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Understanding Human Papillomavirus (HPV) Vaccination Before and During the COVID-19 Pandemic Using Project NeLL

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DNP Scholarly Work

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Abstract

Background

Assessment of the full impact of the COVID-19 pandemic on public health and healthcare systems is still ongoing, but an area of particular interest is the effect on human papillomavirus (HPV) vaccination uptake which was already suboptimal prior to the pandemic. HPV is the most common sexually transmitted infection in the United States (U.S.) and some subtypes are associated with cancers such as cervical and oropharyngeal among others. Prior to the pandemic, the percentage of adolescents receiving recommended doses of the HPV vaccine was increasing, but the national vaccination rate of 52.3% remained short of the 80% goal set by Healthy People 2030. In Georgia, 67% of adolescents initiated the vaccine series and 45.6 % of adolescents completed the series prior to the COVID-19 pandemic.

Purpose

The purpose of this study was to evaluate HPV vaccine uptake in pediatric patients in Georgia who are eligible for the HPV vaccine series prior to and during the height of the COVID-19 pandemic using a deidentified electronic health record (EHR) database

Methods

This retrospective data analysis used EHR data from Emory University's Project NeLL big data repository to examine HPV vaccine uptake in children and young adults ages 9-21 in the greater Atlanta metropolitan area before and after the height of the COVID-19 pandemic. Yearly trend data and an unpaired two-tailed t-test were used to compare average HPV vaccine uptake and overall vaccine refusal between 2020 to 2021 and 2018 to 2019.

Results

A statistically significant decrease in average HPV vaccine uptake were noted in 2020 and 2021 in comparison to 2018 and 2019. There was no significant difference in overall average vaccine refusal in 2020 and 2021 in comparison to 2018 and 2019.

Conclusion

The statistically significant decrease in average HPV vaccine uptake during the height of the COVID-19 pandemic does not appear to be related to vaccine refusal and indicates that catch-up HPV vaccination is necessary.

Keywords: Human papillomavirus, HPV, Vaccine, Immunization Uptake, Vaccination Levels, COVID-19 Pandemic, Big Data

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Background and Significance

Background

Human Papillomavirus (HPV) is a viral infection that can cause epithelial lesions, which manifest as dermal or anogenital warts and depending on subtype may progress to cancer (Luria & Cardoza-Favarato, 2023). In the United States (U.S.), HPV is the most common sexually transmitted infection with more than 42 million Americans infected with a type of HPV that can cause disease (Berman & Schiller, 2017; Centers for Disease Control and Prevention [CDC], 2024b).

HPV is most known for being associated with causing cervical cancer in women and oropharyngeal cancers in men (CDC, 2024a). Cervical cancer is responsible for 4000 fatalities annually and the death rate in Black and Native American women is 65% higher than in White women (American, Cancer Society [ACS], 2023). Prior to the 1970s, cervical cancer was one of the largest causes of cancer mortality in women, but it was reduced by half with routine implementation of the Papanicolaou test for cervical cancer screening in the 1960s (ACS, 2023; Szasz, 2019). HPV is responsible for approximately 37,800 of the 47,984 annual new cases of cancer in the parts of the body where it is commonly found (CDC, 2024d). In addition to cervical and oropharyngeal cancers, HPV is also associated with vaginal, vulvar, anal, rectal, and penile cancers (Berman and & Schiller, 2017; CDC, 2024d).

Although the rate of cervical cancer has fallen largely through screening efforts since the 1970s, the rate has plateaued in recent years and incidence of vulvar, anal, and oropharyngeal HPV-related cancers is rising (ACS, 2023; National Cancer Institute, 2021; Van Dyne et al., 2018). There is great potential in vaccination as an avenue to prevent HPV associated cancers, particularly those occurring in areas that cannot be screened (National Cancer Institute, 2021). The Gardasil-9 (9vHPV) vaccine is the only distributed vaccine against HPV in the U.S. and it protects against 9 HPV types including types 16 and 18 which cause most HPV associated cancers (CDC, 2024a).

Research studies have shown that the HPV vaccine delivers protection lasting at least 12 years following vaccination (CDC, 2024c). It is also noteworthy that fewer young people are getting anogenital warts with the introduction of the vaccine (CDC, 2024c).

Though HPV is a prevalent infection with the potential for serious consequences and preventable a safe and effective vaccine, vaccinations against HPV remain low with 2021 data showing that 58.5% of adolescents aged 13 to 15 received the HPV vaccination series (Office of Disease Prevention and Health Promotion [ODPH], n.d.a). This figure increased from the 2018 data where only 48% of adolescents aged 13 to 15 received this vaccination series, however both these figures are far from the 80% goal set by Healthy People 2030 (National Vaccine Advisory Committee [NVAC], 2018). Healthy People 2030 initiatives aim to reduce the number of infections of HPV types prevented by the vaccine from 15.1% to 8.7% (ODPHP, n.d.b.). Evidence that the COVID-19 pandemic disrupted the administration of routine childhood and adolescent vaccinations added an additional roadblock to increasing HPV vaccination uptake (Patel Murthy et al, 2021). It is essential for the health of the next generation to improve levels of HPV vaccination.

Significance

National Immunization Survey (NIS)-Teen data from 2016 reported that Georgia adolescents had a 67.3% initiation rate for the HPV vaccination and a 45.6% completion rate for adolescents aged 13-17 (Walker et al., 2017). The data also revealed a difference between initiation and completion when stratified by biological sex, numbers were 77% initiation and 55.4% completion for females and 58.0% initiation and 36.2% completion for males aged 13-17. This data indicates that Georgia's adolescent population has significant room for growth around HPV initial vaccination and series completion.

Adolescents are at a disadvantage medically as they are largely not able to consent to their medical procedures and treatments before they turn 18 and reach legal adulthood. A large portion of surveyed parents of unvaccinated adolescents have reported that they are unlikely at all to

vaccinate their children against HPV and hold concerns that the vaccine is not needed (Hansen et al., 2018). Though parents of unvaccinated female children have reported trends of being more open to HPV vaccination, the parents of unvaccinated male children have continued to report that they are unlikely to vaccinate their child.

Purpose Statement

The purpose of this project is to evaluate HPV vaccine uptake in pediatric patients in Georgia who are eligible for the HPV vaccine series prior to and during the height of the COVID-19 pandemic using a deidentified electronic health record (EHR) database.

Clinical Questions

This research project answers the primary question of if there was a difference in HPV vaccine uptake before and during the height of the COVID-19 pandemic in children and young adults ages 9-21 years of age in the greater Atlanta metropolitan area. There is also the question of if there were differences in overall vaccine refusal for caregivers and patients during the same period and for the same population.

Project Objectives

This retrospective data analysis uses deidentified EHR data from Emory's Project NeLL to obtain demographic data from patients ages 9-21 to understand who is receiving the HPV vaccine. HPV vaccine uptake and patient/caregiver refusal of vaccines will be analyzed.

Project Assumptions

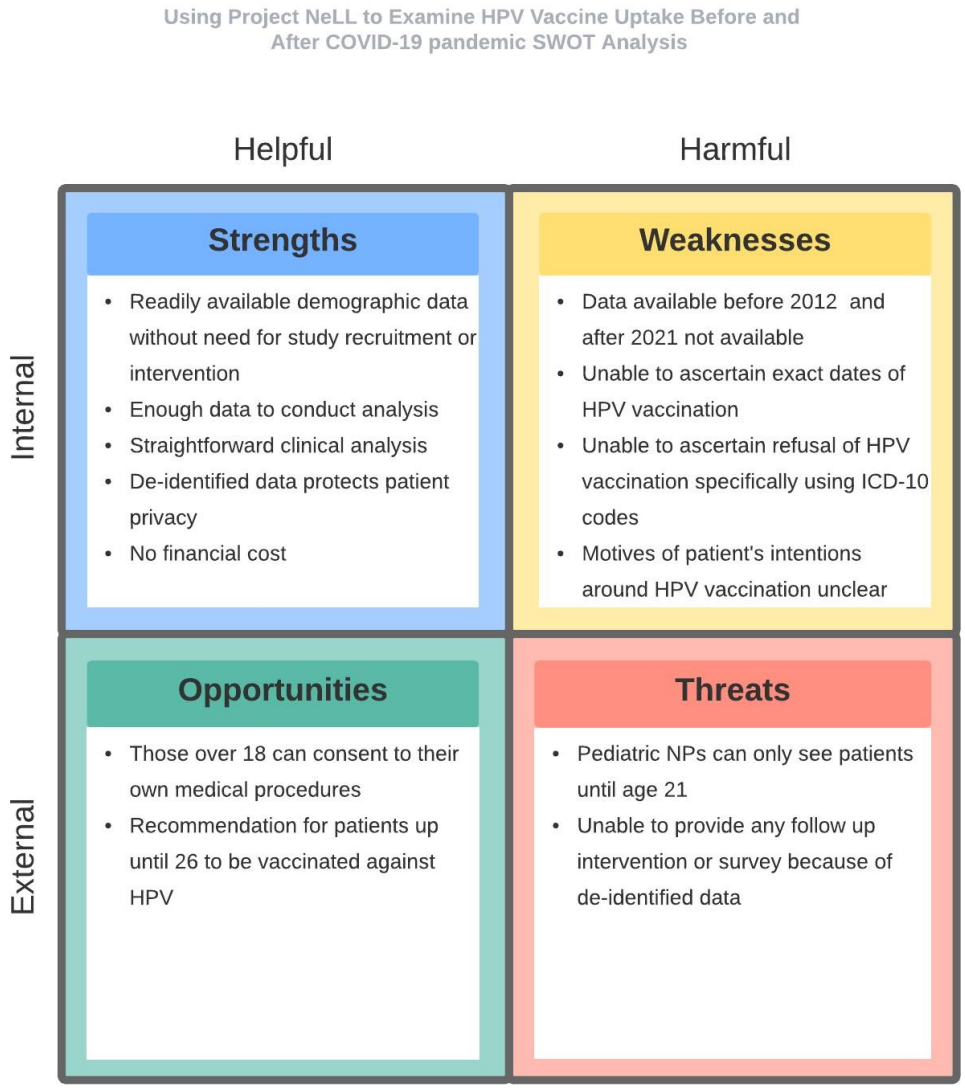
The primary assumption is that those who do not have a history of HPV vaccination or receive the HPV vaccine were offered the HPV vaccine along with other vaccinations. Another assumption is that the EHR is correct in terms of vaccination status. Additionally, there is an underlying assumption that adolescents and their family/caregivers did not vaccinate against HPV because of personal beliefs surrounding the necessity or safety of the HPV vaccine and not because of a stock issue on the

part of the clinic or an allergy to a component of the vaccine. Finally, there is the assumption that patients received their primary care and vaccinations only from the healthcare system where the data repository receives EHR data from.

Project Limitations

Pediatric primary care nurse practitioners are legally prevented from caring for patients beyond the age of 21 with only special exemptions, which limits the upper range of patients included despite the vaccine being currently recommended up until age 26 (CDC, 2024c; Nursing Explorer, n.d.). A limitation to the data being deidentified is that it does not allow for any sort of follow-up educational intervention to improve HPV vaccination levels or surveys to understand why HPV vaccination was not pursued at that time. Project NeLL also only began collecting data in 2012 which excludes the timeframe when the HPV vaccine was initially approved for girls and young women in 2006 and boys and young men in 2009 (Stewart, 2020). At present, Project NeLL does not contain data beyond 2021, which prevents examination of HPV vaccination uptake following the height of the COVID-19 pandemic. Exact dates of patient encounters are not available from Project NeLL, which does not allow for direct comparison between cases of COVID-19 infection and HPV vaccine uptake. Finally, there are limitations in understanding how vaccine refusal impacted HPV vaccine uptake as ICD-10 codes are not specific for patient or caregiver refusal of the HPV vaccine. See Figure 1 below for the entire strengths, weaknesses, opportunities and threats (SWOT) analysis.

Figure 1: Project SWAT Analysis



Theoretical Framework

The theory guiding this project is the Health Belief Model (HBM) (Boston University School of Public Health [BUSPH], 2022). The HBM (Figure 2) was developed in the 1950s by scientists in the U.S. Public Health Service to understand why the public was reluctant to embrace disease prevention strategies such as vaccination and it continues to provide insight in the 2020s about why HPV vaccine uptake remains low. The HBM contains 6 components to explain human action or inaction around a health issue. For this project, these components will be used to explain the contributing factors for reduced HPV vaccine uptake that should be addressed. The HBM provides a framework for understanding human behavior around health, challenges around HPV vaccination, and refining strategies for increasing vaccination rates.

The first two components of the HBM pertain to the individual's perception of the susceptibility and severity of the disease, meaning the individual's perception of the possibility of acquiring HPV and the social or medical consequences of it (BUSPH, 2022). While it is established that HPV is the most common STI in the U.S. with serious consequences for people of both biological sexes, parents of adolescents continue to believe that HPV is not a serious issue for their children (CDC 2024a; Hanson et al., 2018).

Individual perception of susceptibility and severity of HPV being necessary for uptake of vaccination is cause for concern as there is declining overall awareness as HPV as a threat, particularly among males, racial minorities, and rural residents (Chido-Amajuoyi et al., 2021). COVID-19 resulted in over 3 million deaths in 2020 (World Health Organization, 2023). In comparison to COVID-19 in 2020, the likelihood and consequences of contracting HPV seemed less likely.

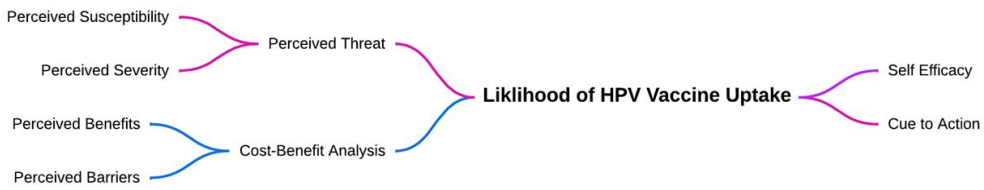
The next two components are perception of benefits and barriers, which are the

individual's perception of the effectiveness of vaccination in reducing the threat of HPV and barriers are the obstacles in receiving the vaccination (BUSPH, 2022). Individuals conduct a cost-benefit analysis to determine if the benefits of vaccination outweigh the perceived barriers. General barriers to HPV vaccination include parental concerns about the risks of the vaccine, lack of knowledge about HPV and the HPV vaccine, and inability to pay for the vaccine (Hanson et al., 2018; Zheng et al., 2021). Beyond vaccine hesitancy, during the COVID-19 pandemic patient family/caregivers cancelled well-child checkups to avoid potential exposure to COVID-19, which has led to delayed vaccinations (Sun, 2021).

The fifth component is a cue to action, such as recommendation of HPV vaccine by a healthcare provider (BUSPH, 2022). Parents of adolescent children state that healthcare provider recommendation is persuasive in the decision to vaccinate their children (Schwartz et al., 2023). Outside of the clinic, community based educational interventions around HPV also demonstrated promising increases in knowledge about HPV and intent to vaccinate (Panagides et al., 2022). With clinic appointments cancelled and community gatherings not possible because of the COVID-19 pandemic, patients and their family/caregivers lacked access to critical information and left vulnerable.

The final component of the HBM is self-efficacy, which is an individual's sense of self confidence about getting the vaccine to protect their health (BUSPH, 2022). Self-efficacy in college students about receiving the HPV vaccine has shown to be greatly influenced by support of peers, family/caregivers, and healthcare providers (Stout et al., 2020). This component highlights the importance of community awareness in influencing the individual's decision.

Figure 2: The Health Belief Model



Literature Review

HPV is the most common sexually transmitted infection in the U.S. and has the potential to cause various cancers such as cervical and oropharyngeal as well as anogenital warts (CDC, 2024a). The HPV vaccine has been found to have nearly 100% efficacy at preventing persistent HPV infection (CDC, 2024c). While HPV vaccination rates have steadily increased in the U.S., they remain far short of the Healthy People 2030 goal of 80% vaccination uptake for adolescents ages 13 to 15 (ODPHP, n.d.a.).

HPV vaccination efforts also faced major challenges during the COVID-19 pandemic that are yet to be fully understood. The U.S. healthcare system, like most global healthcare systems, faced dire challenges that necessitated the sudden reprioritization of healthcare resources during this global emergency. This reorientation led to changes in the provider-patient relationship and as several of the studies included in the review demonstrate efforts to increase HPV vaccination were either paused or greatly disrupted during the COVID-19 pandemic (Kahn, et al., 2021; Kelly et al., 2023; Ryan et al.,2022).

The purpose of this evidence-based project is to gain an understanding of what current research reveals about the scale of disruption to HPV vaccination uptake during the COVID-19 pandemic, the primary causes of that disruption, and lingering impacts that could still be barriers to increasing HPV vaccination coverage in the post-pandemic healthcare landscape. This review serves to take stock of emergent themes in the current body of literature to guide stakeholder

efforts as well as highlight the need for more high-quality studies to better understand the effects of the COVID-19 pandemic on the issue of HPV vaccination uptake. Of particular interest are emerging themes around patient health concerns, public discourse on vaccinations, and drastic changes in healthcare practice because of the COVID-19 pandemic.

Methods

The literature search was conducted using CINAHL and PubMed online tools. CINAHL is a major database for healthcare and biomedicine research from a nursing perspective and includes research from many of the major nursing journals. PubMed is a search engine tool that accesses the MEDLINE database, one of the largest indexes for scientific publications. These two databases offered broad coverage of available research. The years included were from 2020 to 2024 to exclude any literature published prior to the COVID-19 pandemic. In both databases, the following keywords were used to locate relevant articles: "human papillomavirus" OR "HPV" AND "immunization" OR "vaccine" OR “vaccination" AND "rates" OR "levels" OR “uptake” AND "COVID-19" OR “SAR-COV-2” OR "coronavirus disease 2019.”

The initial search on PubMed produced 101,085 papers and CINAHL produced 38,645 results. The inclusion criteria for this review included any original research concerning effects of the COVID-19 pandemic on HPV vaccination uptake. Commentary, editorials, reviews, conceptual models, and book chapters were excluded. Articles were included if they included a pediatric, adolescent, or young adult population. Articles were excluded because they focused on analysis of various topics surrounding both COVID-19 and HPV vaccination but did not specifically address the relationship between the pandemic and HPV vaccination uptake. Articles were evaluated using the Grades of Recommendation, Assessment, Development and Evaluation (GRADE) system (University of Toledo, 2023). Articles which were graded very low quality

were excluded, but some lower-quality articles were included due to their relevance to the topic and recency of the COVID-19 pandemic. Most of the articles produced by the keywords were about COVID-19 and the COVID-19 vaccine, further highlighting how HPV vaccination got lost in the shuffle of the overarching COVID-19 pandemic. The search process ultimately produced 14 relevant articles that met the criteria.

Themes

Developed HPV Vaccination Programs Resist COVID-19 Disruptions

Two studies Patel Murthy et al. (2021) and Lavie et al. (2023) provided high-quality data at a national level that illustrated the challenges and diverse responses among global governments, healthcare systems, and public health leaders as they managed the COVID-19 pandemic attempting to balance other vital public health initiatives such as HPV vaccination. One emerging theme evident in these studies is that the extent to which HPV vaccination uptake was affected in the pandemic appears to be correlated with the sophistication and resilience of a nation's pre-existing HPV vaccination programs.

For instance, using data from 1.4 million school-aged children in Israel, Lavie et al. (2023) found that the pandemic had no appreciable effect on HPV vaccination rates in Israel where the HPV vaccination is administered in schools with parental and patient consent. This stable vaccination rate was despite increased school closures and pandemic-related disruption. Prior to the pandemic, Israel instituted a national campaign to increase HPV vaccination rates and had the benefit of a network of school administered vaccination programs. Similarly, Lavie et al. (2023) noted that data from Australia indicated there was no significant decrease in HPV vaccination uptake during pandemic. However, the researchers noted that the United Kingdom (U.K.) did see a drastic reduction in HPV vaccination rates during the first year of the pandemic

from a high of 86% for school aged children to 59% in 2020. The vaccination rate subsequently recovered the following year after an aggressive public media campaign and catch-up vaccination programs.

In contrast to the results from Israel, the authors of Patel Murthy et al. (2021) found drastic reductions in HPV vaccination rates in the U.S. during the first months of the pandemic, as they observed a median decline of 63.6% in HPV doses administered among adolescents 9-12 years and 71.3% among 13 to 17-year-olds during the first half of 2020 compared with the same span in 2018 and 2019. The authors did note that uptake for routine vaccinations saw similar declines in the early months of the pandemic, followed by recovery once most stay-at-home orders were lifted later in the year. However, HPV vaccination uptake was still down a median of 12.2% for the 9 to 12 group and 28.1% for ages 13 to 17 years-old in June-September of 2020 compared to the same span in 2018 and 2019. This increase in uptake was not adequate to make up for the previous decline, emphasizing the necessity for a coordinated catch-up vaccination public health effort in the U.S.

World Health Organization (n.d). data shows that Australia and the U.K. both had significantly higher rates of HPV vaccination uptake than the U.S. prior to the pandemic, at between 75-79% (AUS) and 84% (UK). This is compared to the U.S. HPV vaccine coverage of between 41-47% and Israel's 46-51% in 2019. Australia and the U.K. both entered the pandemic with proven, highly effective HPV vaccine uptake strategies, which makes their resiliency during the pandemic unsurprising. Israel presents an intriguing case because their pre-pandemic HPV vaccination uptake was much closer to the U.S.'s. This data highlights the need to strengthen U.S. HPV vaccination efforts by bolstering education and promotional efforts and expanding accessibility. Patel Murthy et al. (2021) and Lavie et al. (2023) demonstrated that this kind of

investment helps build vaccination programs that are highly effective and resilient even during a public health crisis.

Fear of COVID-19 as a Barrier to HPV Vaccine Uptake

Increased vaccine misinformation, staffing and resource shortages, and decreased media attention have been proposed as key reasons for reduced HPV vaccination rates in the U.S. during the COVID-19 pandemic. However, the legitimate health concerns patients had about meeting providers in person may have been overlooked as a key barrier, as was noted in multiple studies (Abouelella et al., 2022; Bower at al. 2024; Chido-Amajuoyi et al., 2022; Kahn et al., 2023). Bower et al. (2024) noted that HPV vaccination had an inverse relationship with the number of COVID-19 cases in New York and Long Island. Chido-Amajuoyi et al. (2022) surveyed healthcare workers and found that patient fear of contracting COVID-19 was the top reason cited for both HPV vaccine hesitancy and refusal. Abouelella et al. (2022) also noted increased use of telemedicine and increased fear of contracting COVID-19 as key drivers in reducing HPV vaccine uptake in adolescents during the pandemic. Kahn et al. (2023) surveyed over 1000 primary care providers and found similar results. While 43% of providers reported decreased HPV vaccination uptake during the pandemic, the 7% of providers who reported increased HPV vaccination uptake had implemented specific strategies to reduce patients' potential exposure to COVID-19 (Kahn et al., 2023). These strategies included telehealth appointments, drive-through vaccination clinics, and nurse only vaccination appointments. This finding is particularly interesting because it suggests that the prioritization of patient safety against infection may have been the difference between HPV vaccination uptake increasing or decreasing. This insight should also emphasize the importance of correctly aligning healthcare services and communications strategies with a patient perspective in mind.

COVID-19 Reshapes Routine Healthcare

Several studies further examined the structural shifts and missed opportunities caused by the pandemic that may have contributed to reduced HPV vaccine uptake and may have effects lingering beyond the pandemic (Kelly et al., 2023; Khan et al., 2024; Klassen et al., 2024; Ryan et al., 2022, Schelbar et al., 2024). For instance, Ryan et al. (2022) interviewed 18 clinical managers about their experience during the COVID-19 pandemic. These healthcare professionals identified several key changes in operations that could have contributed to lower HPV vaccination uptake. These include reduced in-person visits, increased stress on healthcare staff, diversion of resources by creating separate units for sick patient care and routine wellness care, and the cancellation of HPV vaccination promotion initiatives as COVID-19 took priority. Khan et al. (2024) also noted stakeholder frustration that resources were scarce during the pandemic and that public health initiatives only addressing the COVID -19 pandemic and vaccination roll out left routine vaccination levels reduced. Schelbar et al. (2024) further emphasized this point by noting that HPV vaccination series completion was far lower than COVID-19 series completion.

Overall, the clinical managers surveyed by Ryan et al., (2022) observed that opportunities for healthcare providers to discuss HPV vaccination decreased during the pandemic, as did the emphasis on HPV vaccination uptake. This is also supported by findings of Kelly et al. (2023), as authors examined over 100,000 well-care visits and found a nearly 16% increase in missed opportunities for HPV vaccination. Klassen et al. (2024) found that 35% of surveyed parents and caregivers of HPV vaccine eligible children stated that they felt that COVID-19 had impacted their ability to get preventative healthcare for their child. Klassen et al. (2024) also found that there was an association between parents and caregivers that felt COVID-19 had affected their

ability to access preventative care and felt a stronger desire to have their children vaccinated against HPV and vaccinated in general. All together this data points to a healthcare system and patient population that were preoccupied with the concerns of the COVID-19 pandemic, resulting in HPV vaccination being deemphasized. Although some of those causes should be rectified in the post-pandemic world, it is also worth noting that many of the issues with staffing, reduced in-person visits from patients, and resource availability remain problematic for many healthcare providers today.

Novel Causes Influencing HPV Vaccination Uptake

Olagoke et al. (2022), Ejezie et al. (2023), Boucher et al. (2023) examined novel factors influencing HPV vaccine uptake during the COVID-19 pandemic that may warrant further investigation. Olagoke et al. (2022) conducted a nuanced analysis of the role that religious beliefs played in HPV vaccination views during the COVID-19 pandemic. They found that certain segments within religious communities were open to learning more about the HPV vaccine, suggesting the need for messaging strategies designed to be delivered in religious settings.

Klassen et al. (2024) had also found a correlation between increased religiosity in parents and caregivers and certainty to vaccinate against HPV. Ejezie et al. (2023) found that rates of HPV vaccination uptake among racial and ethnic minorities were higher than non-Hispanic white adolescents during the pandemic. This reversal of a previous disparity may be explained by racial and ethnic minorities having less access to telemedicine resources, meaning they had more in person visits where healthcare providers had the opportunity to recommend vaccination. Boucher et al. (2023) used a neural network to examine nearly 600,000 English-language tweets related to HPV vaccination during the COVID-19 pandemic. They found little change in the

messaging and tone for groups characterized as vaccine hesitant or anti-vaccination but did note a decline in the mention of the HPV vaccination in pro-vaccine circles. These results suggest decreased attention was being paid to HPV vaccination among key groups that would be interested in the HPV vaccine and this should be considered when designing messaging strategies for catch-up programs. Overall, these studies revealed novel approaches to examining HPV vaccination strategies which could be considered in future vaccination campaigns.

Practice Implications

Understanding the effects of COVID-19 pandemic on HPV vaccination uptake is a vital endeavor with implications for the entire healthcare system and all its stakeholders. As demonstrated in their research, increasing HPV vaccination rates is a community endeavor requiring the support of clinicians, clinic management, and government (Aboulella et al., 2022; Lavie et al., 2023). The current body of literature points to the urgent need for the U.S. to bolster this all-hands-on deck approach to HPV vaccination to build a more effective and resilient vaccination program that can ensure patients continue to receive protection from this virus and its consequences. That may start with ensuring that patients feel assured that when they seek healthcare, they are not at increased risk of getting sick. Prioritizing alternative methods of receiving HPV vaccinations, whether in drive throughs, at home, or in clinical settings with social-distancing and masking policies could help bolster vaccination uptake.

In examining HPV vaccination uptake during the pandemic, we also see the complex and contradictory portrait painted of telemedicine. There is evidence indicating that telemedicine was both a resource that helped providers continue to educate their patients about HPV vaccination and acted as a barrier to in-person interactions necessary for vaccination (Ejezie et al., 2023; Kahn et al., 2023). Navigating this issue will be incredibly important as telemedicine continues

to grow and best practices regarding its use continue to develop. Ultimately, the body of literature on this subject remains in its nascent stage, but synthesizing these lessons from the pandemic will undoubtedly be critical for future efforts to protect patient communities from HPV and guide clinicians and healthcare providers on the optimal practices to support HPV vaccination uptake.

Future Research Suggestions

There are large gaps in the research on the effects that the COVID-19 pandemic had on HPV vaccination uptake, including a dearth of high-quality studies. However, within the current body of literature there are many intriguing questions that can guide future research. Currently, one of the main gaps in research for this topic is the lack of a large-scale study with direct patient data. Many of the articles included in this review were smaller, observational studies that included interviews with providers who were offering second-hand opinions on patient motivations. Other studies that did solicit direct patient perspectives had extremely small sample sizes with demographics that were not representative of their regions or countries.

Additionally, it is critical that more research be done to understand the demographics of patients who did not receive the HPV vaccine during the pandemic so more targeted catch-up efforts can be made. High-quality studies with more patient data will be critical to gaining a better understanding of the factors that resulted in decreases in HPV vaccination uptake and help create robust evidence-based guidelines for community stakeholders, healthcare providers, and public health organizations. Specifically, further data such as that reported by Kahn et al. (2023), on the relationship between vaccination uptake and feelings of patient safety will be important in identifying which practices may make HPV vaccination more convenient and support higher

uptake. Novel questions such as designing communications for religious settings or researching the efficacy of different social media strategies also deserve more investigation.

Ultimately, our understanding of the factors that influenced HPV vaccination uptake during the COVID-19 pandemic are currently incomplete. But until that data is available, it is essential for stakeholders to begin putting these early lessons into practice by building better relationships with their patients, adopting thoughtful messaging strategies, and offering care options that remove key barriers to HPV vaccination uptake.

Setting

Sample

Patients of both biological sexes between the ages of 9-21 were included in this study across the years 2018-2021 from the Project NeLL EHR database. There were three pathways used to find data in the NeLL EHR database: using CPT codes 90649, 90650, and 90651 for HPV vaccine administration, filtering for medications prescribed & administered (HPV vaccine) and further filtering for medications administered, and using ICD-10 codes for caregiver refusal of vaccine (Z28.82) and patient refusal of vaccine (Z28.21). The CPT codes for encounters for the HPV vaccine produced 1527 encounters and the HPV vaccine administration pathway produced 1082 administrations from 2018 to 2021. For general vaccine refusal there were 18 encounters for caregiver refusal of vaccine (Z28.81) and 288 encounters for patient refusal of vaccine (Z28.21) from 2018 to 2021.

The Project NeLL database contains deidentified EHR information from a large metropolitan hospital system in the greater Atlanta area (Perez, 2020). The hospital that the pediatric data primarily comes from serves patients from Dekalb, Fulton, Gwinnett, Cobb,

Henry, and Clayton counties (Emory Healthcare, 2022). In terms of racial demographic, the population served by the hospital is 40% African American Non-Hispanic, 36% Caucasian Non-Hispanic, 13% Hispanic, 8% Asian & Pacific Islander, and 3% other. The patient population is 52% female and 48% male and 24% is under age 18 and 24% is between the ages 18 and 34. In terms of insurance status, 13% of the patient population is uninsured.

Community stakeholder information for areas serviced by the metropolitan Atlanta hospital stated that behavioral issues impacting health are not receiving available vaccinations and not receiving health maintenance exams and recommended screening (Emory Healthcare, 2022). These are factors that could influence uptake of HPV vaccination. Survey participants also listed access to healthcare and affordability of healthcare as environmental factors influencing health for this population. Those who listed healthcare access as a significant environmental factor of health further elaborated that lack of health insurance, the cost of healthcare even with insurance, lack of available appointments, and lack of transportation among other factors as barriers to healthcare access (Emory Healthcare, 2022).

Inclusion and Exclusion Criteria

Then following were included in the dataset: patients of both biological sexes, patients receiving care in greater Atlanta metro area in Georgia, patients with and without insurance, and patients who received the HPV vaccine. The following were excluded from the dataset: patients below the age of 9, patients above the age of 21, data from clinical encounters before 2018, and patients who have no record of the HPV vaccine.

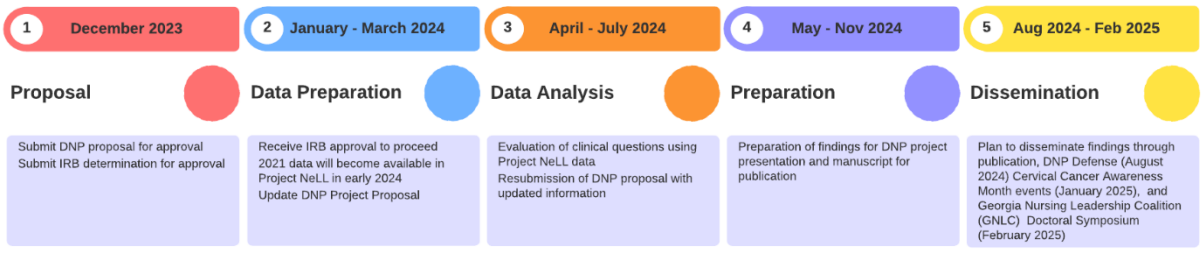
Methods

Data Collection

The Project NeLL database being used for this project was developed by staff at the Emory School of Nursing Center for Data Science (Project NeLL, n.d). It contains de-identified patient data from Emory healthcare that was obtained with the help of the Emory University Data Solutions Group. The database currently contains data from the years 2012 to 2021. The data represents hospital and clinic data for patients receiving healthcare at Emory affiliated hospitals. Demographic data was collected for patients aged 9-21 who receive the HPV vaccination using CPT codes. Patient data was also be acquired for patients with a history of HPV vaccine administration using the medication administration NeLL pathway.

No clinical intervention was completed as a part of this scholarly project. De-identified secondary patient data from Project NeLL was used to answer clinical questions. Patient privacy in NeLL is thoroughly protected through de-identification methods compliant with Health Insurance Portability and Accountability Act (HIPAA) regulations (Project NeLL, n.d.). Patient ID numbers are anonymous, dates of encounters have been shifted, and zip codes are limited to the 3-digit level to protecting patient privacy.

Timetable for Scholarly Project



Resources

Project NeLL access is available to students at Nell Hodgson Woodruff School of Nursing at Emory University (SON) at no cost. GraphPad Prism and Microsoft Excel was used for data analysis. The director of database projects at Project NeLL was a key personnel resource.

Dissemination Plan

This project sought to examine what affect that the COVID-19 pandemic had on HPV vaccine uptake in the greater Atlanta metro area. Results from this research can be used to plan targeted HPV vaccine outreach initiatives as well and understand how big data can be applied to understand health problems such as HPV vaccine uptake. Those who would benefit from this research include pediatric primary care healthcare providers, primary care providers for young adults, pharmacists, cancer centers, patients eligible for the vaccine and their parents/guardians, and organizations involved with increasing HPV vaccine uptake in the Southeastern U.S.

Current plans for dissemination involve working with organizations that are interested in increasing HPV vaccine uptake such as the HPV Workgroup. Additionally, conferences will be identified to share findings with healthcare providers and findings will be prepared for publication in either a pediatric or vaccine centered journal. The HPV Workgroup was established as a connection during the search for partner sites and the author will reach out when findings are ready to be disseminated. An abstract will be submitted for a conference in Georgia Nursing Leadership Conference (GNLC) in January 2025 that will allow connection with healthcare providers. Cervical cancer awareness month events in January 2025 will also allow for connection with eligible patients and their families as well as cancer healthcare providers

Data Analysis

The data was analyzed using unpaired two-tailed t-test to examine whether there were statistically significant differences in average HPV vaccine uptake or general vaccine refusal to compare groups from 2018-2019 and 2020-2021. For statistical analysis of overall vaccine refusal, immunizations not carried out because of patient and caregiver were combined. Trend data was examined for yearly HPV vaccine uptake and general vaccine refusal from 2018-2021.

Results

The average CPT encounters (Figure 5) and Medication Administrations (Figure 6) for the HPV vaccine were reduced in a statistically significant way in 2020 to 2021 in comparison to 2018 to 2019. The average overall vaccine refusal did not show a significant difference between 2020 to 2021 in comparison to 2018 to 2019 (Figure 8). Yearly trend data for CPT encounters (Figure 3) and Medication Administration (Figure 4) for the HPV vaccine both showed a decline in 2020 and 2021, though the number of CPT encounters for the HPV vaccine were considerably higher than the Medication Administration. Yearly trend data for overall vaccine refusal showed an increase in 2020 for immunizations not carried out due to patient refusal but then subsequently decreased in 2021 (Figure 7).

The data could only be analyzed on a yearly basis due to the randomization of dates within a year by the Project NeLL repository to protect patient privacy. Due to exact dates not being available, a direct comparison could not be made to COVID-19 cases in the community and resulting HPV vaccine uptake. The ICD codes for immunization not carried or for patient/caregiver refusal left the exact vaccine being refused unspecified.

Figure 3

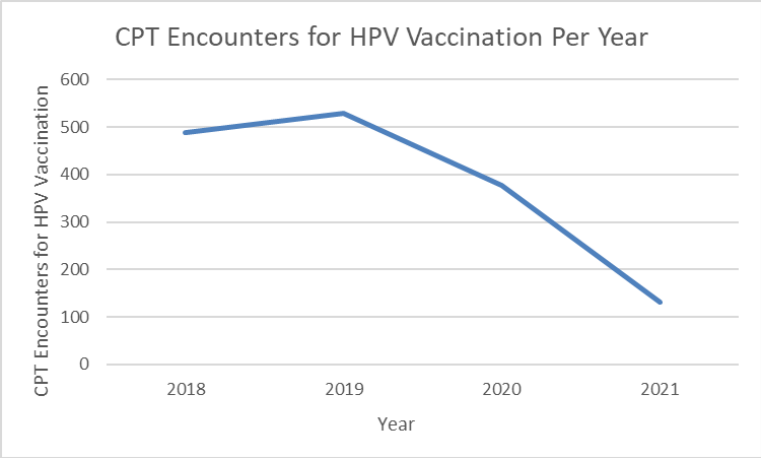


Figure 3: Trend data for CPT Encounters for HPV Vaccine Administration show an increase from 2019 to 2019 and subsequent decreases in 2020 and 2021.

Figure 4

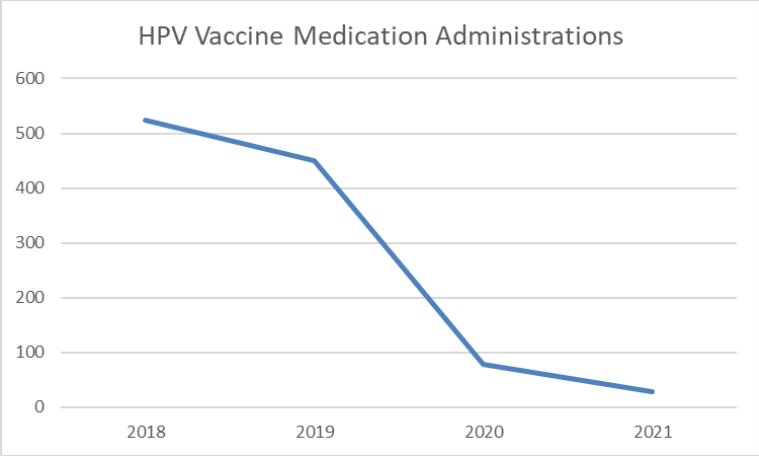


Figure 4: The trend data shows a small decrease in HPV Vaccine Administration from 2018 to 2019, a larger drop between 2019 and 2020, and then another small decrease in 2021.

Figure 5

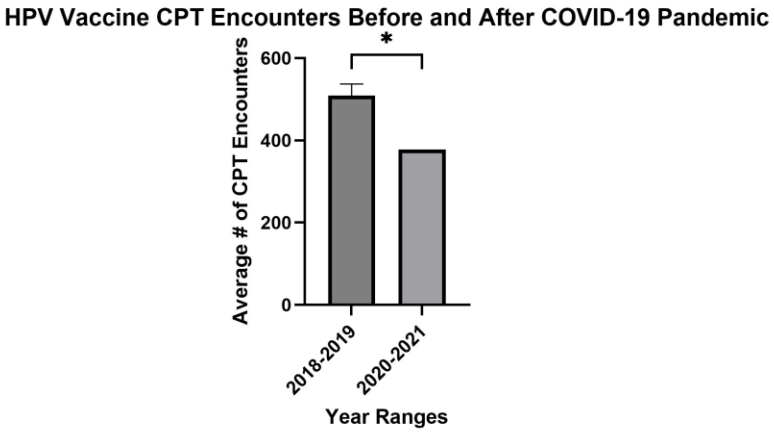


Figure 5: The unpaired two tailed t-test shows a statistically significant reduction in average HPV Vaccine CPT Encounters in 2020 and 2021 in comparison to 2018 and 2019. *P value: 0.0238.

Figure 6

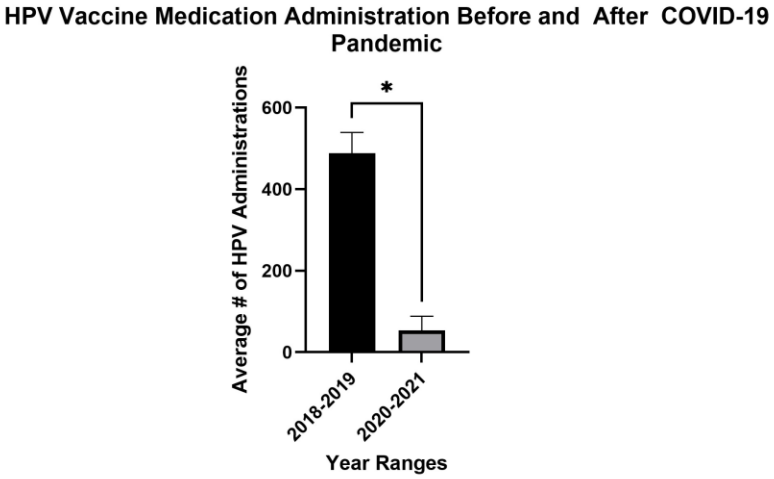


Figure 6: The unpaired two-tailed t-test shows a statistically significant reduction in average HPV Medication Administration in 2020 and 2021 in comparison to 2018 and 2019. *P value: 0.0101.

Figure 7

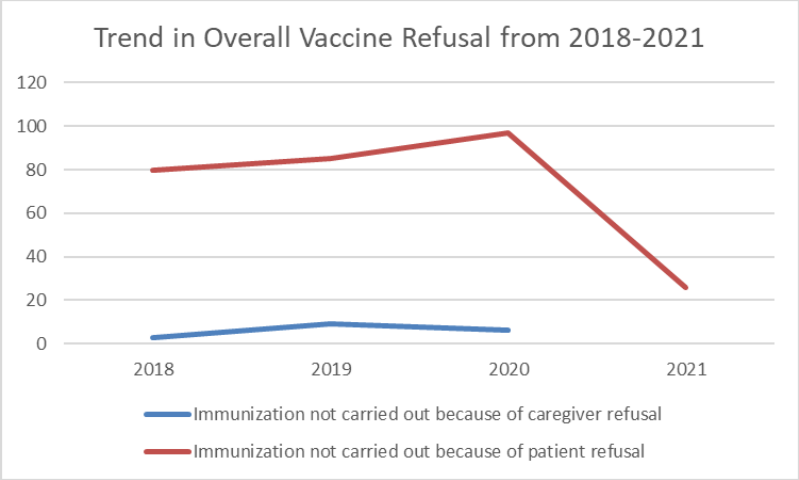


Figure 7: Trend data for overall vaccine refusal per year shows a slight increase for immunization not carried out because of patient refusal in 2019 and 2020 and then a marked decrease in 2021 and consistently low immunizations not carried out because of caregiver refusal from 2018 to 2020 and none in 2021.

Figure 8

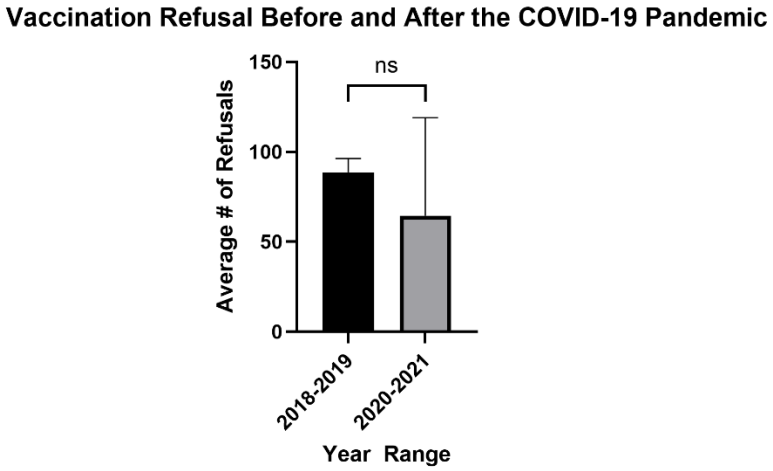


Figure 8: The unpaired two tailed t-test shows no significant difference between average overall vaccine refusal by caregiver or patient in 2020-2021 in comparison to 2018-2019. P value: 0.6001.

Discussion and Conclusion

Average CPT encounters and medication administrations for the HPV vaccine were reduced in a statistically significant manner during the height of the COVID-19 pandemic in comparison to pre-pandemic levels. The influential factors in the decrease of HPV vaccine uptake were likely the COVID-19 pandemic and COVID-19 vaccine roll out. This reduction in HPV vaccine uptake result appears not to be the result of vaccine refusal as the average vaccine refusal for all vaccines showed no difference pre and post COVID-19 pandemic leaving it unable to account for the reduction in HPV Vaccine CPT Encounters and/or HPV Medication Administration. It is unclear why the numbers of HPV medication administrations and CPT encounters differed drastically in 2020, but the overall average for 2020 and 2021 showed a reduction in HPV vaccine uptake.

These results indicate that HPV vaccination should be a priority for both pediatric and adult healthcare providers as many patients missed the opportunity to be vaccinated against HPV during the 2020-2021 period and some may have aged out of pediatric care. It is imperative to continue this data analysis with data from 2022 onwards when available to see if any catch-up progress was made with vaccination.

Recommendations and Implications

The reduction in HPV vaccine uptake in combination with the lack of change vaccine refusal rates indicate that vaccine refusal indicate that future research should examine other causes to reduction in HPV vaccination during the height of the COVID-19 pandemic. It was unable to be ascertained by this project if there was a direct relationship between COVID-19 cases in the community and reduction in HPV vaccine uptake. Strategies in increasing HPV

vaccination should be a priority, and future research should focus on determining how to approach vaccination during future public health emergencies.

Evaluation of the Process and Experience

Throughout this project I was able to learn so much about HPV vaccination, vaccine hesitancy, and project management. I have been able to learn how to be a lead author through improving my scholarly research, data analysis, and writing skills. Though I had initially hoped to do an educational intervention to improve HPV vaccine uptake and made some headway through networking, I was not able to find a clinic collaborator. I took the opportunity to utilize resources available at Emory, such as Project NeLL, and was able conduct a retrospective data analysis and answer an important question. I am proud of all that I have been able to accomplish through my DNP scholarly work and with the mentorship of my DNP faculty advisor Dr. Stacy B. Buchanan.

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