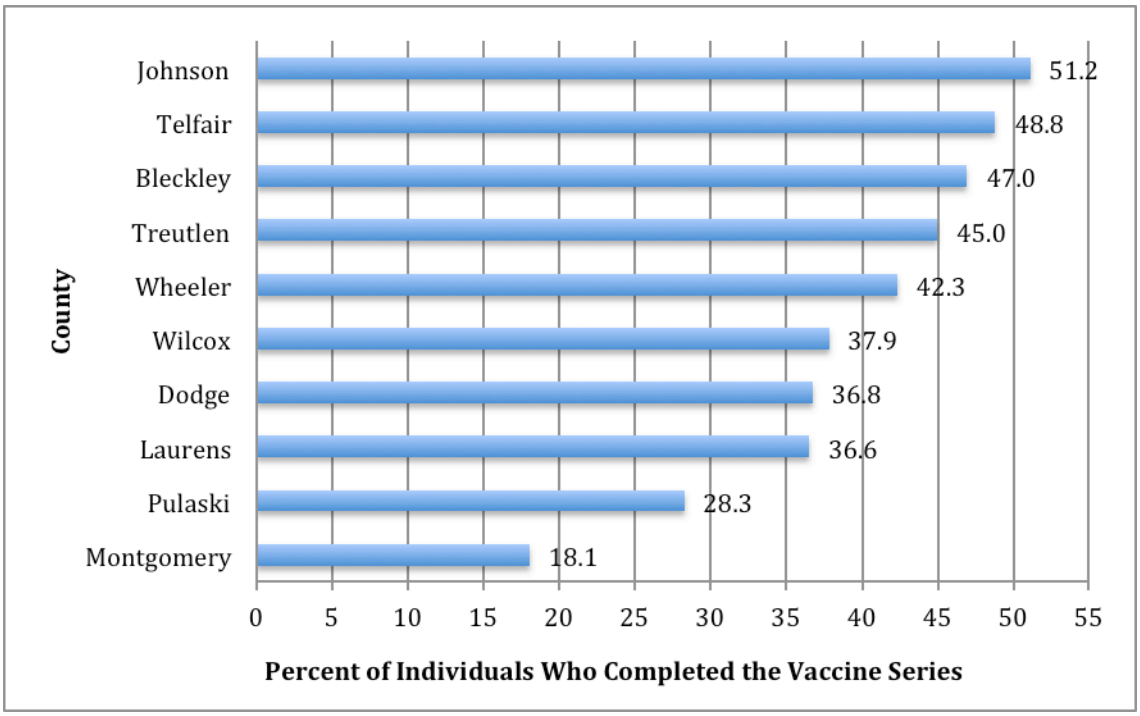


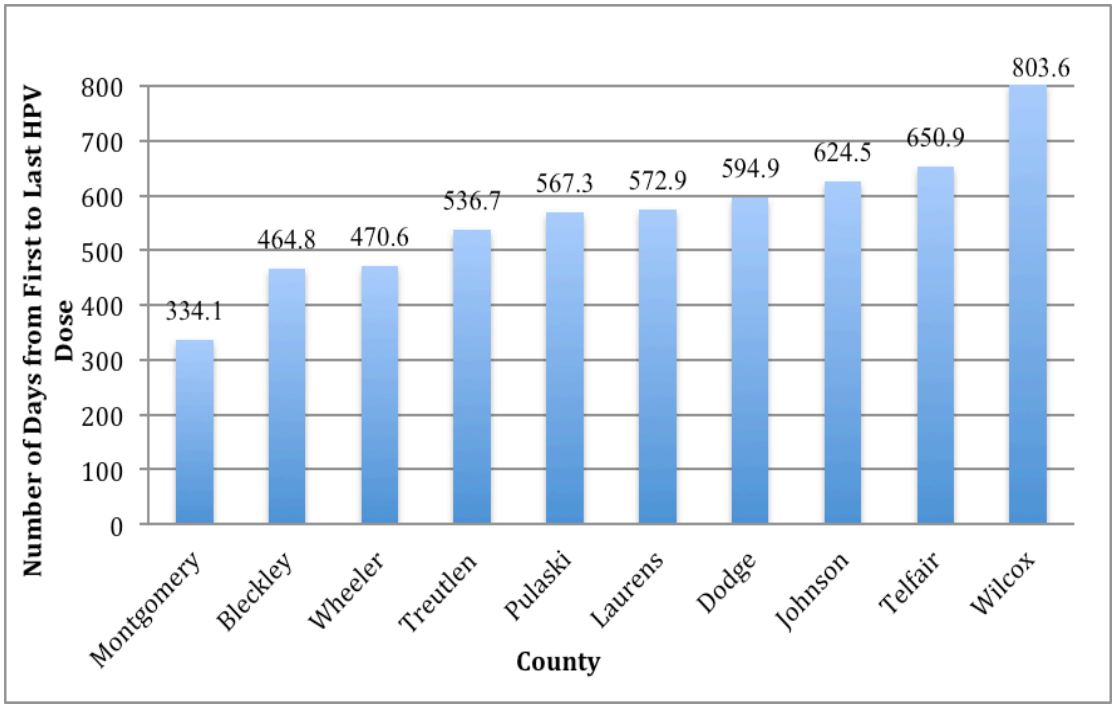
Figure 2 highlights the percentages of vaccine series completion by county among individuals who received at least one vaccine dose at a county health department in the SCHD from 2007-2014. In Johnson County, the county with the highest completion percentage, more than 50% of individuals who received an HPV vaccination completed the series. In contrast, in Montgomery County, fewer than 20% of individuals who received at least one HPV vaccination at the SCHD completed the series. Overall, there was variety in HPV completion percentages across the counties in the SCHD.

Figure 2. Completion percentage among individuals who received at least one HPV vaccine dose through the SCHD by county (AEGIS, GRITS 2007-2014)



Among individuals who completed the HPV vaccine series, the average times to completion across counties served by the SCHD were determined (Figure 3). Montgomery County, at 334 days, had the fastest average series completion time; Wilcox County, at 800 days, had the slowest. Thus, Montgomery County had the lowest completion percentages in the SCHD, but individuals in Montgomery County who completed the HPV vaccine series did so quickly.

Figure 3. Average time to completion among individuals in the SCHD who completed the vaccine series by county (AEGIS, GRITS 2007-2014)



DISCUSSION

In the SCHD, males were fully vaccinated at lower percentages than females. Additionally, in 2010, an increase in vaccine delivery was evident across the study population. This increase was followed by a decline in the years following. On average, the completion percentage in each county in this SCHD subpopulation appeared to be higher than the statewide measure, but was still low. The results for vaccine completion reflect race as a significant variable in the SCHD.

Since rural residence is negatively associated with HPV vaccine initiation (Du, Camacho, McCall-Hosenfeld, et al., 2015), this research is particularly relevant for rural health. In the present study, differences in HPV vaccination percentages among counties were revealed. Completion percentages and average time to completion varied within the SCHD, indicating the individualized needs for each county. Variation among counties is supported by another study evaluating HPV vaccination in Georgia, revealing the importance of a county-level approach to increasing HPV vaccination (Thomas, Strickland, DiClemente, et al., 2013). Moving forward, studies of HPV vaccination in rural areas may benefit from considering county-level differences in addition to larger population analyses to meet the needs of the various communities. Because each county has different healthcare access and delivery challenges, health departments should be encouraged to incorporate a data-driven approach by planning and allocating resources based on the documented needs of their specific subpopulations. However, the most prominent barrier to this approach would likely be the access to and analysis and interpretation of data needed for this type of informed decision making.

Although overall vaccination rates remain low, school-based programs have shown promise in increasing HPV vaccine uptake at the community level. HPV vaccine completion among 11-12 year-old adolescents exceeded 80% in some areas of the UK and in Australia where school-based programs provided the vaccine (Brabin, Roberts, Stretch, et al., 2008; Stretch, 2008; Reeve, De La Rue, Pashen, et al., 2008; Watson, Shaw, Molchanoff, et al., 2009; Brotherton, Deeks, Campbell-Lloyd, et al., 2008). However there have been few studies of school-based programs in the United States, especially in rural settings. Greater insight into this field could be beneficial to the SCHD, as well as to Georgia as a whole. Existing program evaluations showed that school-based interventions were likely to offer other vaccines in addition to that for HPV, provide additional information about vaccination programs, and administer the vaccinations during regular school hours (Stubbs, 2014; Won, Middleman, Auslander, et al., 2015; Caskey, Macario, Johnson, et al., 2013). Further, school-based programs were encouraged to seek long-term financial support, as sustainability of the program budget was a noted weakness (Daley, Kempe, Pyrzanowski, et al., 2014; Hayes, Entzel, Berger, et al., 2013). In one program evaluation, parents whose sons did not have regular doctor's visits were more comfortable with their son receiving the HPV vaccine at a school, indicating a possible target population (Reiter, McRee, Pepper, et al., 2012). Another study assessing parental acceptance of HPV vaccination found that parental opinion on severity of illness and intent to vaccinate adolescents correlated with parental acceptance of school programs, indicating a need for parental education in regard to the importance of the HPV vaccine (Gargano, Weiss, Underwood, et al., 2015). Through further assessment of school-based programs, rural health districts could develop vaccine campaigns best suited to their target population.

Strengths of this study included the fact that, to conduct a comprehensive edpidemiological assessement of this rural population, data were gathered from two sources, GRITS and AEGIS. By utilizing GRITS data, this research allowed inclusion of vaccine data from people who received additional HPV vaccine doses outside of the SCHD. Additionally, this study used a methodological approach to provide evidence-based recommendations for a predominately rural population in Georgia. The results led to a better understanding of the demographic and socioeconomic characteristics associated with HPV vaccine uptake in rural areas.

Limitations included that the information gathered from the SCHD reflected only individuals who had received at least one HPV vaccine dose from one of the ten county health departments. Information regarding adolescents who received HPV vaccinations from private providers in this region or who received additional vaccinations without GRITS documentation was not examined. Furthermore, the residence of the SCHD clients may not have been within the county where they received the HPV vaccine. Additionally, variables assessed were limited to those available in AEGIS and GRITS, which excluded some behavioral, social, motivational, and attitudinal variables that would have been beneficial to evaluate.

As a means of increasing vaccine compliance, future areas of research should focus on why parents or guardians of adolescents choose to vaccinate their children, especially in rural areas. Due to comparable findings at the local level, where overall vaccine uptake and completion was low, targeted interventions should be implemented with a focus on high-risk groups such as males. Furthermore, research could examine the effectiveness of school-based interventions that encourage an increase in HPV vaccine compliance in the general adolescent population across Georgia. Future research could also focus on healthcare provider training in how to address concerns about HPV vaccination. Since healthcare providers have great influence in rural areas, addressing their knowledge and apprehension in providing vaccine recommendations would be a way to affect the larger population they serve.

CONCLUSIONS

By conducting a descriptive epidemiological study of HPV vaccination coverage in the SCHD, we identified demographic and socioeconomic characteristics of individuals who may benefit from additional intervention practices in order to increase uptake and completion of the HPV vaccine series. These individuals include males, non-White clients, and individuals living in counties with low

percentages of HPV vaccine completion. Broad-scale interventions, such as school-based vaccination programs, may be an effective method to increase overall vaccine initiation and completion rates across various demographic and socioeconomic groups, and especially in rural communities.

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