THE ROLE OF PHARMACY IN HPV VACCINATION OF U.S. ADOLESCENTS

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ABSTRACT

Parth D. Shah: The role of pharmacy in HPV vaccination of U.S. adolescents
(Under the direction of Noel Brewer)

Purpose. Pharmacies could play a meaningful role in improving HPV vaccine uptake in US adolescents. This dissertation aimed to evaluate the intrapersonal, provider, and structural factors related to pharmacies as vaccination settings that might motivate parents to obtain pharmacist-provided HPV vaccinations for their children.

Methods. *Aim One:* I conducted structural equation modeling to evaluate how the type of pharmacy parents (n=1,504) use to get medications for their adolescent children was associated with willingness to get these children HPV vaccine from pharmacists. *Aim Two:* I conducted analysis of variance and multiple regression models to examine how parents (n=1,500) perceived relative advantages of vaccine delivery in pharmacies compared to doctors' offices. *Aim Three:* I conducted geospatial analyses to assess whether community pharmacists can improve access to HPV vaccination services in primary health care shortage areas in Texas, which allows pharmacists to immunize adolescents.

Results. *Aim One:* Compared to parents who used chain pharmacies, parents who used independent pharmacies were less willing to get their adolescent children HPV vaccine from pharmacists (β=-.094; p=.001). Service quality and satisfaction suppressed this relationship. *Aim Two:* Parents were more willing to get their children HPV vaccine from a pharmacist if they indicated more relative advantages in vaccine delivery in pharmacies (β=.29; p<.001), and if they believed vaccine delivery features related to patient accessibility were more important than

features related to the health care environment (β=.20; p<.001). *Aim Three:* When pharmacists were included as adolescent vaccine providers along with primary care physicians, census tracts shifted towards adequate coverage in 35% (1,055/3013) of urban tracts and in 18% (92/521) of rural tracts.

Conclusion. Pharmacies could increase HPV vaccine uptake by improving parents' perception of service quality at pharmacies they use. Pharmacies that provide adolescent vaccinations should capitalize on their relative advantages in patient accessibility over doctors' offices, while also improving on vaccine delivery features related to the health care environment which parents believed to be superior in doctors' offices. Pharmacists could potentially increase access to HPV vaccination for parents and adolescents in states that allow pharmacists to immunize adolescents.

To my parents Dilip and Shivani, my sister and brother-in-law Megha nd Dave, and my aunt and cousin Urmi and Anagha.

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LIST OF ABBREVIATIONS

AAP	American Academy of Pediatrics
AAPOR	American Association for Public Opinion Research
ACIP	Advisory Committee on Immunization Practices
ANOVA	analysis of variance
APhA	American Pharmacists Association
AVIP Study	Adolescent Vaccinations in Pharmacies Study
BIC	Schwarz's Bayesian information criterion
BRFSS	Behavioral Risk Factor Surveillance System
CDC	Centers for Disease Control and Prevention
CFA	confirmatory factor analysis
CFI	Bentler’s Comparative Fit Index
CHIAS	Carolina HPV Immunization Attitudes and Beliefs Scale
DIO theory	Diffusion of Innovation Theory
FDA	Food and Drug Administration
FIML	full information maximum likelihood
GIS	geographic information system
HPSA	health professional shortage area
HPV	human papillomavirus
MI	multiple imputations

NACDS	National Association of Chain Drug Stores
NIS-Teen	National Immunization Survey-Teen
NVAC	National Vaccine Advisory Committee
PCP	President's Cancer Panel
RMSEA	root mean squared error approximation
SEM	structural equation model(ing)
Tdap	tetanus, diphtheria, acellular pertussis
TLI	Tucker Lewis Index
ZCTA	Zip Code Tabulation Area

CHAPTER ONE. OVERVIEW AND SPECIFIC AIMS

Widespread uptake of human papillomavirus (HPV) vaccine could prevent thousands of cases of anogenital cancers, including cervical, vulvar, anal, penile, and possibly oropharyngeal cancers. As of 2014, only 40% of girls and 22% of boys ages 13 to 17 have completed the 3-dose HPV vaccine series. This coverage is markedly lower than coverage for other adolescent vaccines in the United States[1] and is well below the Healthy People 2020 goal of 80% for teenagers ages 13 to 15.[2] The underuse of HPV vaccine has been the target of many studies and interventions aimed at improving immunization rates. In 2014, the President's Cancer Panel recommended expanding HPV vaccination to complementary medical settings, including pharmacies.[3] More recently in 2015, the National Vaccine Advisory Committee also supported pharmacist-provided HPV vaccination,[4] recognizing that pharmacists and pharmacies can play an important role in improving access to and opportunities for adolescents to obtain HPV vaccine.

To date, most empirical research on pharmacy provision of HPV vaccine, and more broadly pharmacy provision of adolescent vaccines, has been limited to investigating policy issues regarding pharmacist authority to provide HPV vaccine, and parents' attitudes toward obtaining the vaccine in this setting, such as comfort with and support of vaccinations in pharmacies or by pharmacists.[5,6] These previous studies, however, have not examined explicitly how pharmacies can improve their utility as vaccination settings within American communities. Thus, in order to make pharmacies more viable as alternative settings for the provision of HPV

and other adolescent immunizations, more work is needed to understand the intrapersonal, provider, and structural factors related to pharmacies as vaccination settings that might motivate parents to obtain pharmacist-provided HPV vaccinations for their children. Evidence of these factors that characterize pharmacies as safe and appropriate adolescent vaccination settings would, in turn, greatly inform evolving health care policies around pharmacy practice that look to expand the pharmacist's role in cancer care and prevention. Thus, my dissertation has the following aims:

Aim 1. Establish the role of pharmacy type in parents' willingness to get their children HPV vaccine from pharmacists.

One unstudied area of pharmacy provision of HPV vaccine is how the type of pharmacy that a family typically visits may affect a parent's willingness to obtain HPV vaccine for their child from a pharmacist. Most research on parents' intentions or vaccination behaviors in alternative vaccination settings has categorized all pharmacies as a single type of setting but has not accounted for the various types of pharmacy that exist (e.g., chain drug store or local independent pharmacy). Thus, it is unclear how the type of pharmacy that a family frequents may affect a parent's willingness to obtain HPV vaccine for their child in that setting. Additionally, linking the intervening attitudes and emotions associated with a type of pharmacy to parents' willingness has not been explored. Marketing research has shown that perceptions of service quality and service satisfaction that are associated with a business correlate with purchase intentions of goods and services,[7] an extension of the appraisal, emotional response, and coping framework described by Lazarus.[8,9] As such, these services constructs may be associated with parents' willingness to get their children HPV vaccine from a pharmacist. Accounting for the

variability in pharmacy type and parents' impressions of service quality and satisfaction may help pharmacies improve their vaccination services. Moreover, the application of these services constructs will be a novel approach to understanding possible cognitive and emotional processes that may motivate behavioral intentions regarding HPV vaccination.

Aim 2. Identify whether perceived advantages of vaccine delivery in pharmacies over doctors' offices predict parents' willingness to get their children HPV vaccine from a pharmacist.

A second important but unstudied area is how pharmacies compare to primary care clinics as vaccination settings. Research suggests that parents prefer getting HPV vaccine for their children at doctors' offices. However, no studies have examined whether different features of vaccination services, such as convenient hours and privacy, may lead parents to choose a pharmacy or a doctor's office as a superior vaccination setting. Clarification of the provider characteristics that differ between pharmacies and doctors' offices and how they are associated with vaccination willingness may enable pharmacies to better align their services to meet parents' expectations in adolescent vaccine provision.

Aim 3. Establish whether pharmacists can improve vaccine provider rates in areas with primary care shortages.

A third understudied area is how pharmacists can address geographic disparities in HPV vaccination coverage. Previous research suggests that pharmacists are more frequently located in areas with poor access to health care resources than are primary care physicians.[10,11] Preliminary findings from the UNC Adolescent Vaccinations in Pharmacies (AVIP) study suggest that

parents live closer to pharmacies than to their children's doctors' offices. Providing empirical evidence that pharmacies could potentially alleviate primary care access issues in areas could direct the development of public health interventions to improve vaccination rates in locations that can be considered "health care deserts". Additionally, a geographic study assessing access to health care settings can help inform state pharmacy practice policies intended to expand pharmacist-provided HPV vaccination.

CHAPTER TWO. REVIEW OF HPV VACCINATION AND PHARMACY VACCINE PROVISION

OVERVIEW

In this literature review, I give a broad overview of HPV vaccine and pharmacy vaccine provision. I first review the public health significance of HPV infections and vaccination. Second, I give a summary of trends of HPV vaccine and other adolescent vaccines in the United States. Third, I provide a rationale for why pharmacies may be a more promising setting for vaccine delivery, and characterize the level of support that has been given to pharmacist-provided HPV vaccinations. I conclude with the current state of HPV vaccination and other adolescent vaccinations research in pharmacies.

PUBLIC HEALTH SIGNIFICANCE OF HPV VACCINATION

HPV is the most common sexually transmitted infection in the United States.[12] Approximately 79 million Americans are currently infected with HPV, and an estimated 14 million people become newly infected each year.[13] The prevalence of HPV infections is highest among younger females, with 25% of girls ages 14 to 19 and 45% of women ages 20 to 24 infected,[14] while estimates for males vary substantially from study to study.[15] Over 40 distinct types of HPV can infect the genital tract, but around 90% of infections are self-limiting and resolve in two years.[16] However, persistent infection with high-risk subtypes causes an estimated 360,000 new cases of genital warts[3] and 26,900 new cancer cases[17] each year (anal, cervical, oral-pharyngeal, penile, vaginal, and vulvar cancers). An estimated 11,700 deaths occur each

year due to HPV-related cancers based on cancer-specific death estimates from the American Cancer Society[18] and an assessment of HPV types in cancers.[19] Direct medical costs associated with preventing and treating HPV-related diseases amounts to $8 billion annually.[20]

In 2006, the Food and Drug Administration (FDA) approved a three-dose quadrivalent HPV vaccine that protects against four common subtypes of HPV (6, 11, 16, and 18), conferring immunity against invasive HPV infections that cause 90% of genital warts and 64% of HPV-related cancers.[21] More recently in 2015, the FDA approved a nine-valent vaccine that protects against five additional subtypes (31, 33, 45, 52, and 58) conferring immunity to infections that cause an additional 10% of HPV-related cancers in men and women.[22] The Advisory Committee on Immunization Practices recommends routinely vaccinating all adolescents ages 11 to 12 with the three dose series of HPV vaccine.[21] Catch-up vaccinations are recommended for females up to age 26 and for males up to age 21.[21]

HPV vaccine has proven to be safe since its approval in the United States, and studies on its effectiveness have shown promising results. From 2006 to September 2015, more than 86 million doses of HPV vaccine were administered in the United States.[21] Randomized controlled trials[23] and post-licensure data[21] have shown no major side effects attributed to HPV vaccination. While long-term effectiveness of HPV vaccine in preventing cancer incidence is yet to be demonstrated, studies have shown the vaccine to be highly effective at reducing HPV infections,[23-27] genital warts,[24,26,27] and precancerous lesions.[25,28] One study of Australian females less than 21 years old documented a reduction in the prevalence of genital warts by 93% by 2011 after the introduction of a nationalized HPV vaccination program in 2007.[26] A more recent study conducted in the United States showed a 56% reduction in the prevalence of vaccine-type HPV among young females ages 14 to 19.[27] While fewer studies have been conducted in males, one

large, multinational trial exhibited the vaccine's efficacy in preventing HPV infections in a sample of males ages 16 to 26.[25]

Despite HPV vaccine's apparent benefits, vaccination coverage remains low in the United States. The most recent coverage estimates from 2014 show that HPV vaccine series completion is around 40% for girls and 22% for boys ages 13 to 17.[1] Suboptimal vaccination leaves millions of adolescents exposed to preventable HPV infections and HPV-related diseases, signaling the need to address this important public health problem.

ADOLESCENT VACCINATION PATTERNS IN THE UNITED STATES

HPV vaccine is part of an adolescent immunization schedule that also includes tetanus, diphtheria, and acellular pertussis (Tdap) booster and meningococcal vaccines, all of which are recommended for routine vaccination for adolescents starting at age 11 or 12.[29] The U.S. Department of Health and Human Services created coverage objectives for these three vaccines as part of the Healthy People 2020 initiative, targeting coverage at 80% for adolescents ages 13 to 15.[2] As of 2014, Tdap booster and meningococcal national vaccine coverage are at 88% and 79% respectively among 13 to 17 year olds,[1] demonstrating rates that have either surpassed or are close to the Healthy People 2020 benchmark for adolescent ages 13 to 15. These data show that national HPV vaccine coverage is consistently lower than national coverage of Tdap and meningococcal vaccines. In spite of relatively good national coverage for Tdap and meningococcal vaccines, substantial variation exists among US states in coverage of all three vaccines among adolescents ages 13 to 17. Tdap vaccine coverage ranges from as low as 71% (Mississippi and Idaho) to as high as 95% (Connecticut).[1] Meningococcal vaccine coverage is far more variable, from as low as 46% (Mississippi) to as high as 95% (Pennsylvania).[1] HPV

vaccine series completion is the lowest, ranging from 20% (Tennessee) to 57% (Washington D.C.) for girls, and 9% (Alabama) to 43% (Rhode Island) for boys.[1]

Variable vaccine uptake by state may, in part, be explained by lower health care use patterns among adolescents. Although studies show that adolescents have increased their use of preventive health services over the past two decades, all these studies point to a large percentage of adolescents not routinely attending at least one preventive health care visit with a primary care provider.[30-32] The CDC recommends addressing these missed opportunities to vaccinate adolescents by co-administering multiple vaccines at one visit, known as concomitant vaccination, and immunizing during acute care visits in addition to preventive health care visits.[33] CDC researchers suggest that if the first dose of HPV vaccine were administered when other adolescent vaccines were given, series initiation would be around 93% for 13 to 17 year old girls,[33] and similar estimates possibly achievable for boys. However, completion rates could continue to lag due to the need for additional visits in order to complete the vaccine series. As a result, interest in alternative vaccination settings (i.e., settings outside of traditional primary care clinics) and their utility in the effort to improve HPV vaccine uptake has increased. In a recent review of alternative vaccination settings that I co-authored, pharmacies have been identified as the one of the most promising locations to improve access to and opportunities for HPV vaccinations.[34]

VACCINATION IN PHARMACIES

Vaccination in community pharmacies has become commonplace in the United States. The pharmacy profession has over 20 years of experience providing vaccinations.[35] Currently, all 50 states and Washington D.C. allow pharmacists to immunize.[36] As a result, pharmacists have

played an increasingly large role in vaccination services, particularly for adult populations. The American Pharmacists Association report that consumers make an estimated 250 million visits to pharmacies each week.[37] The National Association of Chain Drug Stores estimates that 93% of U.S. residents live within five miles of a community pharmacy,[38] demonstrating that pharmacists have tremendous reach within American communities. As of 2014, there are 297,100 licensed pharmacists,[39] and among those, an estimated 50% are community pharmacists practicing in 39,000 chain and over 23,000 independently owned community pharmacies located across the United States.[38] Evidence also shows that pharmacists are able to reach medically underserved populations[40,41] in addition to the healthy populations or those with easier health care access. This makes pharmacists one of the most accessible health care providers in the United States.

Over these two decades, pharmacies have successfully implemented high-volume and efficient vaccination programs across the country. Twenty percent of adults received their influenza vaccine from a chain or supermarket pharmacy during the 2011-2012 flu season, an increase from 18% during 2010-2011 flu season.[42,43] A recent study from one large pharmacy chain delivered over 6.2 million vaccine doses to adults over a course of a year.[44] Another local pharmacy chain in Virginia developed an immunization program, and between 1998 and 2007, has delivered over 200,000 vaccines, including 2,500 immunizations to children, of whom over 90% were uninsured.[10] Additionally, a study of California pharmacies found that adult vaccination at pharmacies were provided at a lower unit cost (e.g., labor, materials, and overhead expenses associated with vaccinating a single patient) and more likely to be consistent with ACIP guidelines than vaccination in primary care settings.[45]

Researchers have also noted other additional benefits of going to pharmacies over primary care clinics for vaccinations, namely convenient hours and ease of access.[44,46-48] For

instance, Goad and colleagues found that among the 6.2 million vaccine doses administered at a large chain pharmacy, almost a third of all doses were provided during hours primary care clinics were typically closed.[44] Another study in West Virginia looking among rural population found that convenience of vaccination hours and location of the pharmacy were the two most predictive factors in participating in a pharmacy immunization program.[47] Additionally, patients generally do not need to make an appointment in advance, and in most cases have little or no wait time to get vaccinated.[49] Moreover, the majority of pharmacies do not charge visitation fees that commonly occur in primary care settings.[49] Pharmacists are also consistently ranked as one of the top three most honest and trusted professionals in the United States, below nurses and above physicians,[50] which may also add to their appeal among many patients as immunizers. The established success of pharmacy vaccination services, along with easy access to pharmacies in the surrounding communities, have lead researchers to believe pharmacies may be an ideal location to expand adolescent vaccinations, especially HPV vaccinations.

SUPPORT FOR PHARMACY-LOCATED ADOLESCENT VACCINATION

Over the past decade, several organizations, committees, and panels have taken positions on pharmacy's role in adolescent vaccinations more broadly, and, in recent years, specific to HPV vaccination. Pharmacists' scope of practice has been a continual concern for medical organizations, chiefly those representing pediatricians and family medicine physicians, specialties that provide the vast majority of care to adolescents. Many primary care physicians are not comfortable with adolescent immunizations, especially HPV vaccination, in pharmacies, arguing that stand-alone services will encourage parents to have fewer comprehensive primary care visits for their adolescent children.[51] As a result, medical organizations take positions that

reaffirm physicians as the primary, and preferable source of all preventive care for pediatric patients, preferring pharmacists play a limited role in pediatric preventive care.

One of the earliest to take a position was the American College of Physicians in 2002, who supported pharmacists in their role as vaccine educators, facilitators, and immunizers, "as appropriate and allowed by state law".[52] The Society of Adolescent Medicine in 2006 endorsed the use of pharmacies as a possible alternative setting for adolescents who are unable to access preventive health services to get vaccines, arrange referrals for adolescents to primary care providers to get recommended vaccines, or to furnish vaccine educational materials appropriate for adolescents.[53] In 2010, the American Academy of Pediatrics (AAP) gave limited support for pharmacy-located adolescent vaccinations as state pharmacy practice laws allow it, supporting pharmacist to provide vaccine only if patients have unreliable access to a primary care clinic;[54] although, they have generally continued to oppose expanding pharmacists' role in vaccination. AAP and the American Academy of Family Physicians have both lobbied against expanding pharmacy-based immunization practices to include adolescent vaccinations, especially HPV vaccine.[55] While the concern that pharmacy-based vaccinations would undermine the patient-centered medical home is well intentioned, no evidence supports this concern. Preliminary findings from the Adolescent Vaccination in Pharmacies survey, a national study of parents of adolescents ages 11 to 17, found that only seven percent of parents disagreed that they would take their child to a physician just as often if given the opportunity to get their child vaccinated from a pharmacist (unpublished).

Federal groups, panels, and committees have taken positions that are more supportive of expanding adolescent vaccination to pharmacies. Schaffer and colleagues as part of a CDC working group published a report in 2008 evaluating the capacity and readiness of several

vaccination settings outside the traditional medical home to vaccinate adolescents, and concluded that pharmacies were well-suited within the National Vaccine Advisory Committee's quality standard.[35] In 2014, The President's Cancer Panel made recommendations to expand HPV vaccination to complementary medical settings such as pharmacies in an effort to expand access to HPV vaccine, and ultimately help vaccine uptake.[3] Most recently in 2015, the National Vaccine Advisory Committee (NVAC) provided further support for pharmacist-provided HPV vaccination, identifying pharmacists and pharmacies as important to providing further access to and opportunities for adolescents to get HPV vaccine.[4] As a result, the growing national interest in pharmacies has caught the eye of research to better understand the role of pharmacies in adolescent vaccinations, particularly for HPV vaccination.

HPV VACCINATIONS IN PHARMACIES

Research on pharmacy-located HPV vaccination has largely focused on policy issues involving pharmacist vaccination authority,[56,57] prevalence of vaccinations,[58,59] or support and comfort with pharmacies as a vaccination setting for adolescent vaccines generally,[58,60] or HPV vaccine specifically.[5,6] As of 2015, 47 states allow pharmacists to administer HPV vaccine, but their degree of autonomy to vaccinate adolescents varies greatly.[61] For instance, 43 states allow pharmacists to vaccinate adolescents as young as age 18, but only 23 states allow pharmacists to vaccinate adolescents as young as age 12.[61] Additionally, state pharmacy practice statutes that dictate the process by which pharmacists may administer vaccines vary substantially, with some states allowing pharmacists to provide vaccines with independent authority and others restricting vaccination pursuant to a prescription from a primary care provider.[57] Despite the substantial variability in pharmacist authority to provide HPV vaccine, it is likely many pharmacists would

be interested in administering HPV vaccine to adolescents if authority was expanded. A survey of North Carolina pharmacists found that nearly two-thirds of pharmacists were supportive of pharmacy immunization expansion to include HPV vaccination.[56]

Prevalence of adolescent vaccinations in pharmacies is likely to be very low at present, and no precise national estimates are publicly available. In a 2009 survey of state pharmacy association directors, less than 25% reported that pharmacies routinely carried adolescent vaccines (defined as Tdap, HPV, meningococcal, and Hepatitis B vaccines) in their states, whereas over 50% routinely carried influenza vaccine.[59] In another 2010 survey of mostly racial and ethnic minority parents living in a large urban setting, around 5% had their adolescents ages 11 to 14 immunized at a pharmacy for any adolescent vaccine.[58] In a third study, 6,790 doses of HPV vaccine were administered to adults (≥ 18 years old) during off-peak hours over a 12 month period at a large pharmacy chain, representing about .1% of all vaccine doses given to adults at that pharmacy.[44] Personal correspondence with the same large pharmacy chain revealed that for the 2014 calendar year, 3,032 HPV vaccine doses were provided nationally to adolescents ages 11 to 17 (unpublished), supporting the assumption of very low use of pharmacies for HPV vaccination. While the number of pharmacies carrying adolescent vaccines may have increased since 2009, the stark contrast between the availability of adolescent vaccines versus influenza vaccine and the number of adolescent vaccines reportedly administered indicate low demand among parents for adolescent vaccination, limited awareness of adolescent vaccination services at pharmacies that would not warrant larger vaccine supplies, or slow diffusion of a novel health care service.

Support or comfort among parents to get any adolescent vaccine at a pharmacy tends to be lower compared to support of or comfort with primary care clinics, but still significant. In one

study, parents who lived in rural compared to urban areas were more likely to find vaccination settings outside of the medical home, including pharmacies, as the best setting for adolescent vaccination.[60] In addition, over one third of parents were accepting of getting their children vaccinated in a pharmacy.[60] This may point to the utility of pharmacies for parents who live in areas with limited access to preventive health services. However, these studies are limited in that they examined HPV vaccine jointly with other adolescent vaccines, making it difficult to determine whether the level of comfort with HPV vaccination in pharmacies is similar to other vaccinations.

Two studies have examined correlates of comfort with pharmacies as a vaccination setting among parents and their adolescent sons.[5,6] In both studies, parents whose sons did not have a recent health care visit were more comfortable with using pharmacies as compared to parents whose sons did have a recent health care visit. Additionally, one of the studies showed that previous use of alternative settings, and higher perceived barriers to getting HPV vaccine were positively correlated with comfort with using pharmacies and other alternative settings.[6] These findings also point to the possible benefit of pharmacies reducing barriers to HPV vaccination for hard-to-reach adolescents. However, these studies are limited in that the samples did not include parents of adolescent girls.

GAPS IN PHARMACY-LOCATED HPV VACCINATION RESEARCH

While the studies previously described provide formative research in our understanding of pharmacy-located HPV vaccination, large gaps in our knowledge hinder our ability to inform future public health research and health policy aimed at using pharmacies as adolescent vaccination settings effectively. First, all the studies categorize pharmacies as a single type of

setting and do not account for the various pharmacy types that exist (e.g., chain drug store, local independent pharmacy). Thus, it is unclear how the type of pharmacy may affect a parents' willingness to obtain HPV vaccine for their children in that setting. If engagement in HPV vaccination service is influenced by the pharmacy type, this could help current pharmacies to align their business practices to make themselves more appealing to parents' preferences.

Second, research shows that parents prefer going to a primary care clinic to get their children HPV or other vaccine as opposed to going to pharmacies.[5,6,58,60] However, no studies have examined how different features of vaccination services, such as convenient hours and privacy, may lead parents to choose a pharmacy over a doctor's office as a superior vaccination setting, or vice versa. Understanding the features that influence a parent's willingness will provide further insight on how pharmacies can meet parents' expectations in the vaccination experience.

Lastly, no studies have examined whether pharmacies, a setting identified for having convenient locations in neighborhoods, could alleviate geographic disparities in HPV vaccination coverage. Research reviewed in this chapter suggests that pharmacies could play a role in improving access to HPV vaccinations. Previous studies have shown geographic variations in HPV vaccination coverage,[62,63] and these geographic variations may be in part due to unequal distribution of health care resources.[63] If pharmacies could potentially alleviate primary care access issues in areas with poor vaccination coverage, the use of pharmacies as a vaccination outlet could direct the development of public health interventions aimed to improve vaccination rates, and help inform state pharmacy practice policies intended to expand pharmacist-provided HPV vaccination.

CONCLUSION

HPV vaccination rates are too low, stifling its potential to prevent thousands of cancer cases in the coming years. Expanding access of HPV vaccination to pharmacies may help improve vaccination rates and reduce geographic disparities. However, in order to do this, engagement with pharmacies as a vaccination setting needs to increase. More research is needed to understand how pharmacies can improve as a vaccination setting to increase demand for pharmacist-provided vaccinations among parents, and whether they can alleviate low vaccination rates in areas with poor access to preventive care.

CHAPTER THREE. RESEARCH AIM ONE: PHARMACY TYPE'S RELATIONSHIP WITH HPV VACCINATION WILLINGNESS

OVERVIEW

This chapter focuses on Aim One of my dissertation. I begin by explaining the theoretical relationship among service quality, satisfaction, and purchase intentions and their operational definitions. I then give a brief overview of how service setting may influence service quality. Third, I present a conceptual model for how pharmacy type may impact HPV vaccination willingness, my hypotheses for the proposed relationships among the study constructs, and the study's implications. Next, I present an overview of the data source and procedures. Fifth, I go over the analytical approaches I plan to use to test my hypotheses. I conclude the chapter with a discussion of strengths and limitations of the proposed research aim.

SERVICE QUALITY, SATISFACTION, AND PURCHASE INTENTIONS

Attitude theories such as theory of reasoned action and theory of planned behavior have proven versatile in conceptualizing a wide realm of social behaviors.[64] However, researchers have noted that self-regulatory processes (e.g., monitoring, appraisal, and coping) are important in turning attitudes into intentions, and ultimately intentions into actions.[65] As such, many researchers have looked to characterize the link between attitudes and intentions, particularly in marketing research which is principally preoccupied with increasing customer engagement.

Marketing research has shown that a firm's performance has been closely tied to improving customer perceptions of service quality and feelings of satisfaction. Understanding the

intricacies of how customer perceptions develop allows companies to leverage their relative advantages in competitive markets, ultimately increasing customer engagement with their products and services.[66] Marketing research over the past three decades has aimed to characterize the underlying cognitive process that strengthens behavioral intentions for customer engagement, specifically purchase intentions for existing or novel products and services.[66] This has relevance for pharmacies that intend to improve on established health services (e.g., medication dispensing, counseling), or engage customers in new services (e.g., HPV vaccinations for adolescents). One widely used framework used to understand the roles of the different services constructs, namely perceived service quality and customer satisfaction, was first developed by Lazarus, and then further advanced by Bagozzi.

Framework for emotion and adaptation. Lazarus' appraisal, emotional response, and coping framework[8] formed the foundation of the current understanding of purchase intentions. The framework begins with an appraisal; a person first establishes the significance of an actual or hypothetical event (primary appraisal) and then assesses his or her ability to cope with the consequences of that event (secondary appraisal).[9] Once a person has established the significance of the event and the resources available to cope with it, he or she will then have an emotional response (e.g., anger, guilt, anxiety, sadness).[9] The resulting emotional response will cause a person to cope, or adapt, to the environmental stimulus that caused the situational appraisal and emotional response.[9] Lazarus used this framework mostly as it applied to physiological or psychological stress. The transactional model of stress and coping builds on Lazarus' theoretical work, and has been applied to various environmental stressors such as racism and socioeconomic status, and individual stressors such as chronic diseases like cancer and HIV/AIDS.[67] Bagozzi

also applied Lazarus' framework to explain how attitudes may be linked to behavioral intentions to contexts and outcomes of interest in marketing research.

Self-regulation of attitudes and intentions. Bagozzi criticized contemporary attitude theories (e.g., theory of reasoned action, theory of planned behavior), arguing that subjective norms and attitudes are not sufficient predictors of behavioral intentions, and aimed to address the relevance of cognitive and emotional self-regulatory processes that may mediate the effect of subjective norms and attitudes on behavioral intentions.[65] Similarly to Lazarus, Bagozzi proposed that attitudes were evaluative appraisals which he named "outcome-desire units" (Figure 3.1). A person engages in an activity because he or she looks to achieve a particular goal or outcome (e.g., purchase a product). An outcome can either be unattained (outcome desire conflict) or achieved (outcome desire fulfillment) which leads to an affective response (emotional reactions). As a result, a person will begin a coping response (e.g., maintain or increase purchase intentions). Marketing researchers have used this theoretical framework to evaluate the relationships among perceived service quality, satisfaction, and purchase intentions.[7,66,68-71]

Service quality and satisfaction. Service quality is conceptualized as "the consumer's overall impression of the relative inferiority/superiority of organizations and their services."[72] Service quality within the previously discussed frameworks operationalizes as an attitude, since the construct encompasses an appraisal process judging a service as either favorable (outcome-desire fulfillment) or unfavorable (outcome-desire conflict). Satisfaction is conceptualized to be a distinct construct from perceived service quality in that it is "a summary of cognitive and affective reaction to a service incident (or sometimes to a long term service relationship)."[73] Therefore, satisfaction is an emotional response that develops from a service incident or long-

term service relationship. As a result of this emotional response, satisfaction (or dissatisfaction) is theorized to have a direct influence on an individual's purchase intentions. Empirical research supports perceived service quality and satisfaction as two separate constructs,[72] and support the relationship between the services constructs and purchase intentions as causally linked: increases in perceived service quality leads to increases in satisfaction, which leads to stronger purchase intentions.[7,66,68-71]

MEASURING PERCEIVED SERVICE QUALITY IN DIFFERENT SERVICE SETTINGS

Perceived service quality varies substantially based on the context in which firms provide services. The rationale for this is that customers' perceptions of service quality have several dimensions that manifest themselves as customers engage with a service at a firm,[74-76] and certain dimensions of service quality may be more salient to a particular product and service or organization type.[77] The most widely used measure for perceived service quality has been SERVQUAL, a five-factor scale developed by Parasuraman, Berry, and Zeithaml.[75] Parasuraman and colleagues originally defined service quality to have 10 components or constructs: reliability, responsiveness, competence, access, courtesy, communication, credibility, security, understanding/knowing the customer, and tangibles.[74] Later, these constructs were empirically tested and distilled into five dimensions: reliability, tangibles, responsiveness, empathy, and assurance (definitions of dimensions in Table 3.1).[75,76] The researchers looked to develop a "skeleton" measure that could be adapted to any service context.

However, since the development of SERVQUAL, many researchers have criticized the scales' generalizability to various service settings. For instance, Cronin and Taylor questioned

Parasuraman and colleagues' original conceptualization of service quality as a gap between service performance and service expectations.[7] Cronin and Taylor found that a scale that just focused only on performance-based measures (called SERVPERF) explained more of the variance observed in four service industries (banking, pest control, dry cleaning, and fast food).[7,78] A study conducted by Lee and colleagues 10 years later in South Korea also found the performance-based measures outperformed the original SERVQUAL measure.[79] Additionally, several researchers have noted that the stability of the SERVQUAL dimensions were highly service context dependent, and certain dimensions may play a more significant role than others depending on the service and industry.[77-81] As a result, when measuring service quality for a certain industry, researchers should take extra care to understand the underlying criteria customers may use to evaluate service quality, and adapt scales, particularly the SERQUAL measure, to reflect the dimensions of this attitude.

Service quality in pharmacies. As pharmacies have progressively moved away from product driven businesses to more service oriented practices, service quality scales should reflect this shift when attempting to accurately gauge a customer or patient's perceptions. Hedvall and Paltschik operationalize SERVQUAL's original 10 constructs as they pertain to a customer's perceived service quality in a pharmacy that is more service oriented (Table 3.2; construct definitions found in Appendix I).[82] Their definition of perceived service quality can be operationalized as a customer's appraisal of the commitment, confidentiality and professionalism of the pharmacist, and the milieu of the pharmacy.[82] Since the commitment dimension is defined to be oriented towards a specific product purchased rather than engagement with a future service (e.g., HPV vaccination), I will use a modified definition of perceived service quality as a

customer's appraisal of the confidentiality and professionalism of the pharmacist, and the milieu of the pharmacy.

RESEARCH QUESTIONS

Pharmacies as a health care setting can vary substantially in appearance and range of services. As discussed in Chapter Two, pharmacies have mostly been studied as one category among several other kinds of alternative vaccination settings for adolescents. In reality, several types of pharmacies exist, including chain pharmacies (e.g., CVS and Walgreens), local-independently owned pharmacies, and pharmacies located in medical practices and hospitals. To the best of my knowledge, no empirical evidence has been published on the association of pharmacy type on a parent's willingness to get his or her child HPV vaccine from a pharmacist. While pharmacists and pharmacy businesses have been providing adult vaccination services for over two decades, adolescent vaccine provision is a relatively new service for this health profession. Customer perceptions of service quality and their satisfaction are established predictors of customer engagement with existing and new services in other industries. Understanding the impact of perceived service quality and satisfaction on a parents' willingness to get HPV vaccine from a pharmacist may provide direction for how pharmacies can better align their business and clinical practice to appeal to parents' expectations for vaccination services. As a result, I propose the following research questions for Aim 1:

1. Is pharmacy type associated with a parent's willingness to get his or her child HPV vaccine from a pharmacist?

2. Do dimensions of perceived service quality at a pharmacy and overall satisfaction with the health services at a pharmacy mediate the relationship between pharmacy type and willingness to get HPV vaccine?
3. How do the dimensions of perceived service quality at a pharmacy and overall satisfaction of health services at a pharmacy mediate the association between pharmacy type and willingness to get HPV vaccine?

CONCEPTUAL MODEL AND HYPOTHESES

Pharmacy type's impact on HPV vaccination willingness. My conceptual model draws upon the theoretical framework developed by Lazarus[8] and Bagozzi,[65] and the operationalization of perceived service quality by Hedvall and Paltschik (Figure 3.2).[82] The central component of this study is the relationship between pharmacy type (defined as a chain or non- chain pharmacies) and a parent's willingness to get his or her child HPV vaccine from an immunizing pharmacist.

There is currently no evidence on how pharmacy type has an impact on a parent's willingness to get HPV vaccine. Anecdotal evidence suggests that parents who usually go to independent pharmacies or pharmacies located in clinics or hospitals (i.e., non- chain pharmacies) may have higher willingness to get HPV vaccine for their children at these locations compared to parents who go to pharmacies like CVS or Kroger (i.e., chain pharmacies). This may be due to greater intimacy parents feel at these pharmacy locations compared with chain pharmacies. Thus, I first hypothesize that:

Hypothesis 1. Parents who go to non-chain pharmacies have higher willingness to get their children HPV vaccine from a pharmacist than parents who go to chain pharmacies.

Mediation. Bagozzi's framework suggests that some pharmacies can strengthen parents' willingness to get HPV vaccine (i.e., strengthen purchase intentions) by increasing parents' perceptions of service quality and satisfaction. This conceptual model includes four distinct mediators, three comprising service quality perceptions and one comprising overall satisfaction with health services at the pharmacy.

The first two mediators, professionalism (i.e., having the customer's best interest at heart and performing the duties of the pharmacist promptly and accurately) and confidentiality (i.e., creating an atmosphere enabling customers to feel that they are cared for and enabling them to feel free to discuss problems and ask questions) may play a role on how pharmacy type exerts its effect on satisfaction.[82] Parents may evaluate their interpersonal interactions with pharmacists, judging how attentive and caring they are to requests, or how easily they can talk about sensitive health problem. Similarly, the third mediator, milieu (i.e., the physical premises of the pharmacy), may intervene on the effect pharmacy type has on satisfaction by parents evaluating the physical space as appropriate for certain types of health services, or generating impressions of how accessible the pharmacy is during operating hours. Thus, parents who go to independent pharmacies or pharmacies located in clinics or hospitals (compared to chain pharmacies) may have more favorable perceptions of the pharmacist's professionalism and confidentiality, and more favorable perceptions of the pharmacy's milieu, leading to higher overall satisfaction, resulting in higher willingness to get their children HPV vaccine from pharmacists. Based on the previously described theory and empirical research conducted in other service settings, I hypothesize:

Hypothesis 2. The effect of pharmacy type on parents' willingness to get their child HPV vaccine from a pharmacist will be mediated by the three service quality appraisals and overall satisfaction with health care services at the pharmacy.

Hedvall and Paltschik suggest in their evaluation of the four service quality dimensions that professionalism and milieu are the two factors of service quality that are minimum preconditions for the services offered.[82] Their empirical finding suggests that beyond fulfilling those two preconditions, pharmacists can provide "added value" by emphasizing confidentiality.[82] In other words, it may be that appraisals of the pharmacist's professionalism and the milieu of the pharmacy are more strongly associated with overall satisfaction than appraisal of a pharmacist's confidentiality, leading to higher willingness to get HPV vaccine. Based on this finding, I will explore whether the mediated paths between pharmacy type and parents' willingness to get HPV vaccine that include perceived professionalism and milieu will be more positively correlated than the mediated path that includes perceived confidentiality.

SIGNIFICANCE AND IMPLICATIONS OF THE STUDY

This study may be one of the first theoretical contributions to evaluating pharmacy's utility in adolescent vaccination services. Exploring the mediators of the association between pharmacy type and parents' willingness to get their children HPV vaccine from a pharmacist can help pharmacies pinpoint how to engage established and new patients to participate in new adolescent vaccination services, ultimately making HPV vaccine provision in pharmacies a viable alternative to the traditional medical home or other vaccination setting. A deeper understanding of the processes through which pharmacy type influences willingness to vaccinate

can inform the design of new or revised pharmacy practice models that capitalize on parent's perceptions of what they deem as quality health services.

OVERVIEW OF DATA SOURCE AND PROCEDURES

Data source: The Adolescent Vaccinations in Pharmacies (AVIP) Study. The AVIP study was an online survey of U.S. parents of adolescents conducted from November 2014 to January 2015. Study participants were members of an existing, national panel of non-institutionalized adults maintained by a survey company.[83] The national panel was created through probability-based sampling of U.S. households using a combination of random-digit dial and addressed-based sampling frames. Eligible respondents were parents of at least one child between the ages of 11 to 17 who lived with them at least half of the time. We focused on parents of children between ages 11 and 17 since recommendations for adolescent vaccines begin at age 11, and adolescents in this age range are still minors and, in most instances, need a parent's permission to get vaccinated. Parents were asked to answer survey items thinking about their child, or one of their children, aged 11 to 17 they identified in the beginning of the survey. As incentives, the survey company provides a computer and free internet access to panel members from non-internet households. Those panel members who have an existing computer and internet access get points for completing surveys that can be redeemed for small cash payments.

The survey company sent email invitations to a random selection of 2,845 panel members who previously indicated they had at least one child between the ages 11 and 17. A total of 1,760 parents responded by accessing the survey website, providing informed consent, and completing an eligibility screener. A total of 1,518 parents were eligible and went on to complete some portion of the survey. After we excluded 14 panel members for failing to answer more than one-

third of survey questions, our final analytic sample consisted of 1,504 parents. Respondents included residents of all 50 states and Washington DC. Our overall response rate was 61.2%, based on the American Association for Public Opinion Research Response Rate 5 calculations for online probability-based panel surveys, which takes into account contacted panel members who were ineligible to participate (n = 389).[84,85]

Measures for analyses & survey item development. Measures for Aim One analyses are located in Appendix 2. Survey items were developed based on previous research among parents, adolescents, and health care providers.[86-90] Additional items for the AVIP survey were adapted from other sources.[7,91,92] The AVIP survey instrument was cognitive tested with a convenience sample of 18 parents of adolescents ages 11 to 17 to ensure the clarity of survey items, and pre-testing with 26 parents from the national panel to ensure proper survey functionality. The full AVIP survey instruments are available online at www.unc.edu/~ntbrewer/hpv.htm.

HPV vaccination willingness. The outcome of interest for this study is willingness to get HPV vaccine from a pharmacist. Parents were first prompted with the statement "Imagine you and [child's name] decided to get the HPV vaccine for [him/her]." Parents were then asked "How willing would you be to have [child's name] receive it from an immunizing pharmacist?" Parents indicate the extent of their willingness as "definitely not willing" to "definitely willing" (coded 1-4).

Service quality and satisfaction items. Parents were asked to respond to nine items about their perceptions of service quality and one item about their feeling of overall satisfaction at the pharmacy they usually go to for their children's prescription medications. A parent was first asked to "think about the pharmacy you would usually go to if you needed to get [child's name] prescription medications." They then indicated what kind of pharmacy it is. This pharmacy type

variable will be recoded so that chain pharmacy, a pharmacy in a grocery store, and a pharmacy in a big box store (termed "chain pharmacies") is the referent coded "0," and a pharmacy in a clinic or hospital or an independent pharmacy (termed "non-chain pharmacies") is coded "1." Next, parents were asked the extent to which they disagreed or agreed with nine statements about their perceptions of service quality at this pharmacy ("strongly disagree" [1] to "strongly agree" [5]). Finally, parents were asked the extent to which they were dissatisfied or satisfied with the health services they receive at the pharmacy ("completely dissatisfied" [1] to "completely satisfied" [7]).

Covariates. The survey company provided parent and household demographics including parent sex, age, race and ethnicity, education, as well as household income, urbancity, and U.S. region of residence. Additionally, the survey included questions that assessed parents' beliefs and attitudes about adolescent vaccinations and who the primary health care decision maker is for the index child. For demographic and health characteristics for the parent's index child (reported by the parent), we assessed sex, age, race and ethnicity, perceived health status (five-point response-scale ranging from "excellent" [1] to "poor" [5]), HPV and other adolescent vaccinations status, and previous use of an alternative vaccination setting (defined as having received a vaccine at a pharmacy, school, or health department).

Missing data. Missing responses for any given survey item for this research aim is no more than 0.8%. Traditional methods for handling missing data such as listwise and pairwise deletion or mean substitution are no longer recommended due to these methods distorting standard errors, biasing parameter estimates, and reducing statistical power with respect to the deletion approaches.[93] Instead, I will employ full information maximum likelihood (FIML) estimation, a preferred method by several leading methodologists.[94-97] In situations of missing

data, FIML estimation determines parameter estimates by employing likelihood functions based only on the means, variances, and covariances of the variables on which the case has complete data, partitioning the data into subsets based on patterns of missingness. FIML estimation has advantages over multiple imputation (MI), another recommended method for handling missing data, in that it is more efficient than MI, it always produces the same results unlike MI, and it avoids potential conflicts that could arise between the analytic model and the MI model that is predicated on the multivariate normal distribution assumption.[96] FIML estimation is available in several statistical packages, including Stata and M*plus* (Los Angeles, CA).

AIM ONE ANALYTIC APPROACH

I will use Stata version 13.1 (College Station, TX) for data cleaning and variable recoding, descriptive statistics, and other basic analyses. I will conduct confirmatory factor analysis and structural equation modeling in M*plus* 7.4. All hypothesis tests will use two-tailed tests with a critical alpha of 0.05.

Confirmatory factor analysis of nine perceived service quality items. As I described earlier, I conceptualized perceived service quality as having three dimensions: professionalism, confidentiality, and milieu. For the purpose of this study, our scale development prioritized creating indicators that encapsulated professionalism, confidentiality, and milieu. We decided to not include the commitment dimension as this dimension was more oriented towards a specific product purchased, while our model was looking to engage parents in a future service (HPV vaccination). Candidate indicators can be found in Appendix II. I will conduct confirmatory factor analysis to evaluate the hypothesized factor structure, depicted in Figure 3. I will use maximum likelihood robust standard errors to account for data that are not likely multivariate

normally distributed. I will test CFA models to evaluate if my hypothesized model fits the data better than alternative models.[98]

I will first run separate measurement models for each latent variable (represented by ovals), which specify the hypothesized relationship among indicator variables and the latent factor. I will use several test statistics to evaluate model fit, including χ^2 statistics (p>.05), the root mean square error of approximation (RMSEA <.08 = acceptable; RMSEA<.05 = ideal),[99] the Bentler Comparative Fit Index (CFI>.90),[100] and the Tucker Lewis Index (also known as the Non-normed Fit Index; TLI>.90).[101] I will respecify the model using both theory and empirical tests (e.g., Bayes Factor derived from Bayesian Information Criterion) in order to improve fit if any of these statistics demonstrate that the model's fit is not adequate.[94,97] Finally, I will evaluate reliability of the factors using coefficient ω ("omega"; ω>.70). Coefficient ω is a superior alternative for calculating scale reliability compared to Cronbach's α ("alpha") as ω relaxes the assumption that all items in a single factor or scale are essentially tau equivalent.[102] If the tau equivalent assumption is held, ω will equal Cronbach's α.

Structural equation model for mediation analysis. I will use structural equation modeling (SEM) to evaluate my mediation hypothesis in Aim 1, following the analytic steps outlined by Bollen[94] and Kline.[97] SEM is a method for estimating causal structures among a set of latent (i.e., unobserved) variables, and it represents the integration of path analysis and confirmatory factor analysis (i.e., a simultaneous estimation of both structural and measurement models). SEM has advantages over other analytic approaches such as ordinary least squares (OLS). For instance, measurement error can be incorporated into the model, either by using multiple indicators for each latent variable or by setting the measurement error of a single indicator to some nonzero value indicating the proportion of measurement error in the measure. Another key advantage in

SEM is that measurement and structural parameters are estimated simultaneously using full-information estimation procedures, and standard errors are concurrently generated for indirect and total effects.

Similar to the analysis plan for the confirmatory factor analysis described earlier, I will use an iterative model building process and employ the same fit statistics described earlier to test model fit (e.g., RMSEA, CFI, and TLI). The final structural equation model will specify the relationship among the exogenous variable (pharmacy type), the latent variables (professionalism, confidentiality, milieu), and the measured variable for overall satisfaction, and the measured dependent variable of willingness to vaccinate.

To test my hypotheses, I will first estimate a measurement model showing the relationship between pharmacy model and a parent's willingness to get his or her child HPV vaccine from an immunizing pharmacist (Figure 3.4)

Based on *hypothesis 1*, I predict that:

- Prediction 1: Non- chain pharmacies will be associated with higher willingness to get HPV vaccine from an immunizing pharmacist compared to chain pharmacies. Path c will be positive and significant.

Once the direct path has been estimated, I will use the structural model depicted in Figure 3.5 to estimate standardized path coefficients and *p*-values for Hypotheses 1.2. The pathways in SEM are similar in interpretation to traditional methods for mediation analysis.[103] The product terms from path a, d, and c (a*d*c) represent the mediated effect.[103,104]

Based on *hypothesis 2*, I predict that:

- Prediction 2: Non-chain pharmacies will elicit higher perceptions of service quality compared to chain pharmacies; a_1, a_2, and a_3 pathways will each be positive and statistically significant.
- Prediction 3: Higher perceptions of service quality will be associated with higher overall satisfaction; d_1, d_2, and d_3 pathways will each be positive and statistically significant.
- Prediction 4: Higher perceptions of overall satisfaction will be associated with higher willingness to get HPV vaccine from a pharmacist; b pathway will be positive and statistically significant.
- Prediction 5: Perceived service quality and overall satisfaction will mediate the relationship between pharmacy type and willingness to get HPV vaccine; each mediated pathway (a_1*d_1*b; a_2*d_2*b; a_3*d_3*b) will be positive and statistically significant.

Alternative approach to examining mediation. If the proposed analytic approach using SEM does not work (i.e., the models do not converge), I will instead fit path models using ordinary least squares (OLS) regression. I will plan to use the PROCESS macro in SAS as an alternative, a computational procedure useful for estimating multiple and serial mediation models.[105]

POWER ANALYSIS

SEM power calculations are different from those typically used for OLS. SEM power calculations take into account the structure of the model, and the hypothesized factor loading of observed variables on unobserved latent variables (e.g., the measurement model).[106] Two calculations are necessary to determine the power needed for an SEM. First, the minimum

sample size needed for model structure derived from the ratio of observed to latent variables. Second, the sample size needed to detect the hypothesized effect derived from the correlation between any two latent variables and the desired minimum effect size.

The specific power calculations used for this study is the lower bound sample size calculation for structural equal models:[106]

$n = \max(n_1, n_2)$

where:

$$n_1 = \left\lceil 50\left(\frac{j}{k}\right)^2 - 450\left(\frac{j}{k}\right) + 1100 \right\rceil$$

$$n_2 = \left\lceil \frac{1}{2H}\left(A\left(\frac{\pi}{6} - B + D\right) + H + \sqrt{\left(A\left(\frac{\pi}{6} - B + D\right) + H\right)^2 + 4AH\left(\frac{\pi}{6} + \sqrt{A} + 2B - C - 2D\right)}\right)\right\rceil$$

$$A = 1 - \rho^2$$

$$B = \rho \arcsin\left(\frac{\rho}{2}\right)$$

$$C = \rho \arcsin(\rho)$$

$$D = \frac{A}{\sqrt{3 - A}}$$

$$H = \left(\frac{\delta}{z_{1-\alpha/2} - z_{1-\beta}}\right)^2$$

Where "n_1" refers to the sample size needed for model structure, "n_2" refers to the sample size needed to detect the hypothesized effect between any two variables in the structural model, "j" is the number of observed variables, "k" is the number of latent variables, "ρ" is the estimated Gini correlation for a bivariate normal random vector between any two latent variables, "δ" is the

anticipated effect size, "α" is the Sidak-corrected Type I error rate, "β" is the Type II error rate, and "z" is a standard normal score.[106,107] The sample "n" needed for sufficient power will depend on if n_1 or n_2 is larger.

The hypothesized structural model has 14 observed variables and 3 latent variables. Based on a desired effect size > .05, desired statistical power $\geq$ .8, and alpha = .05, I would need a minimum sample of 89 people to account for model structure (not including covariates as controls) and a minimum sample size of 1,172 people to estimate an effect size >.05. Minimum sample for model structure would increase to 1,423 if an additional 15 observed variables were added to the structural model (total = 29) as covariates. As a result, the study is sufficiently powered with an analytic sample of 1,504.

STRENGTHS AND LIMITATIONS

To the best of my knowledge, this will be the first study to empirically evaluate how pharmacy type is associated with parent's willingness to get HPV vaccine from a pharmacist. Moreover, this study applies a theoretical model to understand possible cognitive and emotional responses that may motivate parents to get HPV vaccine and other adolescent vaccines at a pharmacy. Data from this study come from a national sample of U.S. parents of adolescents with a good response rate for online surveys. Additionally, I developed the survey items based on previous theoretical and empirical marketing research, and refined them based on feedback from pharmacy practice experts and cognitive interviews of parents of adolescents. A notable limitation for this study is the cross-sectional design, which limits interpretations of results to only inferring associations, and not the directionality of these associations. While the relationships among service quality, satisfaction, and purchase intentions have been causally

supported through other empirical studies, future studies as it applies to pharmacies should evaluate the temporal relationship among these constructs in longitudinal studies. Parents' responses were also self-reports, which may lead to response bias in certain survey questions such as their children's health status and vaccination history. While this study developed nine items to measure three service quality dimensions, future research should expand on this analysis to evaluate the construct validity of this measure of service quality in a pharmacy, and identify additional indicators that may increase the precision of the measure.

TABLE 3.1 PARASURAMAN'S SERVQUAL DIMENSIONS, DEFINITIONS, AND COMPONENTS

Dimension	Definitions	Included constructs
Reliability	Ability to perform the promised service dependably and accurately	Reliability
Tangibles	Appearance of physical facility, equipment, personnel and communication materials	Tangibles
Responsiveness	Willingness to help customers and to provide prompt service	Responsiveness
Empathy	Provision of caring, individualized attention to customers	Understanding & knowing the customer Access
Assurance	Knowledge and courtesy of employees and their ability to convey trust and confidence	Communication Credibility Security Competence Courtesy

Note. Empathy comprises of two of the original service quality constructs: understanding/knowing the customer and access. Assurance comprises of five of the original service quality constructs: communication, credibility, security, competence, and courtesy.

TABLE 3.2 HEDVALL & PALTSCHIK'S SERVQUAL DIMENSIONS, DEFINITIONS, AND COMPONENTS

Dimensions	Definitions	Included constructs
Professionalism	Having the customer's best interest at heart and performing the duties of the pharmacist promptly and accurately	Communication Competence Courtesy Responsiveness
Confidentiality	Creating an atmosphere enabling customers to feel that they are cared for and enabling them to feel free to discuss problems and ask questions	Security Understanding & knowing the customer
Milieu	The physical premises of the pharmacy	Accessibility Tangibles
Commitment	Making a special effort to serve the customers particularly by giving them advice about the products purchased	Credibility Reliability

FIGURE 3.1 THE EMOTIONAL SELF-REGULATION OF THE ATTITUDE-INTENTION RELATIONSHIP (ADAPTED FROM BAGOZZI 1992)

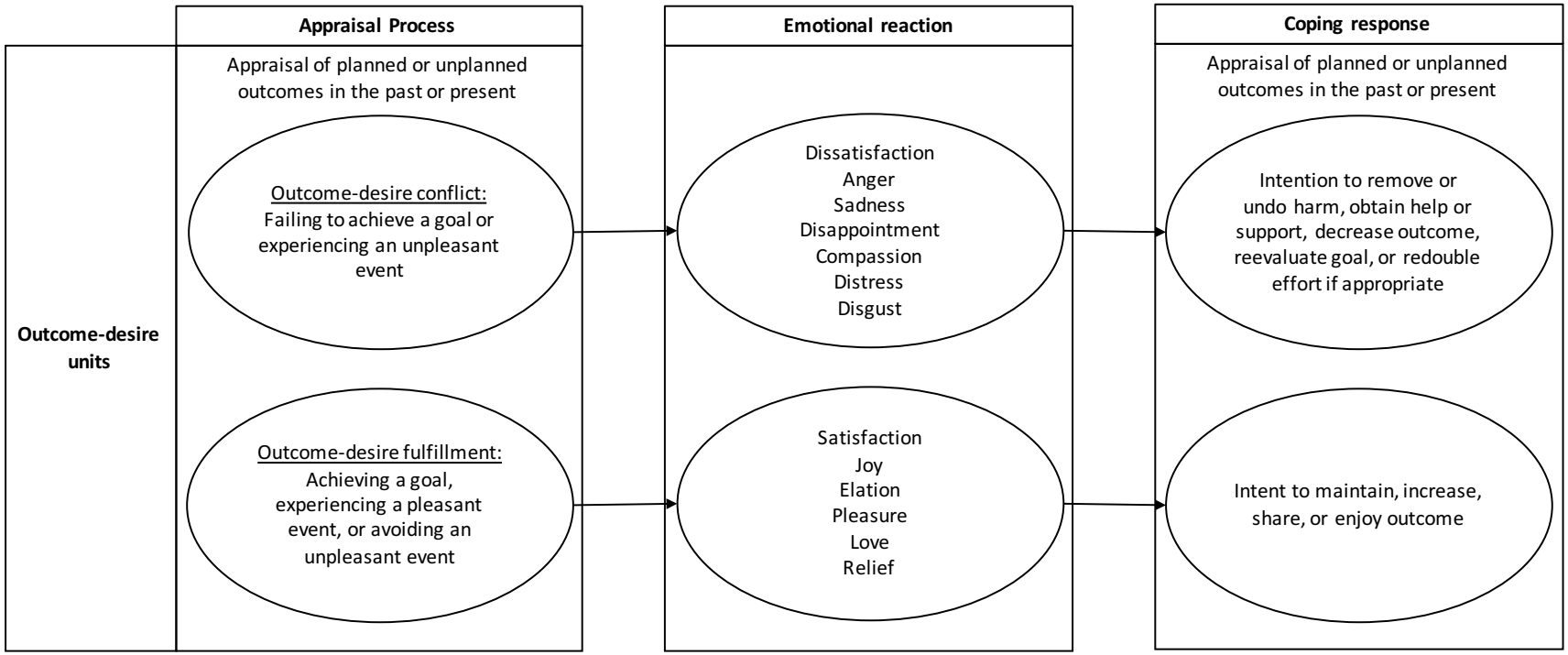


FIGURE 3.2 AIM ONE CONCEPTUAL MODEL

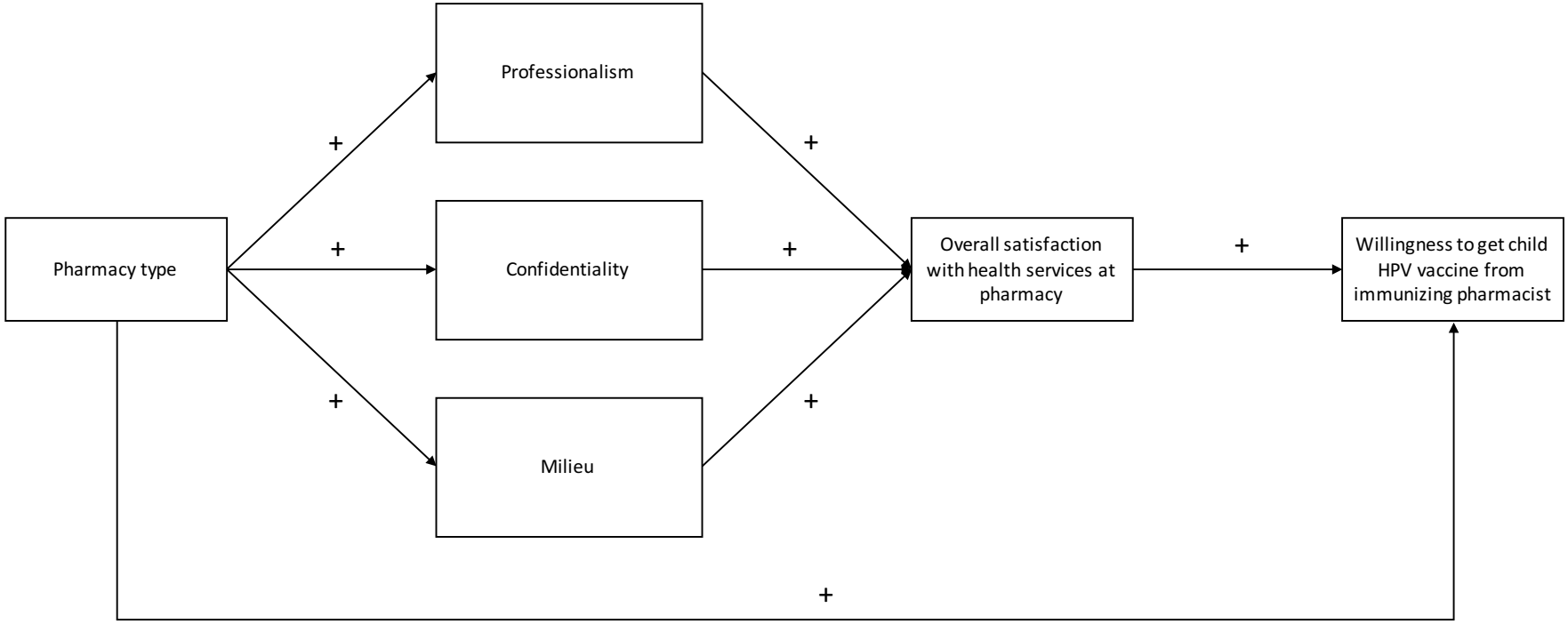


FIGURE 3.3 CONFIRMATORY FACTOR ANALYSIS

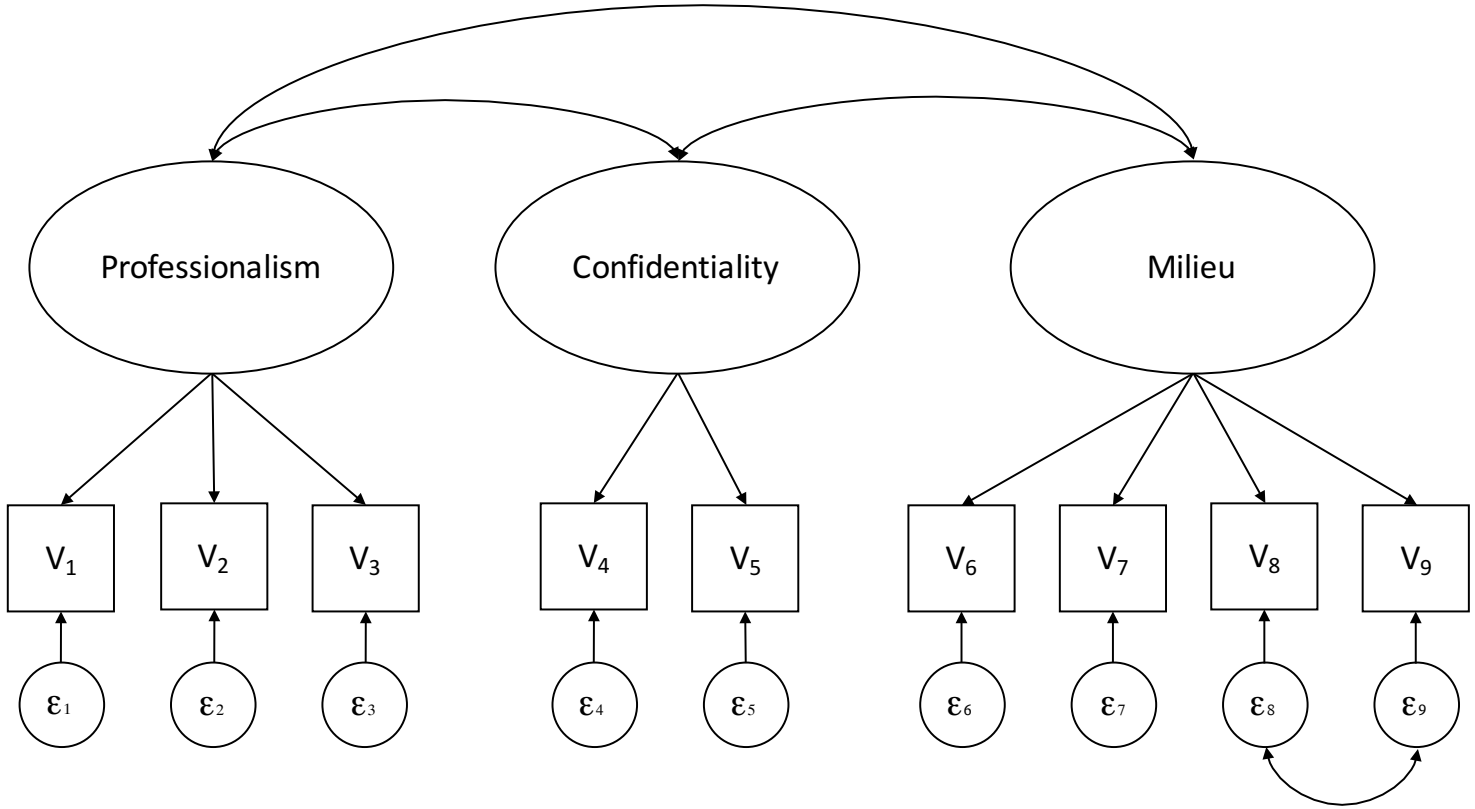


FIGURE 3.4 AIM ONE ANALYTIC PATHWAY FOR *HYPOTHESIS 1*

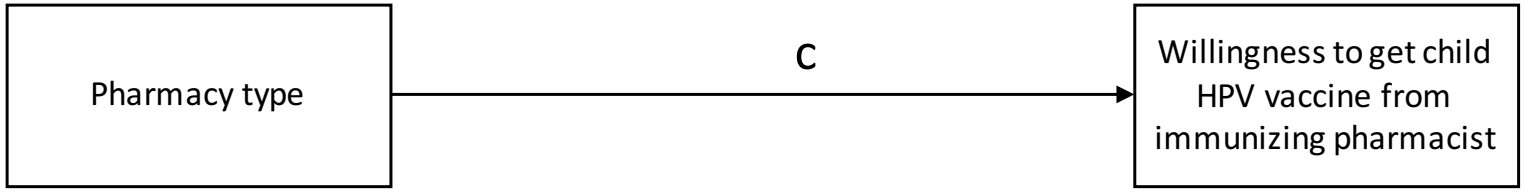
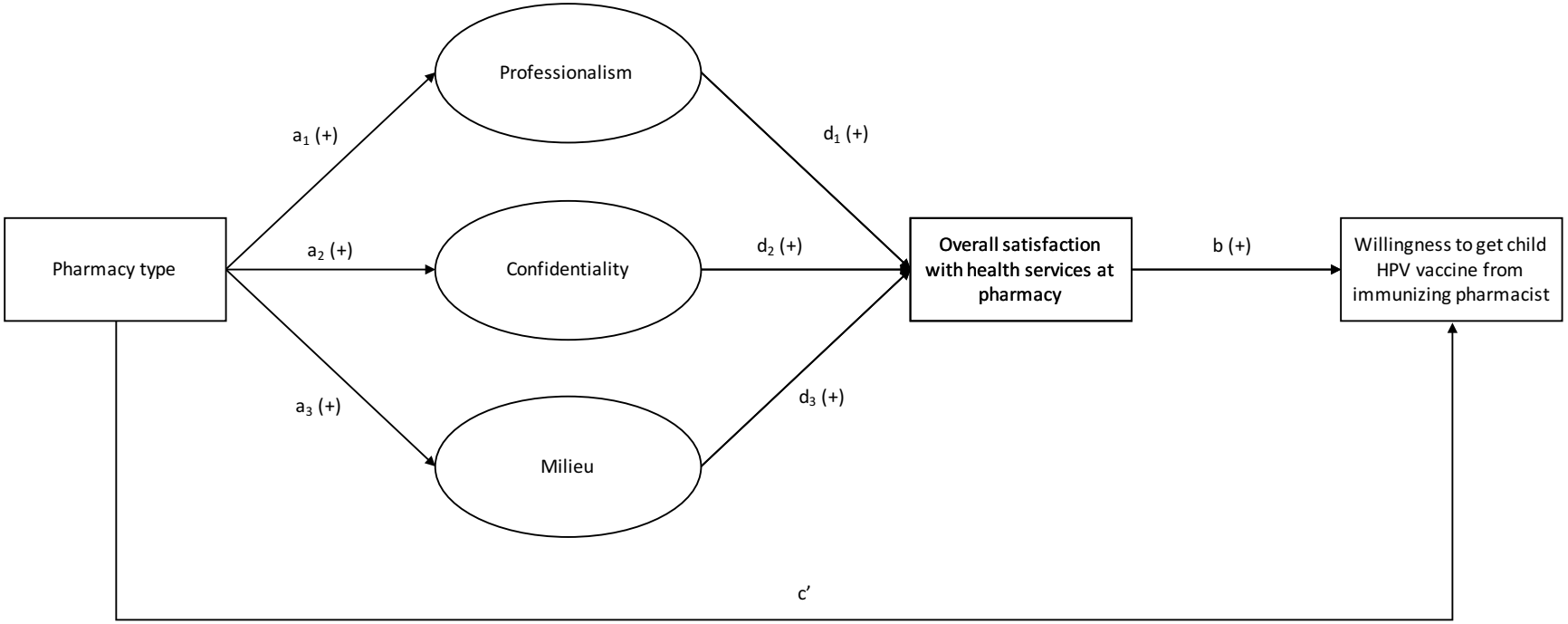


FIGURE 3.5 AIM ONE ANALYTIC PATHWAYS FOR *HYPOTHESIS 2*



Note. Depicted is a simplified structural equation model. Squares represent measured variables, ovals represent latent variables (factors). For ease of interpretation, I do not depict indicator variables for each latent variable, error terms and correlations.

CHAPTER FOUR. RESEARCH AIM TWO: COMPARING PHARMACIES AND DOCTORS' OFFICES AS VACCINATION SETTINGS

OVERVIEW

This chapter focuses on the Aim Two of my dissertation. I first give a brief overview of the current research about preferences for pharmacies as vaccination settings. Second, I go over the relative advantages of pharmacies over other alternative vaccination settings, and describe a diffusion of innovation framework in which pharmacies may offer relative advantages over the traditional medical home for adolescent vaccinations. Third, I propose my hypotheses for this research aim. Fourth, I briefly describe the data sources and procedures for this aim. Finally, I end the chapter with the analytic approaches used to test my hypotheses, and conclude the chapter with a concise discussion of strengths and limitations.

PREFERENCES FOR PHARMACIES AS VACCINATION SETTINGS

To date, very few studies have evaluated preferences to get adolescent vaccines, and specifically HPV vaccine, at pharmacies. However, the limited empirical research shows that parents and their adolescents prefer going to their primary care provider to get vaccines over other alternative vaccination settings, including pharmacies.[5,6,58,60,108] In one study conducted in Houston, TX, only 5% of parents of adolescents ages 11 to 14 selected pharmacies as a potential alternative vaccination setting.[58] Another smaller study conducted in Monroe County, NY also found that relatively few parents were willing to have their teen aged 15 to 17 vaccinated at a

pharmacy.[108] However, that same study showed that teens were more willing to have teens vaccinated at a pharmacy than their parents.[108] A third study conducted in Colorado also found parents preferred getting their adolescents vaccinated in a medical home compared to alternative settings.[60] While the study did not explicitly ask about the acceptability of pharmacies relative to doctors' offices, the comparatively lower acceptability of alternative vaccination settings may lead to a reasonable conclusion that pharmacies would have been deemed as less preferable, as well. Similarly to these three studies that focused on adolescent vaccines, two other studies found that parents and their adolescent sons' comfort with HPV vaccination in alternative settings, including pharmacies, was lower compared to doctors' offices.[5,6] However, these studies may understate parents and adolescents' interest in getting vaccinated in alternative settings because the study participants may not have been thinking about all the various attributes of vaccine delivery that could make alternative settings more attractive than primary care clinics. Additionally, these studies may discount the opinions of parents and adolescents who may have significant barriers going to a primary care provider.

Acceptability, willingness, or comfort with vaccination in alternative settings, including pharmacies, may be higher for certain groups of parents who historically have had greater barriers to access health care. Non-native English speaking parents were less likely to have a medical home or routine source of care for their adolescents, and were more likely to find alternative vaccination settings acceptable places for vaccinations.[58] Parents living in rural areas, and those who found alternative settings increasingly convenient were more likely to find alternative settings acceptable for adolescent vaccinations.[60] Additionally, parents who have not taken their sons to a health care provider in the past year were more likely to be comfortable with getting their sons HPV vaccine in alternative settings.[5] Parents also cited alternative settings,

including pharmacies, as convenient options for HPV vaccination.[5] Similar findings from another study showed that parents who had not taken their sons to their regular health care provider for routine care, and parents who perceived increased barriers to get HPV vaccine were more comfortable with pharmacies and schools as vaccination settings.[6] Across the studies, it appears that medically underserved parents and their adolescents may benefit the most from receiving vaccination services in alternative settings like pharmacies. Thus, proper leverage of pharmacies as HPV vaccination outlets may serve to improve access to this and other adolescent vaccines, ultimately increasing uptake.

RELATIVE ADVANTAGES OF PHARMACY VACCINATION SERVICES

Rogers' Diffusion of Innovation Theory defines innovation as "an idea, practice, or object that is perceived as new by an individual."[109] An innovation can be preventive in nature,[109] such as a vaccination service. Given its relatively new place in pharmacy practice and low awareness and adoption among parents of adolescents, pharmacy provision of HPV and other adolescent vaccinations can be viewed as an innovation within this theoretical framework. Rogers argues that widespread adoption of preventive innovations depends on its relative advantage, compatibility, complexity, trialability, and observability.[109,110] While the Theory proposes that all the five traits of an innovation are important for widespread adoption in a social system, relative advantage has been found to be the single most important predictor for widespread adoption.[109] Thus this research aim will focus on the relative advantages of pharmacy vaccination services and its association with willingness to get HPV vaccine from a pharmacist.

Relative advantage of an innovation is defined as "the degree to which an innovation is perceived as better than the idea it supersedes."[109] An individual must merely perceive the

innovation as having advantages over its predecessors rather than demonstrating objective advantages.[109] Several relative advantages of pharmacies over other alternative vaccinations settings, and in many instances doctors' offices, were described in detail in Chapter 2. These advantages can include more convenient locations in communities,[44,47,49] longer operational hours,[44] no need for appointments,[49] and little to no wait times for vaccinations.[49] Anecdotes from community pharmacists and patients identified another possible advantage of pharmacies as the ability to do real-time adjudication of health services billing (i.e., knowing the cost of health services up front). On the other hand, parents have expressed safety and privacy concerns with alternative vaccination settings like pharmacies.[5,6,58,60] In addition, perceptions of administrative and clinical staff at a pharmacy (e.g., welcoming demeanor of staff) may also play a role in parents' willingness to get HPV vaccine, although this has never been empirically tested to the best of my knowledge. Parents may not see all the relative advantages of pharmacies or doctors' offices when expressing their preferences for vaccination settings. Parents may also give more weight to some features (e.g., parents may value vaccination safety more over convenient locations or operator hours) of vaccine delivery when considering their preferred vaccination outlet.

RESEARCH QUESTIONS AND HYPOTHESES

Studies have identified reasons why pharmacies may be considered acceptable vaccination settings. However, no studies have directly evaluated how pharmacies compare to doctors' offices based on important features of vaccine delivery. Additionally, past studies have not explicitly tested whether the perceived advantages of pharmacies are associated with

willingness to get HPV vaccine from pharmacists. As a result, the research questions and hypotheses for my proposed Aim 2 are:

1. When comparing a pharmacy to a doctor's office, which vaccination setting outperforms the other with respect to several key aspects to vaccine delivery?

   Hypothesis 1. Compared to doctors' offices, parents believe pharmacies are superior vaccination settings with respect to taking less time to get their child vaccinated, getting their child vaccinated without an appointment, more convenient hours to get their child vaccinated, and learning the cost of vaccinations before they are administered.

   Hypothesis 2. Compared to doctor's offices, parents believe pharmacies are inferior vaccination settings with respect to vaccination safety, privacy during vaccination, and having more welcoming staff.

2. How are perceived relative advantages of pharmacy and doctor's offices with respect to vaccination services associated with parents' willingness to get HPV vaccine from a pharmacist?

   Hypothesis 3. Parents who indicate the most important feature of vaccination is taking less time to get their children vaccinated, getting their children vaccinated without an appointment, more convenient hours to get their children vaccinated, or learning the cost of vaccinations before they are administered will be more willing to get HPV vaccine from a pharmacist compared to parents who indicate the most important feature of vaccination is vaccination safety, privacy during vaccination, or having more welcoming staff.

Hypothesis 4. Parents who identify more advantages for getting their children vaccinated at pharmacies will have higher willingness to get their children HPV vaccine from a pharmacist.

Research also shows that certain beliefs, attitudes, and sociodemographic characteristics of parents and adolescents are associated with greater acceptability and comfort with alternative settings, but these correlates are not consistent across studies. Additionally, the applicability of these correlates of support to pharmacy provision of HPV and other adolescent vaccines are limited by previous studies' inclusion of other alternative vaccination settings such as schools and health departments, which can mask true support of pharmacies as vaccination settings. As an exploratory component to the study hypotheses, I will also characterize how sociodemographic characteristics of parents and their adolescents are associated with perceived relative advantages of pharmacies or doctors' offices.

SIGNIFICANCE AND IMPLICATIONS OF THE STUDY

Successful implementation of adolescent vaccination programs in pharmacies depends on understanding the features of vaccine delivery that are important to parents. Using the concept of relative advantage from Diffusion of Innovation theory offers a sound, empirical basis to explore attitudes of different vaccine delivery features. Leveraging the features of vaccine delivery that are important to parents getting their children vaccinated would be a particularly effective business strategy for pharmacies looking to expand their vaccination platform and clinical services. Equally as important, identifying vaccine delivery features that parents believe to be inferior in pharmacies compared to doctors' offices also provides a starting point for quality

improvement on current community pharmacy practice models to meet patient expectations of quality adolescent vaccine delivery.

OVERVIEW OF DATA SOURCE AND PROCEDURES

Data source. The data for this research aim come from the AVIP study. I describe the study in Chapter 3, and all variables for this study are located in Appendix 2.

Vaccination site comparison items. Parents responded to eight items about the relative advantages of pharmacies and doctors' offices. They were first prompted to "imagine [CHILD'S NAME] needed a vaccine such as tetanus booster, meningitis vaccine, or HPV vaccine. Also imagine these vaccines are available at pharmacies and doctor's offices." Then parents answered seven questions about whether a pharmacy or doctor's office would be better at a particular characteristic of vaccine delivery. Parents could respond by selecting "pharmacy," "doctor's office," or "they're the same." Finally, parents were asked "which of these is most important when choosing between a pharmacy and a doctor's office as a place to get [CHILD'S NAME] vaccinated?" Parents responded by selecting what they believed to be the most important characteristic of vaccine delivery for their children.

HPV vaccination willingness and covariates. The outcome of interest for this study is willingness to get HPV vaccine from a pharmacist. This variable and other potential covariates were previously described in Chapter Three and are located in Appendix II.

Missing data. Missing responses for any given survey item for this research aim is no more than 1.9%. I will use multiple imputations to generate datasets with imputed values using Stata 13.1 (College Station, TX).

AIM TWO ANALYTIC APPROACH

I will use Stata version 13.1 for data cleaning and variable recoding, descriptive statistics, and other basic analyses and regression analyses. All statistical tests will use two-tailed tests with a critical alpha of 0.05.

Beliefs about relative advantages. I will begin my analysis by examining the proportion of parents who believe pharmacies are superior (or inferior) to doctors' offices for seven features of vaccine delivery (hypotheses 2.1 and 2.2). First, I will generate new site comparison variables based on the original items (Appendix 2; IV_1-IV_7) where I drop the parents who indicated that pharmacies and doctors' offices are the same. I will then code the new site comparison variables so that "doctor's office" is the referent (coded "0") and "pharmacy" is the non-referent category (coded "1"). I will then conduct tests on the equality of proportions using large-sample statistics, which is similar to Student's *t*-test but for dichotomous outcomes. The null hypotheses for this test will be that the proportion of parents who indicate pharmacies are better will be the same as the proportion of parents who indicate doctors' offices are better (i.e., the proportion between the two groups of parents equals .5 for the null hypotheses). Based on ***hypothesis 1*** and ***hypothesis 2***, I predict that:

- Prediction 1: A higher proportion of parents will believe pharmacies are superior to doctors' offices with respect to (1) taking less time to get their child vaccinated, (2) getting their child vaccinated without an appointment, (3) more convenient hours to get their child vaccinated, and (4) learning the cost of vaccinations before they are administered.

- Prediction 2: A lower proportion of parents will believe pharmacies are superior to doctors' offices with respect to (1) vaccination safety, (2) privacy during vaccination, and (3) having more welcoming staff.

Differences in HPV vaccination willingness by vaccine delivery feature. For the second set of analyses, I will examine how willingness to get HPV vaccine from a pharmacist varies by the importance placed on the seven vaccine delivery feature (*hypothesis 3*). First I will use descriptive statistics to characterize the proportion of parents who indicate which feature of vaccine delivery was most important to them (IV_8 in Appendix 2). Next, I will conduct an independent sample (between subjects) Student's *t*-test comparing the mean willingness for responses that I predict will be higher for pharmacies compared to doctors' offices. Then I will conduct an analysis of variance (ANOVA) to evaluate if there are differences in willingness to get HPV vaccine among groups of parents who indicated the most important feature of vaccine delivery were taking less time to get their children vaccinated, getting their children vaccinated without an appointment, more convenient hours to get their children vaccinated, or learning the cost of vaccinations before they are administered. Similarly, I will also conduct a second ANOVA to evaluate if there are differences in willingness to get HPV vaccine among groups of parents who indicated the most important feature of vaccine delivery were vaccination safety, privacy during vaccination, or having more welcoming staff. Based on ***hypothesis 3***, I predict that:

- Prediction 3: Mean willingness will be higher for parents who responded 2, 3, 4, and 5 to the importance item compared to parents who responded 1, 6, and 7 ($\overline{x_2} = \overline{x_3} = \overline{x_4} = \overline{x_5} > \overline{x_1} = \overline{x_6} = \overline{x_7}$; $p<.05$).

Correlates of HPV vaccination willingness. For the third set of analyses, I will evaluate how parents' beliefs about the relative advantages of pharmacies and doctors' offices as vaccination settings are associated with willingness to get their children HPV vaccine from pharmacists (*hypothesis 4*). I will begin by creating a contrast code for the site comparison items ($IV_1 - IV_7$) so that parents who indicate a doctor's office is better are coded as "-1," parents who indicate that a pharmacy and doctor's office are the same are coded as "0," and parents who indicate a pharmacy is better coded as "1." I will then generate a composite variable summing the contrast coded site comparison items, where composite scores will range from "-7" to "7," and then rescale the composite item so that scores are bounded between "-1" and "1." I will then test the bivariate association between parents' willingness to get HPV vaccine with the composite variable, as well as several covariates specified in the data source and procedures section of Chapter 3. All statistically significant correlates will then be combined in a multivariable linear regression model. All regression analyses will used Huber-White robust standard errors to account for any heteroskedasticity,[111] and will report standardized regression coefficients (βs). Based on ***hypothesis 4***, I predict that:

- Prediction 4: Adjusting for statistically significant covariates, higher composite scores will correlate with higher willingness (β-coefficient on composite score > 0; $p<.05$).

As an exploratory analysis, I will also evaluate how sociodemographic characteristics of parents and adolescents correlate to the relative advantages composite indicator.

STRENGTH AND LIMITATIONS

To the best of my knowledge, this will be the first study to empirically evaluate the differences between pharmacies and doctors' offices on various features of adolescent vaccine

delivery, and how these features are associated with parents' willingness to get their children HPV vaccine from pharmacists. Data from this study come from a national sample of U.S. parents of adolescents with a good response rate for online surveys. Additionally, survey items were developed based on previous empirical research on the preferences for alternative vaccination settings for adolescents, and based on feedback from pharmacy practice experts and cognitive interviews of parents of adolescents. A notable limitation for this study is the cross-sectional design, which limits interpretations of results to only inferring associations, and not the directionality of these associations. Parents' responses were also self-reported, which may lead to response bias in certain survey questions like their children's health status and vaccination history, or lead to an overestimation of their willingness to get HPV vaccine from pharmacists. While the study focuses on several provider-level characteristics of vaccine delivery, there may be other features of vaccine delivery that are important predictors to parents' willingness to get HPV vaccine from pharmacists.

CHAPTER FIVE. RESEARCH AIM THREE: PHARMACISTS' IMPACT ON THE AVAILABILITY OF VACCINE PROVIDERS

OVERVIEW

This chapter focuses on Aim Three of my dissertation. I first give a brief overview of several studies that have evaluated geographic disparities in HPV vaccination. Second, I provide a rationale for the link between health care access to vaccination services and geographic disparities in HPV vaccination. Third, I propose the potential role that pharmacists have in addressing geographic disparities in HPV vaccination. Fourth, I propose my hypotheses for this research aim. Fifth, I describe the data sources and procedures I will use for my analysis. Finally, I end the chapter with the analytic approaches used to test my hypotheses, and conclude the chapter with a concise discussion of strengths and limitations.

GEOGRAPHIC DISTRIBUTION OF HPV VACCINATION

In recent years, there has been great interest in characterizing how vaccination coverage varies geographically, particularly for HPV vaccination. While there are studies about geographic variation of HPV vaccination in adults,[112-114] for the purpose of this dissertation aim, I will focus on studies whose target populations are pre-adolescents and adolescents.[62,63,115-119] This is because contributing factors for HPV vaccination in adults may differ from those influencing vaccination for adolescents. The studies can be grouped into national-, state-, and local-level geographic analyses.

Several studies using national surveys have shown that HPV vaccination coverage varies among states, and have identified potential explanations for these geographic disparities. NIS-Teen data consistently show that vaccination coverage varies substantially among states. In the most recent data from 2014, HPV vaccine series completion ranged from 20% (Tennessee) to 57% (Washington D.C.) for girls, and 9% (Alabama) to 43% (Rhode Island) for boys.[1] A 2016 study using 2011 and 2012 NIS-Teen data evaluated how individual and neighborhood characteristics affected HPV vaccine initiation among 13-17 year old girls. Henry and colleagues found that girls living in low-income communities had higher vaccination rates.[63] Studies have also used Behavioral Risk Factor Surveillance System's (BRFSS) survey data to estimate geographic disparities in HPV vaccination. One study using 2008 BRFSS data found significant geographic disparities in parent-reported HPV vaccine initiation in Delaware, New York, Oklahoma, Pennsylvania, Texas, and West Virginia, with coverage ranging from 21% (Texas) to 50% (New York) for girls ages 13 to 17.[115] A second study using 2010 BRFSS also found vaccination coverage to differ from state to state for boys and girls ages 9 to 17.[120] Interestingly, the NIS-Teen data found community-level poverty was positively associated with HPV vaccination coverage,[63] while poverty measured at larger spatial units (e.g., state) in BRFSS was negatively associated with HPV vaccination coverage.[115] These conflicting results highlight that statistical inferences about correlates of HPV vaccination may be misleading as units of analysis are aggregated, although they may also reflect important differences in the data sources (e.g., provider-verified vaccination in NIS-Teen as compared to parent self-report in BRFSS).

Studies have also looked at geographic disparities in vaccination coverage within states. One study using 2008 BRFSS data from Texas found that county initiation rates ranged from 7% to 29% for girls ages 11 to 17.[116] Similar to the previously described national studies, this 2008

study found that county-level poverty was associated with higher vaccination coverage, while the larger public health region was associated with lower vaccination coverage, demonstrating a similar discrepancy in association as units of analyses are aggregated. Two studies in North Carolina also found geographic variation in vaccination coverage. The first NC study, aimed at reevaluating strategies in cervical cancer prevention, found that HPV vaccine initiation rates for girls varied by county, ranging from 15% to 62%.[119] The second NC study found areas in North Carolina with especially low coverage of publicly funded HPV vaccinations for uninsured or publicly insured boys and girls.[62] Trogdon and Ahn note that contributing factors to higher vaccination coverage were being racial and ethnic minorities, religious institutions per capita in an area, and outpatient visits per capita in a local area.[62] Factors that appear to be associated with lower vaccination coverage included area-level poverty, proportion of population with less than high school education, and health professional shortage areas.[62]

Finally, studies have also looked at local-area geographic disparities in HPV vaccination. Two studies in Los Angeles evaluated access to HPV vaccination services at safety-net clinics in high-risk communities. The first study found that most people who live in high-risk communities for HPV-associated cancers and chlamydia lived within three miles of HPV vaccination services through safety-net clinics, with the exception of two high-risk neighborhoods "located outside of the primary urban core."[117] The researchers noted that low-income residents living in less impoverished neighborhoods face greater barriers to accessing safety-net clinics.[117] Finally, other health care organizational factors such as limited clinic hours may be contributing to the overall low uptake of HPV vaccine.[117] A follow-up study found that proximity to a safety-net clinic that provided HPV vaccination services did vary for racial and ethnic minorities, with Asian minorities (Chinese and Korean) living the furthest away.[118] However, 80% of low-income girls

lived within three miles of a safety-net clinic, leading the researchers to conclude that increasing outreach of existing services is more of a priority than reducing geographic barriers in accessing vaccination services in Los Angeles.[118] This study's sample was modest (n = 479) and homogenous, which may account for the lack of associations between predictor variables and vaccination coverage and limits generalizability to the rest of Los Angeles residents.

In summary, these studies show that geographic disparities in HPV vaccination exist both among and within states. However, differences among these studies make it unclear why these geographic disparities may exist. Across the studies, racial and ethnic minorities, particularly those who identify as Hispanic, have higher vaccination coverage. However, there is disagreement of how socioeconomics factors such as income, education, and area-level poverty are associated with vaccination coverage. As mentioned earlier, one reason for the diverging results is how the unit of analysis was derived and aggregated to get population level estimates.[62,115,116] A second reason is that some of these studies focused on populations who are medically underserved or disenfranchised,[62,117,118] which can cause problems for inferring generalizability.

HEALTH CARE ACCESS AND VACCINATION

Characteristics of health care systems and the communities people live in can influence their access to vaccination services and, in part, influence their use of vaccination services. Researchers have long noted that where people live matters and can influence their ability to obtain health care and the probability of obtaining quality health care.[121] Andersen's Behavioral Model of Health Care Utilization is the most widely used model to conceptualize individual and contextual factors that promote and discourage health care use.[122,123] Andersen describes a set of

factors as "enabling" health care utilization.[122] Many of these enabling factors are at the individual level, such as income and health insurance status.[122] Other enabling factors are at the community level, such as the number of health care facilities and personnel in a neighborhood.[122]

The spatial patterns of HPV vaccination and screening, and their association with cancer incidence[117,124] and mortality[124] suggest that spatial targeting of public health interventions may reduce geographic disparities. As an example, high cervical cancer burden in Appalachia are associated with low HPV vaccination coverage.[125] Reiter and colleagues suggest that lower vaccination coverage may be due to greater barriers in accessing primary care.[125] Three of the previously described studies explicitly looked at health care access as a contributing factor for HPV vaccination.[62,117,118] While the two studies in Los Angeles did not find a correlation between location of safety-net clinics and vaccination coverage, the researchers noted it is possible that other characteristics of the health care system (e.g., clinic operating hours) could influence access and use.[117] Additionally, the LA study's sample was modestly sized and homogenous, likely making it not representative of the rest of LA residents. In contrast, the North Carolina study suggested that areas with health professional shortages are associated with lower vaccination coverage.[62]

ACCESS TO AND USE OF PHARMACY-LOCATED VACCINATIONS

Typically, in HPV vaccination research, most measures of health care use examine access to and interactions with primary care providers such as pediatricians and family medicine physicians (hence forth referred to as primary care physicians). This makes sense as the large majority of adolescent vaccinations are given in practices with these two primary care specialties.[33] However, lower health care utilization patterns among adolescents in the United

States[30-32] suggests that additional modes of accessing vaccination may improve vaccination coverage. Moreover, the unequal distribution of primary care physicians in communities also warrants the investigation of the accessibility of alternative vaccination settings.

As discussed in Chapter Two, pharmacies are an ideal alternative to the traditional medical home for vaccinations. NACDS reports that 93% of U.S. residents live within five miles of a community pharmacy.[38] Research also suggests pharmacies have more convenient hours and ease of access within neighborhoods compared to primary care clinics.[44,46-48] Table 5.1 shows unpublished data from the AVIP study on average time (in minutes) it takes a parent to get to a pharmacy and his or her child's doctor's office. The paired *t*-tests show that parents were closer to pharmacies where they usually go to get their children's prescriptions as compared to their children's doctors' office in both urban and rural areas. Taken together with the data from NACDS, one may infer that pharmacists are more geographically dispersed (e.g., they may not cluster as much in location) compared to primary care physicians. The lower amounts of clustering may be due to pharmacy businesses wanting to avoid competition with each other in a given area. The data may also suggest that pharmacists are located closer to residential areas compared to primary care physicians.

Research presented in Chapter Two also suggests that very few parents are going to pharmacies to get HPV vaccine for their children, but unpublished findings from the AVIP survey show that parents may be using pharmacies to get other vaccines for their children (Table 5.2). About eight percent of parents in the AVIP sample (n/N = 119/1,504) have used a pharmacy to get their child vaccinated. Among these parents, 84% went to a pharmacy to get their child influenza vaccine (n = 100), nine percent to get adolescent vaccines (n = 11), and eight percent to get other non-adolescent vaccines (n = 10). The preference for parents to get influenza vaccine

over other vaccines for their children at a pharmacy may be driven in part by the yearly promotion of seasonal influenza vaccinations. Additionally, pharmacists have been providing influenza vaccinations for a much longer period of time than other vaccines, which may lead to greater awareness among parents and capacity for this service. Thus, meaningful use of pharmacies for vaccinating children may be directed towards vaccines outside of the adolescent platform. However, these data suggest that some parents do seek vaccinations in pharmacies for their children, and offers a possible setting to further establish the use of adolescent vaccines like HPV vaccine in pharmacies.

RESEARCH QUESTION AND HYPOTHESES

Studies have looked at issues of access to and use of HPV vaccination services. However, to the best of my knowledge, no studies have explicitly examined access to pharmacist-provided vaccinations compared to access to primary care physician-provided HPV vaccinations. Thus, the purpose of this dissertation aim is to understand how pharmacists can improve access to HPV vaccination services in areas that may be considered primary care shortage areas and have low vaccine coverage. The research questions and hypotheses for Aim 3 are:

1. Are primary care physicians more geographically clustered than pharmacists?

   Hypothesis 1. Primary care physicians are more spatially clustered than pharmacists.

If physicians are more geographically clustered than pharmacists, this will provide evidence that parents and their children may be geographically closer to pharmacists, and thus have easier access to pharmacists than access to primary care physicians.

2. Will including pharmacists as primary care providers increase the number of areas with adequate health care provider coverage?

Hypothesis 2. The number of areas with adequate health care provider coverage increases if pharmacists are included with primary care physicians as adolescent vaccine providers.

In addition to being geographically more dispersed, there are also some findings that support pharmacists are more readily located in areas that can be considered medically underserved.[10,47] If pharmacists can fill in gaps in primary care shortages, then this may present an opportunity for parents and adolescents who face greater barriers to accessing primary care physicians to find some types of preventive care like adolescent vaccinations in pharmacies.

SIGNIFICANCE AND IMPLICATIONS OF THE STUDY

Targeted strategies to improve local HPV vaccination coverage can begin by identifying areas that are potential "health care deserts" for primary care physicians, and complement vaccination efforts in those areas with alternative vaccine providers like pharmacists. If pharmacists are located in communities at a higher frequency compared to primary care physicians, particularly in areas of low vaccination coverage, public health researchers are warranted in promoting interventions that use pharmacies as additional vaccination outlets. Additionally, geographic studies that account for additional health care resources outside of traditional medical homes can help identify ways to improve or optimize existing health care systems in communities, especially in situations where adolescents and parents face substantial barriers to accessing primary care providers.

OVERVIEW OF DATA SOURCES AND PROCEDURES

Protocol for choosing study state. I focus on one state for the purpose of this research aim since pharmacy practice laws governing a pharmacist's authority to vaccinate are state specific. I

selected Texas based on inclusion and exclusion criteria I applied to the 48 contiguous states in the U.S. The two main inclusion criteria were:

1. Allowing pharmacists to vaccinate adolescents as young as 11 with HPV vaccine, and
2. Requiring reporting vaccine doses to the state immunization information system (IIS) or having high participation rates in the IIS from the study population.

Exclusion criteria that I considered for state selection were:

3. Higher than national average HPV vaccination rates for boys and girls, and
4. Small pharmacy work force.

Based on these criteria, potential states for this study were Mississippi, New Mexico, Texas, and Washington. After contacting each state's immunization branch, Texas and New Mexico agreed to provide data for this study. I ultimately selected Texas as it has a larger population that is geographically dispersed, and has a large pharmacy work force.

Vaccination data. Vaccination data will be collected from ImmTrac, the Texas Immunization Branch's IIS. While all vaccine providers are required to report any vaccine dose to ImmTrac, individual participation in ImmTrac is voluntary. However, ImmTrac has around a 92% participation rate from all individual less than 18 years of age in Texas. Thus, estimated coverage for adolescent vaccines will be fairly accurate. ImmTrac will provide vaccination coverage for HPV vaccine series initiation (≥1 dose), HPV vaccine series completion (≥3 doses), and HPV vaccine series follow-through (percentage who completed HPV vaccine series among those who initiated). ImmTrac will also report vaccination coverage for meningococcal, Tdap, and influenza vaccines. Since ImmTrac cannot report on individual counts for vaccinations, all vaccination rates will be reported as percentage of pre-adolescents or adolescents vaccinated in a given zip code. ImmTrac will not report vaccine coverage for zip codes that have 50 or fewer

pre-adolescents and adolescents. Vaccination coverage that will be reported will be stratified by the following age cohorts: 9-10 year olds, 11-12 year olds, 13-17 year olds, and 11-17 year olds. Additionally, ImmTrac will provide coverage estimates for the 2010 to 2015 calendar years.

Pharmacists workforce data. Pharmacist workforce data will come from the Texas Board of Pharmacy (available at: http://www.pharmacy.texas.gov/dbsearch/tables.asp). These data are publically available and updated regularly. Information reported includes the pharmacist's name, license number, public address (place of employment), employment type (e.g., community, hospital), and license status (e.g., active, inactive, expired). For my analysis, I will only include pharmacists with active licenses who work in community pharmacies.

Primary care physician workforce data. Physician workforce data will come from the Texas Medical Board (available at: http://store.tmb.state.tx.us/). Similar to the pharmacist data, physician data are publically available and include physician name, license type, activity status, practice address, and practice specialty. For my analysis, I will only include physicians with active licenses who practice in pediatrics and family medicine in outpatient clinics.

Census data. Demographic variables for race and ethnicity and total population will come from the 2010 Census.[126] I will use the Census Bureau's American Community Survey, 2010-2014 estimates,[127] to estimate additional sociodemographic characteristics such as percentage of children ages 9 to 17 with different types of insurance and the percentage of population with various educational attainment (e.g., less than high school, some college). I will also collect geographic boundaries of Texas using the 2015 TIGER shape file (available at: https://www.census.gov/geo/maps-data/data/tiger-line.html).

Additional covariates. Additional county characteristics such as persistent poverty and outpatient visits per capita will come from the Area Health Resource File (AHRF; available at: http://ahrf.hrsa.gov/download.htm).

Data preparation. Practice addresses will be available from pharmacist and primary care physician workforce datasets. Practice addresses will be geocoded and merged to shape files by joining the geocoded points to a geographic spatial unit such as census tracts or Zip Code Tabulation Area (ZCTAs). The first attempt for geocoding will be to join the workforce data with census tracts, as these are both geographically and economically meaningful units. If joining the geocoded workforce data to census tracts is not feasible, then I will use ZCTAs. Since zip codes are not geographic units used by the Census Bureau, I will cross-walk zip codes to Zip Code Tabulation Areas (ZCTAs) using a procedure developed by the Robert Graham Center.[128] ZCTAs were created by the U.S. Census Bureau to provide an aggregated unit of analysis that approximates the shape of zip codes. ZCTAs will provide satisfactory variation in vaccination coverage while also having sufficient data to approximate area-level characteristics.[62] Texas has 2,600 zip codes that aggregate to 1,936 ZCTAs.[128] Census-tract and county-level characteristics will be converted to ZCTAs using weighted averages.[62] I will use Stata 13.1 to merge datasets, clean data (e.g., ZCTA conversions), and conduct multiple imputation procedures for missing cases where vaccination coverages in zip codes were unavailable.

Geographic information system (GIS) processing. I will use ArcGIS (Redlands, CA) software (or similarly the open source software QGIS) to conduct geoprocessing functions and manage geospatial data. After cleaning and merging datasets in Stata 13.1, I will import the cleaned dataset into ArcGIS and examine maps for merge errors. I will then use the GIS software to map the location of pharmacists and primary care physicians based on their coordinates that

are geocoded from their publicly available addresses. By having each pharmacist and primary care physician geocoded, I can derive area estimates of the number of pharmacists and primary care physicians by geographic area, Euclidian or Manhattan distances from census tract centroids, or a ratio of providers to patient population for each census tract.

AIM THREE ANALYTIC APPROACH

I will use ArcGIS or Stata 13.1 for descriptive statistics, geospatial statistical tests, and other basic analyses. All statistical tests will use two-tailed tests with a critical alpha of 0.05.

Geographic dispersion of pharmacists and physicians. I will begin my analysis by evaluating the spatial autocorrelation of pharmacists and physicians based on the reported practice addresses provided by the Texas Board of Pharmacy and Medical Board (*hypothesis 1*). Using ArcGIS, I will calculate a global Moran's *I* for the spatial distribution of pharmacists and primary care physicians to assess the extent of spatial autocorrelation.[129] The formula for Moran's *I* is:

$$I = \left[\frac{n}{\left(\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\right)}\right]\frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\,(y_i - \bar{y})(y_j - \bar{y})}{\sum_{i=1}^{n}(y_i - \bar{y})^2}$$

Where n is the number of ZCTAs, y_i and y_j are the number of pharmacists or primary care physicians in locations i and j, w_{ij} is the neighbor spatial weight, $(y_i - \bar{y})(y_j - \bar{y})$ is the covariance term, and $\sum_{i=1}^{n}(y_i - \bar{y})^2$ is the normalization term to scale I to the overall variance in the dataset. To calculate the spatial weights, I will use a first order queen criterion to identify adjacent observations to be included as "neighbors" (e.g., neighboring census tracts), and use row standardization so that different census tracts are comparable to one another. Moran's *I* is analogous to Pearson's correlation coefficient; it provides a summary over the entire study area

of the level of spatial similarity observed among neighboring observations.[130] Moran's *I* ranges from -1 to 1, and variables that have high spatial clustering will have a Moran's *I* that approaches |1| (with some exceptions going out of range).

Since values of Moran's *I* are scale dependent (i.e., the values *I* takes depends on the scale of the geographic unit of analysis), there are instances where global Moran's *I* gives an incorrect measurement of autocorrelation for a study area. Thus, I will also consider calculating local indicators of spatial association (LISAs), which provide a local measure of similarity between each neighbor's associated value and those of nearby neighbors.[131] The most commonly used LISAs is local Moran's *I*, which is a transformation of the global Moran's *I* for any given geographic region in a study area.[131] In addition to calculating Moran's *I*, I will generate choropleth maps to visualize the spatial autocorrelation among pharmacists and primary care physicians. Based on ***hypothesis 1***, I predict that:

- Prediction 1: Primary care physicians will be positively spatially autocorrelated ($I_{MD}>0$; $p<.05$).
- Prediction 2: Pharmacists will be positively spatially autocorrelated ($I_{Rx}>0$; $p<.05$).
- Prediction 3: The spatial clustering of primary care physicians will be more than the spatial clustering of pharmacists ($I_{MD}>I_{Rx}$; $p<.05$).

Pharmacists' role in primary care health professional shortage areas. For the second analysis, I will descriptively evaluate how the number of primary care health professional shortage areas (HPSA) in Texas will change if pharmacists are included as primary care providers (*hypothesis 2*). The Health Resources and Services Administration define a geographic area as a primary care HPSA if it:[132]

- Is a rational area for the delivery of primary medical care services.

- Meets one of the following conditions:
    - Have a population to full-time-equivalent primary care physician ratio of at least 3,500:1.
    - Have a population to full-time equivalent primary care physician ratio of less than 3,500:1 but greater than 3,000:1 and have unusually high needs for primary care services or insufficient capacity of existing primary care providers.
- Demonstrates that primary medical professionals in contiguous areas are overused, excessively distant, or inaccessible to the population under consideration (detailed definition available at: https://ruralhealth.und.edu/pdf/hpsa.pdf).

Within the definition, primary medical professionals only count as physicians. Additionally, population is defined as the total population living in a geographic area. Since I will not have data to reliably demonstrate if primary medical professionals are overused, excessively distant, or inaccessible in a given area, I will focus my definition of primary care shortages as the ratio of population to the number of primary medical professionals. In order to evaluate the number of ZCTAs that can be designated as an HPSA, I will first calculate the ratio of total population to primary care physicians. Any census tracts that have a population to primary care provider (physicians only) ratio of at least 3,500:1 will be designated as a shortage area. I will then redefine HPSAs to also include community pharmacists, and recalculate the ratio of total population to primary care physicians and pharmacists. Under the new HSPA definition, any census tracts that have a population to primary care provider (physicians and pharmacists) ratio of at least 3,500:1 will be designated as a shortage area. I will use a proportion test to evaluate if the number of census tracts that are shortage areas significantly differ based on the two definitions of HSPAs. Based on ***hypothesis 2***, I predict that:

- Predication 4: There will be fewer census tracts with shortage areas if I designate HPSA to also include pharmacists.

In addition to the analysis plan for *hypothesis 2*, I will also consider an alternative approach by evaluating whether the ratio of primary care providers to patient population will rise more in areas with primary care shortages compared to areas with no shortages if pharmacists are included as primary care providers.

STRENGTHS AND LIMITATIONS

To the best of my knowledge, this will be the first study to analyze the distribution of pharmacists and primary care physicians and how this pattern is associated with HPV vaccination coverage in Texas. This study benefits from high adolescent participation in ImmTrac, which will help generate fairly accurate vaccination coverage estimates. This study also benefits from having a census of the pharmacist and primary care physician workforce that will allow for accurate analyses of the geographic distribution for these two types of health care providers. Additionally, this study will also be able to provide information on how vaccination trends varied over time within the state. An important limitation is that if I use ZCTAs rather than census tracts, the interpretation of results can lead to representational error in spatial analyses because ZCTAs were not created as geographic markers.[133] Additionally, no inferences can be made about individual-level characteristics since vaccination data provided by ImmTrac will be aggregated at the level of zip codes. Finally, while this study is primarily ecological, there are many contributing factors at the state, county, and local level that may affect vaccination coverage that cannot be accounted for, such as the availability of publically funded vaccination programs (e.g., Vaccines for Children), the change in the number of providers in an

area over time, and the movement of families from one area to another both within and out of the state.

TABLE 5.1 PARENT'S REPORTED TIME TO HEALTH CARE SETTING

	Pharmacy Mean minutes ($CI_{95\%}$)	Doctor's office Mean minutes ($CI_{95\%}$)	*t*
Rural (*n* = 233)	14.8 (13.0 - 16.7)	18.5 (16.3 - 20.3)	3.91 (*p*<.001)
Urban (*n* = 1240)	11.1 (10.5 - 11.7)	17.5 (16.8 - 18.2)	16.78 (*p*<.001)

TABLE 5.2 TYPE OF VACCINES PARENTS GOT FOR THEIR CHILDREN AT PHARMACIES

	n	(%)
Vaccine type		
Flu	100	(84)
Other vaccines	10	(9)
Tdap	6	(5)
HPV	4	(3)
Meningococcal	1	(<1)

Note. Parents were able to choose multiple vaccines for their children.

CHAPTER SIX. STUDY ONE: THE ROLE OF PHARMACY TYPE IN PARENTS' WILLINGNESS TO GET HPV VACCINE FROM PHARMACISTS

INTRODUCTION

The President's Cancer Panel and the National Vaccine Advisory Committee recommended expanding HPV vaccine provision in pharmacies as one strategy to improve access to and opportunities for HPV vaccinations,[3,4] whose rates have lagged considerably behind those of tetanus, diphtheria, and acellular pertussis (Tdap) and meningococcal vaccinations.[134] Since 1994, pharmacists have played an increasingly large role in immunization efforts,[35] and may be well positioned to improve HPV vaccine uptake. For instance, 20% of U.S. adults received their influenza vaccine from chain or supermarket pharmacies in 2011-2012.[43] Pharmacies have tremendous potential reach within communities; consumers make an estimated 250 million visits to pharmacies each week,[135] and about 93% of U.S. residents live within five miles of a community pharmacy.[38] Pharmacies also have longer operating hours and are easier to access within communities compared to traditional medical settings when considering vaccination services.[44,46-48]

A recent study found that almost one-third of parents were willing to get their children HPV vaccine from pharmacies.[136] However, the study did not examine how parents' willingness to get their children vaccinated from pharmacists varies by the types of pharmacies they typically frequent. This is important to understand because customers may hesitate to engage in pharmacy-located adolescent vaccination due to varying degrees of perceived quality in the health care

services provided at different pharmacies. For example, patients surveyed by Consumer Reports highly rated independent-owned pharmacies or pharmacies located in health systems like Kaiser Permanente, while less favorably rating chain pharmacies like Walgreens and Walmart.[137] In turn, we hypothesized that parents who go to independent pharmacies or pharmacies located in a clinic or hospital have higher willingness to get their children HPV vaccine from a pharmacist than parents who go to chain pharmacies (*Hypothesis 1*).

Understanding how customers' perceptions of quality develop may help pharmacies find tangible ways to improve their health care delivery, ultimately increasing customer engagement with their products and services.[66] Marketing research has demonstrated that consumer perceptions of service quality and their feelings of satisfaction are strong predictors of consumer engagement with services.[7,66,68-71] The conceptualization that service quality perceptions for a particular business will elicits an emotion response of satisfaction, which in turn leads to engagement with an established or new service or product in that business is grounded in Lazarus' emotion and adaptation[8] and Bagozzi's self-regulation of attitudes and intentions frameworks.[65] By extension, it may be reasonable to conclude that consumers' service quality perceptions may vary by the types of pharmacy they go to, which in turn results in varying levels of satisfaction and willingness to engage in new services like adolescent vaccination. As such, we hypothesized that the association of pharmacy type on parents' willingness to get their child HPV vaccine from a pharmacist will be mediated by perceptions of service quality and overall satisfaction with health care services at the pharmacy (*Hypothesis 2*).

To the best of our knowledge, no study has examined how different kinds of pharmacies parents go to for their children's medications may affect their perceptions of service quality, feelings of satisfaction, and willingness to get HPV vaccination. As such, the purpose of this

study was to examine how the type of pharmacy parents report using is associated with their willingness to get HPV vaccine for their children from pharmacists.

METHODS

Data source and procedures

Study participants. The Adolescent Vaccinations in Pharmacies (AVIP) Study was an online, cross-sectional survey of U.S. parents of adolescents conducted from November 2014 to January 2015. Study participants were members of an existing, national panel of non-institutionalized adults maintained by a survey company.[83] The national panel was created through probability-based sampling of U.S. households using a combination of random-digit dialing and address-based sampling frames. Eligible respondents were parents of at least one child ages 11 to 17 who lived with them at least half of the time. Parents answered survey items about their children who they identified at the beginning of the survey.

Analytic sample. The survey company randomly selected 2,845 parents from a panel comprised of members from all 50 states and the District of Columbia. Approximately 14% (n=391) of invited panelists were not eligible to complete the survey. Of the 2,454 eligible parents, 1,518 completed some portion of the survey. After we excluded 14 panelists who did not complete at least two-thirds of the survey, our final analytic sample contained 1,504 parents whose sociodemographic characteristics are summarized in Table 6.1. The response rate was 61% (1,504/2,454) based on American Association for Public Research Response Rate Five.[84,85]

Measures

Survey item development. We developed survey items based on previous research among parents, adolescents, and health care providers,[86-90] or adapted items from other sources.[7,91,92] We

cognitively tested the AVIP survey with 18 parents of adolescents ages 11 to 17 to ensure the clarity of survey items, and we pre-tested the instrument with 26 parents from the national panel to ensure proper survey functionality. The full AVIP survey instrument is available online at www.unc.edu/~ntbrewer/hpv.htm.

Predictor. The survey instructed parents to first "think about the pharmacy you would usually go to if you needed to get [child's name] prescription medications," and then asked parents to identify the pharmacy type. We combined chain pharmacy, a pharmacy in a grocery store, and a pharmacy in a big box store into the referent category (termed "chain pharmacies," coded "0"), an independent pharmacy as a second category (coded "1"), and a pharmacy in a clinic or hospital as a third category (coded "2").

Mediators. The survey included items about parents' service quality perceptions assessed in three factors adapted from work by Hedvall and Paltschick:[82] professionalism, confidentiality, and milieu (five-point response scale ranging from "strongly disagree" [1] to "strongly agree" [5]; Appendix III). Three items represented the latent variable "professionalism": the appraisal of the pharmacists keeping the customers' best interests at heart, and performing their clinical duties promptly and accurately. Two items represented the latent variable "confidentiality": the appraisal of the pharmacists creating an environment where customers feel that they are cared for, and enabling them to feel free to discuss problems and ask questions. Four items represented the latent variable "milieu": the appraisal of physical premises of the pharmacy and appearance of the pharmacists. The survey also assessed parents' feeling of overall satisfaction with health services at the pharmacy (seven-point response scale ranging from "completely dissatisfied" [1] to "completely satisfied" [7]).

Outcome. The outcome was willingness to get HPV vaccine from an immunizing pharmacist. Parents were first prompted with the statement "Imagine you and [child's name] decided to get the HPV vaccine for [him/her]". Parents were then asked "How willing would you be to have [child's name] receive it from an immunizing pharmacist?" The four-point response scale ranged from "definitely not willing" to "definitely willing" (coded 1-4).

Covariates. The survey company provided sociodemographic characteristics including parent sex, age, race and ethnicity, education, household income, urbancity ("non-metropolitan statistical area" or "metropolitan statistical area"), and U.S. region of residence. The survey included items from the Carolina HPV Immunization Attitudes and Beliefs Scale (CHIAS) that assessed parents' HPV vaccine confidence.[87] Two items assessed how many minutes it takes parents to get to the pharmacy and their child's primary care provider. One item assessed the parent's familiarity with the pharmacists at the pharmacy they frequent (three-point response scale ranging from "not well at all" [1] to "very well" [3]). For demographic and health characteristics for the parent's index child (reported by the parent), the survey assessed sex, age, race and ethnicity, HPV vaccinations status ("no doses," "1+ doses," or "series completion"), perceived health status ("poor health" [1] to "excellent health" [5]), and previous use of an alternative vaccination setting (defined as the index child having received a previous vaccination at a pharmacy, school, or health department).

Statistical analyses

One-way analysis of variance. First, we conducted one-way analysis of variance (ANOVA) to identify between group differences in mean scores on the three service quality appraisals, overall satisfaction, and willingness to get HPV vaccine from a pharmacist among the

pharmacy types parents typically use. We used Bonferroni multiple comparisons tests to evaluate the statistical significance between group scores.

Confirmatory factor analysis. Second, we used confirmatory factor analysis (CFA) to evaluate the extent to which the nine service quality items loaded onto three, sufficiently distinct factors. Models considered to have excellent fit to the observed data on global fit indices had a root mean squared error approximation (RMSEA) of less than .05, and a Comparative Fit Index (CFI) and Tucker Lewis Index (TLI) of greater than .95.[138] We also evaluated each model's Schwarz's Bayesian Information Criterion (BIC, Appendix IV). A difference of 10 or more in BICs between two competing models provides strong support for the model with the most negative BIC.[139] We also looked at modification indices to evaluate if any indicators in the measurement model should be correlated based on sound theoretical justification.[97] We used full information maximum likelihood estimation with robust standard errors, which uses Huber-White sandwich estimators to account for possible non-normality in the distribution of the errors in the model.[140] Finally, we evaluated internal consistency reliability of each factor using coefficient-ω (omega; Appendix III).[102] The hypothesized three-factor model with an error correlation had superior fit compared to alternatives (RMSEA=.031, CLI=.99, TLI=.99, and BIC=-113; Appendix IV and Appendix V), and was used for the structural equation model (SEM).

Structural equation modeling. Finally, we created a SEM to evaluate how the three service quality factors and overall satisfaction mediated the relationship between pharmacy type and parents' willingness to get HPV vaccine for their children from pharmacists. We conducted our SEM analyses using full information maximum likelihood estimation using bootstrapped resampling procedures.[140] We assessed the statistical significance of direct and indirect

(mediated) effects employing 5,000 random sample draws with replacement from the existing dataset to generate bias-corrected confidence intervals.[141] Similar to the CFA, we examined model fit by evaluating its RMSEA, CFI, and TLI, and calculated BICs to compare our hypothesized model to alternative models (Appendix IV). Our results are based on the hypothesized model due to the presence of an association between one of the pharmacy type predictors and willingness outcome.

Our initial SEM included the following covariates: parent's sex, age, education, distance lived from pharmacy and child's primary care provider, household income, urbanicity, U.S. region of residence, child's sex, race and ethnicity, HPV vaccination status, and child's perceived health status. We also adjusted for child's age, child's previous use of alternative settings for vaccinations, and parent's HPV vaccine confidence based on findings from earlier, related studies.[6,32,87,142,143] Our final SEM only included covariates that were associated with the willingness outcome (Table 6.3). All covariates were correlated with predictors and mediators to adjust for their effects.

We used Stata 13.1 (College Station, TX) to run descriptive statistics and ANOVA. We used Mplus 7.4 (Los Angeles, CA) to run the CFA and SEM. All statistical tests were two-tailed with a critical α=.05. Bias corrected confidence intervals that do not contain zero were statistically significant.

RESULTS

Correlates of willingness to get HPV vaccine from immunizing pharmacists

Overall, 44% of parents were either probably or definitely willing to get HPV vaccine from a pharmacist ($\bar{x}$=2.31, SD=.93). Parents' average willingness varied by pharmacy type

(p=.046; Table 6.2); 45% of parents who went to chain pharmacies expressed willingness to get HPV vaccine from a pharmacist compared to 37% who went to independent pharmacies or 39% who went to pharmacies in clinics or hospitals.

Pharmacy type. The hypothesized structural equation model fit the data well (RMSEA=.041; CFI=.97; TLI=.96; Figure 6.1). In analyses that controlled for covariates but not the mediators, parents who went to independent pharmacies reported lower willingness to get HPV vaccine (β=-.088; p=.001) compared to parents who went to chain pharmacies. After including the service quality latent variables and overall satisfaction measure as mediators in the SEM, the negative association between independent pharmacies and parents' willingness to get HPV vaccine from pharmacists increased in magnitude (β=-.094; p=.001; Table 7.3 and Figure 6.1). In contrast, there was no association between pharmacies located in a clinic or hospital (compared to chain pharmacies) and willingness to get HPV vaccine for analyses that controlled for only covariates and analyses that included mediators and covariates.

Covariates. Parents were more willing to get HPV vaccine from pharmacists if they had children previously vaccinated in alternative settings (β=.18; p<.001), if they knew their pharmacists moderately well (β=.11; p<.001) or very well (β=.07; p=.011), and had older children (β=.08; p=.002). Parents were less willing to get HPV vaccine from pharmacists if they had children identified as (β=-.05; p=.046), but were more willing if they had children categorized as Other (β=.08; p=.001). Willingness to get HPV vaccine remained lower for parents who identified their children as Black (β=-.05; p=.034) in analyses that only included parents of Black or White children (n=1,351).

Pharmacy type and service quality factors

The three pharmacy types elicited different ratings of professionalism, confidentiality, and milieu (Table 6.2). Parents who went to independent pharmacies compared with parents who went to chain pharmacies gave higher appraisals of professionalism (4.24 versus 3.78; $p<.001$) and confidentiality (4.38 versus 3.98; $p<.001$). No difference was observed with regard to milieu. Parents who went to pharmacies located in clinics or hospitals compared with parents who went to independent pharmacies gave lower evaluations of professionalism (3.73; $p<.001$), confidentiality (3.95; $p<.001$), and milieu (3.79; $p=.001$). Parents gave higher ratings of milieu at chain pharmacies compared to pharmacies in clinics or hospitals (3.98 versus 3.79; $p=.02$), but ratings for professionalism and confidentiality did not differ.

Mediation analyses

Service quality to willingness to get HPV vaccine. Appraisals of professionalism ($\beta=.22$; $p=.01$) and milieu ($\beta=.22$; $p=.02$) were positively associated with overall satisfaction, while appraisal of confidentiality was not ($\beta=.00$; $p=.97$; Table 6.3). Overall satisfaction was positively associated with parents' willingness to get HPV vaccine from pharmacists ($\beta=.11$; $p<.001$). Results from the mediation analyses (Table 6.4) show that the paths from professionalism (pathway product=.024, $CI_{95\%}$: .006-.054) and milieu (pathway product=.024, $CI_{95\%}$: .006-.051) were positive, statistically significant, and similar in magnitude. However, the path from confidentiality was not statistically significant.

Pharmacy type to willingness to get HPV vaccine. Parents who went to independent pharmacies gave higher appraisals of professionalism ($\beta=.17$; $p<.001$), confidentiality ($\beta=.14$; $p<.001$), and milieu ($\beta=.07$; $p=.03$) compared to those who went to chain pharmacies. Parents who went to pharmacies located in clinics or hospitals gave lower appraisal of milieu ($\beta=-.08$;

p=.01) compared to those who went to chain pharmacies, but did not give different appraisals of professionalism (β=-.01; *p*=.63) or confidentiality (β=-.02; *p*=.60). In the mediation analyses for independent pharmacies compared to chain pharmacies, the sum of the mediating paths was statistically significant (pathway product=.006, $CI_{95\%}$: .002-.011). Among the individual paths between the independent pharmacy indicator and willingness outcome, only the mediating path including professionalism was statistically significant (pathway product=.004, $CI_{95\%}$: .001-.010). In the mediation analyses for pharmacies located in clinics or hospitals compared to chain pharmacies, the sum of all mediating paths, as well as the individual mediating paths including professionalism, confidentiality, and milieu were not statistically significant.

DISCUSSION

Marketing research has consistently shown service quality and satisfaction predict customer engagement in health care,[144] banking,[145] telecommunication,[146] and tourism[147] industries. Similarly in our study, perceived service quality and overall satisfaction are predictors of parents' willingness to get HPV vaccine for their children from pharmacists. Perceived service quality and satisfaction also varied by the type of pharmacy parents usually go to for their children's prescription medications. This result supports the notion that customers' perceived service quality is dependent on their interaction with service environments.[77]

Inconsistent with our hypothesis 1, parents were less willing to get HPV vaccine from pharmacists if they usually went to independent pharmacies, and not different if parents usually went to pharmacies in clinics or hospitals compared to chain pharmacies. Parents' willingness to get HPV vaccine was similar for those who usually went to independent pharmacies and pharmacies in clinics and hospitals, and both means were lower compared to parents who usually

went to chain pharmacies. The detection of an association in the SEM for the group of parents who used independent pharmacies but not one for the group who used pharmacies in clinics or hospitals may be due to insufficient statistical power. Independent pharmacies are likely to be less consistent in their appearances and types of non-dispensary services they provide for patients, which could lead parents to perceive them as less ideal for adolescent vaccinations as compared to chain pharmacies. Additionally, parents may be less willing to get their children HPV vaccine at pharmacies in clinics and hospitals by virtue of proximity to their children's medical providers.

Our second hypothesis was partially supported by the presence of a mediating effect of service quality factors and satisfaction between independent pharmacies to parents' willingness to get HPV vaccine. Appraisals of service quality and feeling of satisfaction were high across pharmacy types, which may explain the small effect size seen through the mediated path. Consumer Reports also showed generally high appraisal of the different pharmacies they evaluated.[137] Also of note, Hedvall and Paltschik proposed that appraisals of professionalism and milieu are preconditions for service quality.[82] Our findings corroborate their proposition as evidence of mediating paths from professionalism and milieu. In light of a negative association between willingness and independent pharmacies, service quality and satisfaction act as suppressors suggesting inconsistent mediation. As such, other important mediators may possibly help explain the negative relation between independent pharmacy type and parents' willingness. For instance, the service quality factors and satisfaction item are global measures of an attitude and affect that do not take into account specific aspects that are important to vaccine delivery that parents consider when judging a location acceptable for adolescent vaccinations, such as perceptions of safety and privacy.[5,6] In this study, our aim was to look at how a general attitude

towards a pharmacy type relates to parents engagement with a hypothetical service. Future studies that relate pharmacy service context with health service engagement, or look at implementation of quality improvement efforts in pharmacies, may benefit from survey instruments that include service quality and satisfaction items that are tailored to the specific service a consumer engages in, such as adolescent vaccination, at the point of service transaction.[77]

Familiarity with pharmacists was also strongly associated with parents' willingness, which may have been acting as a proxy for parents' perceptions of trust with their pharmacists. Trust is a key predictor of medical service use and patient satisfaction.[148] We found that the majority of our sample (61%) did not know their pharmacist at all. Lack of familiarity could be driven by pharmacists focused on administrative responsibilities and current business models that are dependent on reimbursement from dispensing services, rather than focused on cognitive services like medication therapy management and counseling.[149] Pharmacies should find ways to promote patient-provider communication not only to make vaccinations more viable, but also to make pharmacies a more acceptable health care setting. Patient-pharmacist communication, in the form of patient education and counseling, is made all the more important in light of our finding that parents were more willing to get HPV vaccine from pharmacists as their confidence in HPV vaccination increased.

This study has notable strengths, including a national sample of U.S. parents of adolescents and novel survey items examining various motivating factors that influence parents' willingness to get HPV vaccine from pharmacists. The hypotheses were grounded in established theory on service quality, and provided a novel application of a marketing theory to the adolescent vaccination literature. The analytic approach of structural equation modeling allowed us to look

at complex mediation, model latent variables, and account for measurement error. Our study is limited by a cross-sectional study design that prevents us to establish temporal relationships among variables, thus limiting our inferences to associations. In addition, satisfaction and willingness can be conceptualized as multidimensional constructs, and the study would have benefited from multi-item measures. Parents also supplied their own responses to the survey, which can lead to response biases. Finally, our study was not designed to directly address perception differences of pharmacies or pharmacists due to racial and ethnic differences. The lower willingness in parents of Black compared to White children may be akin to other findings of medical mistrust with physicians,[150] but a possible explanation for the association for "Other" race is ambiguous due to the necessity of combining racial categories to maintain statistical power. Future studies may be warranted to understand the modifying effects of race and ethnicity on perceptions of service quality and satisfaction in pharmacies.

CONCLUSIONS

With 77% of U.S. pharmacies providing vaccination servies,[151] pharmacists can play a meaningful role in increasing HPV vaccine uptake. In our study, close to half of parents expressed willingness to get HPV vaccine from pharmacists, but their willingness varied by the type of pharmacy parents typical use. Service quality and satisfaction were key predictors of parents' willingness, but notably so was parents' familiarity with pharmacists. These correlates signal to the importance of looking to best practices in improving patient experiences at the pharmacies, particularly those that promote pharmacist-patient communication.

TABLE 6.1 SAMPLE DEMOGRAPHIC CHARACTERISTICS (*N*=1,504)

	n or avg	(%) or (SD)
Parent Characteristics		
Sex		
Male	668	(44)
Female	836	(56)
Age (yrs)	43.9	(7.84)
Race/Ethnicity		
Non-Hispanic White	1058	(70)
Non-Hispanic Black	135	(9)
Hispanic	212	(14)
Other race/ethnicity	99	(7)
Education		
High school degree or less	576	(38)
Some college or more	928	(62)
HPV vaccine confidence	3.65	(.77)
Pharmacy type used for index child's prescriptions		
Chain pharmacy	829	(55)
Grocery store pharmacy	169	(11)
Big box pharmacy	218	(15)
Pharmacy in clinic or hospital	124	(8)
Independent pharmacy	155	(10)
Parent's familiarity with pharmacist		
Not well at all	907	(61)
Moderately well	479	(32)
Very well	108	(7)
Child Characteristics		
Sex		
Male	765	(51)
Female	739	(49)
Age (yrs)	14.0	(2.01)
Race		
White	1175	(79)
Black	160	(11)
Other	153	(10)
Ethnicity		
Non-Hispanic	1236	(83)
Hispanic	258	(17)
HPV vaccination status		
0 doses	808	(54)
≥1 dose	458	(30)
Series completion	237	(16)

Vaccinated in alternative settings		
No	994	(66)
Yes	510	(34)
Household Characteristics		
Household income		
Less than $35,000	329	(22)
$35,000 - $74,999	470	(31)
$75,000 or more	705	(47)
Urbanicity		
Non-metropolitan statistical area	236	(16)
Metropolitan statistical area	1268	(84)
Region		
Northeast	261	(17)
Midwest	393	(26)
South	499	(33)
West	351	(23)

Note. Frequencies for specific characteristics may not total to 1,504 participants due to missing responses.

TABLE 6.2 PARENTS' EVALUATIONS MEAN PROFESSIONALISM, CONFIDENTIALITY, MILIEU, OVERALL SATISFACTION, AND WILLINGNESS TO GET HPV VACCINE FROM PHARMACISTS BY PHARMACY TYPE

	The pharmacy parents typical use to get their children's prescriptions				
	Chain pharmacy (SD) *n* = 1216	Independent pharmacy (SD) *n* = 155	Pharmacy in clinic or hospital (SD) *n* = 124	*F*	*p*
Professionalism[a]	3.78 (.88)	4.24 (.86)	3.73 (.86)	19.99	<.001
Confidentiality[a]	3.98 (.85)	4.38 (.81)	3.95 (.89)	15.42	<.001
Milieu[a]	3.98 (.75)	4.14 (.82)	3.79 (.83)	7.11	<.001
Overall satisfaction[b]	5.42 (1.51)	5.92 (1.45)	5.47 (1.56)	7.42	<.001
Willingness to get HPV vaccine[c]	2.34 (.92)	2.18 (1.03)	2.19 (.96)	3.09	0.046

Note. Total number of missing cases for each ANOVA were less than 1%.

[a] Professionalism, confidentiality, and milieu were measured with five-point response scales ("strongly disagree" [1] to "strongly agree" [5]).

[b] Overall satisfaction was measured with a seven-point response scale ("completely dissatisfied" [1] to "completely satisfied" [7]).

[c] Willingness to get HPV vaccine was measured with a four-point response scale ("definitely not willing" [1] to "definitely willing" [4]).

TABLE 6.3 DIRECT EFFECTS OF PREDICTORS ON SERVICE QUALITY FACTORS, OVERALL SATISFACTION, AND WILLINGNESS TO GET HPV VACCINE FROM PHARMACISTS (*N*=1,504)

Predictors	Mediators				Outcome
	Professionalism	Confidentiality	Milieu	Overall satisfaction	Willingness
Pharmacy type					
Chain pharmacy *(ref)*	-	-	-	-	-
Independent pharmacy	.17*** [.12, .22]	.14*** [.09, .19]	.07* [.01, .12]	-	-.09** [-.15, -.04]
Pharmacy in clinic or hospital	-.01 [-.06, .04]	-.02 [-.07, .04]	-.08** [-.14, -.02]	-	-.04 [-.09, .01]
Service quality factors[a]					
Professionalism	-	-	-	.22* [.05, .40]	-
Confidentiality	-	-	-	.00 [-.18, .16]	-
Milieu	-	-	-	.22* [.05, .40]	-
Overall satisfaction	-	-	-	-	.11*** [.06, .16]
Index child vaccinated in alternative settings[b]					
No *(ref)*	-	-	-	-	-
Yes	-	-	-	-	.18*** [.13, .23]
Familiarity with pharmacists[b]					
Not well at all *(ref)*	-	-	-	-	-
Moderately well	-	-	-	-	.11*** [.06, .16]
Very well	-	-	-	-	.07* [.02, .13]
Index child's race[b]					
White *(ref)*	-	-	-	-	-

Black	-	-	-	-	-.05* [-.09, -.001]
Other	-	-	-	-	.08** [.03, .13]
Index child's age[b]		-	-	-	.08** [.03, .12]
HPV vaccine confidence[b]	-	-	-	-	.17*** [.12, .23]

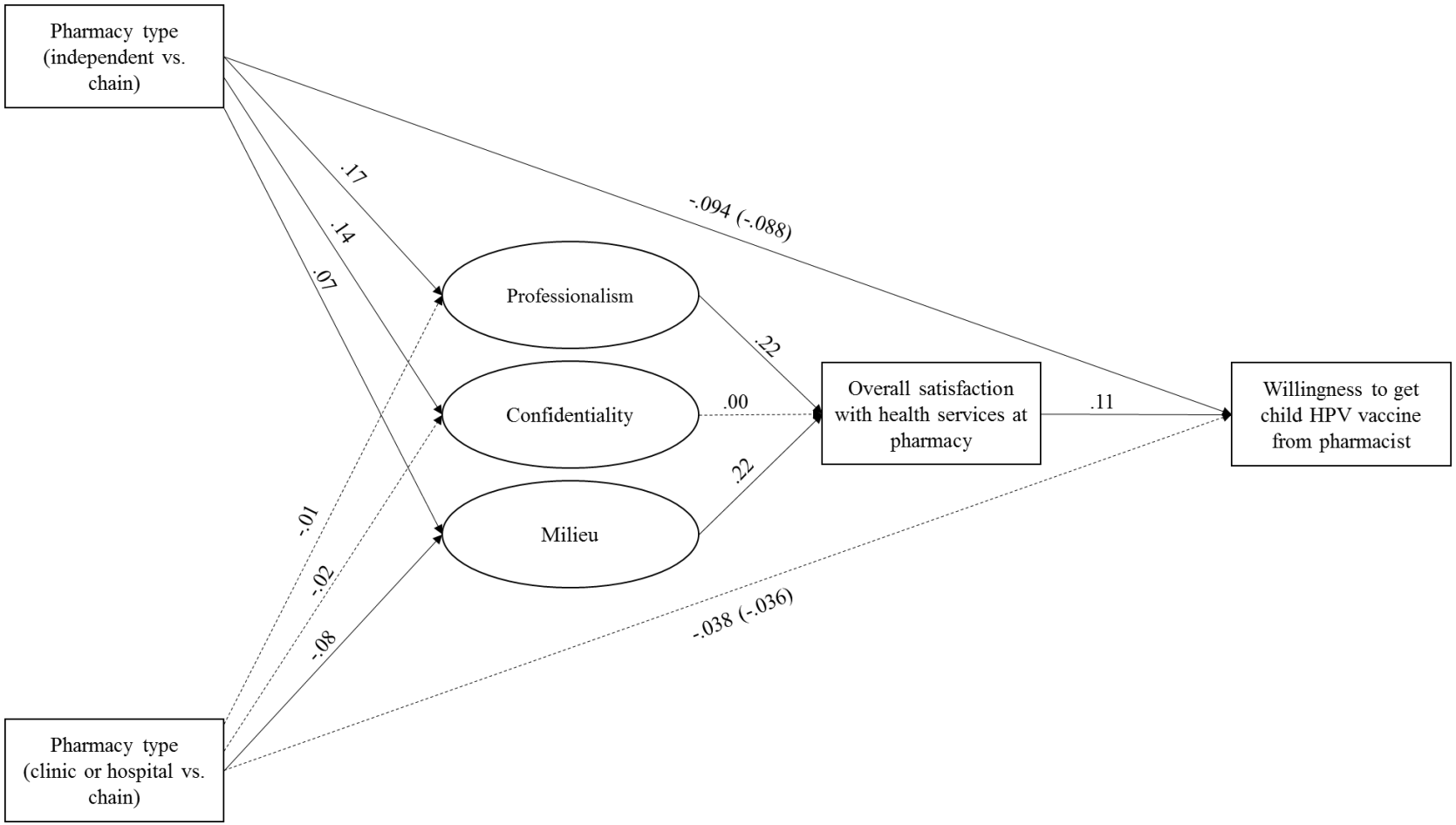
Note. Estimate of coefficients ($\hat{\beta}$) are standardized. 95% confidence intervals are bias corrected.
*p <.05; **p<.01; ***p<.001.
[a] Professionalism, confidentiality, and milieu were correlated with each other.
[b] Model adjusted for statistically significant effects of covariates on willingness outcome variable. All covariates were correlated with pharmacy type, service quality factors, and overall satisfaction.

TABLE 6.4 INDIRECT EFFECTS OF PHARMACY TYPE TO WILLINGNESS TO GET HPV VACCINE FROM PHARMACISTS

Mediation paths	$\widehat{\beta}$	[$CI_{95\%}$]
Professionalism via …		
Overall satisfaction → Willingness to get HPV vaccine from immunizing pharmacist	.024*	[.006, .054]
Confidentiality via …		
Overall satisfaction → Willingness to get HPV vaccine from immunizing pharmacist	.000	[-.021, .018]
Milieu via …		
Overall satisfaction → Willingness to get HPV vaccine from immunizing pharmacist	.024*	[.006, .051]
Independent pharmacy vs retail chain pharmacy via …		
Professionalism → Overall satisfaction → Willingness to get HPV vaccine from immunizing pharmacist	.004	[.001, .010]
Confidentiality → Overall satisfaction → Willingness to get HPV vaccine from immunizing pharmacist	.000	[-.003, .003]
Milieu → Overall satisfaction → Willingness to get HPV vaccine from immunizing pharmacist	.002	[.000, .005]
Sum of mediating effects	**.006***	**[.002, .011]**
Pharmacy in a clinic or hospital vs retail chain pharmacy via …		
Professionalism → Overall satisfaction → Willingness to get HPV vaccine from immunizing pharmacist	.000	[-.002, .001]
Confidentiality → Overall satisfaction → Willingness to get HPV vaccine from immunizing pharmacist	.000	[-.001, .001]
Milieu → Overall satisfaction → Willingness to get HPV vaccine from immunizing pharmacist	-.002	[-.005, .000]
Sum of mediating effects	**-.002**	**[-.005, .000]**

Note. Estimate of coefficients ($\hat{\beta}$) are standardized. 95% confidence intervals [$CI_{95\%}$] are bias corrected.
*p <.05

FIGURE 6.1 STRUCTURAL EQUATION MODEL ASSESSING IMPACT OF PHARMACY TYPE ON WILLINGNESS TO GET HPV VACCINE FROM PHARMACIST



Note. Numbers are standardized coefficients ($\hat{\beta}$). Estimates of coefficients ($\hat{\beta}$) in parentheses are the direct effects of pharmacy type on willingness to get HPV vaccine without controlling for mediators (only direct effect of independent pharmacy statistically significant). Goodness of fit tests: χ^2= 616; RMSEA = .041; CFI = .97; TLI = .96. Factor loadings, residuals, correlations between variables, and covariates were omitted to simplify presentation. Dashed lines represent statistically nonsignificant pathways.

CHAPTER SEVEN. STUDY TWO: RELATIVE ADVANTAGES OF PHARMACIES AND DOCTORS' OFFICES AS VACCINATION SETTINGS

INTRODUCTION

The President's Cancer Panel and the National Vaccine Advisory Committee recommended expanding HPV vaccine provision in pharmacies to help improve access and opportunities for HPV vaccination,[3,4] whose completion rates for U.S. adolescent boys (27%) and girls (37%) ages 13 to 15 remaining well below the Healthy People 2020 objective of 80% coverage for children these ages.[134] Pharmacy-located vaccinations presents advantages for adolescents over vaccination in traditional medical settings given their convenient locations within communities,[44,47,49] longer operating hours,[44] and ability to administer vaccines with no appointment and short wait times.[49]

Past studies[5,6,58,60,108] have identified reasons why pharmacies may possibly be considered acceptable vaccination settings. However, no studies have directly evaluated how pharmacies compare to doctors' offices based on important features of vaccine delivery. Within the context of Diffusion of Innovation ("DOI") Theory, adolescent vaccination in pharmacies, particularly HPV vaccination, could be viewed as an innovation since adolescent vaccine delivery is a relatively new service provided by some pharmacies. Widespread adoption of an innovation like pharmacy-located adolescent vaccination depends on five traits: relative advantage, compatibility, complexity, trialability, and observability.[109,110] Among these traits, relative advantage, "the degree to which an innovation is perceived as better than the idea it supersedes," has been found to be the most important predictor for adoption.[109] Vaccination in pharmacies and

doctors' offices can be distinguished as having relative advantages based on important delivery features like safety and convenient hours.

Parents who have reported positive attitudes about vaccinating their children in pharmacies or other alternative settings suggest that the main appeal of these settings is increased convenience or access to vaccination services.[5,60] Based on these observations, we hypothesized that compared to doctors' offices, parents believe pharmacies are superior vaccination settings when considering vaccine delivery features related to patient accessibility (*hypothesis 1a*). However, past research also showed parents and adolescents prefer going to traditional medical settings to get vaccines over alternative vaccination settings, including pharmacies,[5,6,58,60,108] expressing safety and privacy concerns.[6,58] While parents' positive attitudes for using alternative settings appear to be rooted in patient accessibility, parents' preferences for vaccinating their children in traditional medical settings appear to be grounded in their expectations of what constitutes an acceptable clinical environment for vaccinations. Therefore, we also hypothesized that compared to doctor's offices, parents believe pharmacies are inferior vaccination settings when considering vaccine delivery features related to the health care environment (*hypothesis 1b*).

Additionally, the saliency of the relative advantage of a vaccine delivery feature may also be important to consider when evaluating parents' decision to get their children vaccinated from pharmacists. As such, we believe that parents who place the greatest importance on vaccine delivery features that relate to patient accessibility are more willing to get HPV vaccine from a pharmacist compared to parents who place the greatest importance on features that relate to the health care environment (*hypothesis 2*). We also believe, after controlling for the importance parents place on vaccine delivery features, parents who identify more relative advantages for

getting their children vaccinated at pharmacies have higher willingness to get their children HPV vaccine from a pharmacist (*hypothesis 3*).

No previous studies have explicitly tested whether the perceived relative advantages of pharmacies, and the importance placed on these relative advantages, are associated with willingness to get HPV vaccine from pharmacists. For this study, we aimed to characterized how parents perceive relative advantages of vaccine delivery between pharmacies and doctors' offices, and how these perceptions relate to parents' willingness to get HPV vaccine for their children from pharmacists.

METHODS

Data source and procedures

Study participants. The Adolescent Vaccinations in Pharmacies (AVIP) Study was an online, cross-sectional survey of U.S. parents of adolescents conducted from November 2014 to January 2015. Study participants were members of an existing, national panel of non-institutionalized adults maintained by a survey company.[83] The national panel was created through probability-based sampling of U.S. households using a combination of random-digit dialing and address-based sampling frames. Eligible respondents were parents of at least one child ages 11 to 17 who lived with them at least half of the time. Parents answered survey items about their children who they identified at the beginning of the survey.

Analytic sample. The survey company randomly selected 2,845 parents from a panel comprised of members from all 50 states and the District of Columbia. Approximately 14% (*n*=391) of invited panelists were not eligible to complete the survey. Of the 2454 eligible parents, 1,518 completed some portion of the survey. After we excluded 14 panelists who did not complete at least two-thirds of the survey and four panelist who did not complete our study's

variables of interest, our final analytic sample contained 1,500 parents whose sociodemographic characteristics are summarized in Table 7.1. The response rate was 61% (1,500/2,454) based on American Association for Public Research Response Rate Five.[84,85]

Measures

Survey item development. We developed survey items based on previous research with parents, adolescents, and health care providers,[86-90] or adapted items from other sources.[7,91,92] We cognitively tested the AVIP survey with a convenience sample of 18 parents of adolescents ages 11 to 17 to ensure the clarity of survey items, and we pre-tested the survey with 26 parents from the national panel to ensure proper survey functionality. The full AVIP survey instrument is available online at www.unc.edu/~ntbrewer/hpv.htm.

Relative advantages of vaccine delivery by setting. The survey told parents to "imagine [child's name] needed a vaccine such as tetanus booster, meningitis vaccine, or HPV vaccine. Also imagine these vaccines are available at pharmacies and doctors' offices." Then parents answered seven questions about whether a pharmacy or doctor's office would be better at a particular vaccine delivery feature. Parents could respond by selecting "pharmacy", "doctor's office", or "they're the same". The seven features were: 1) providing privacy during vaccination, 2) being a safer place for vaccinations, 3) having more welcoming staff, 4) more likely to get vaccinated without an appointment, 5) taking less time for vaccinations, 6) more convenient hours for vaccinations, and 7) telling the cost of vaccines before delivery. Finally, parents were asked "which of these is most important when choosing between a pharmacy and a doctor's office as a place to get [child's name] vaccinated?" Parents responded by selecting the vaccine delivery feature they believed was most important.

The seven vaccine delivery features were conceptualized into two broad categories during analysis (Figure 7.1): "health care environment" and "perceived patient accessibility". We coded the vaccine delivery feature items so that indicating a doctor's office was better was "-1," a pharmacy and doctor's office were the same was "0," and a pharmacy was better was "1." We then summed the seven contrast-coded vaccine delivery feature items, and scaled it so that the relative advantage composite score ranged from "-1" to "1." Therefore, parents who scored closer to -1 believed doctors' offices had more relative advantages in adolescent vaccine delivery, while parents who scored closer to 1 believed pharmacies had more relative advantages in adolescent vaccine delivery.

Outcome variable. The outcome of interest for this study is willingness to get HPV vaccine from an immunizing pharmacist. Parents were first prompted with the statement "Imagine you and [child's name] decided to get the HPV vaccine for [him/her]." Parents were then asked "How willing would you be to have [child's name] receive it from an immunizing pharmacist?" Parents indicate the extent of their willingness as "definitely not willing" [1] to "definitely willing" [4].

Sociodemographic characteristics. The survey company provided parent and household demographic characteristics including parent sex, age, race and ethnicity, education, household income, urbancity ("non-metropolitan statistical area" or "metropolitan statistical area"), and U.S. region of residence. The survey included five items about parents' HPV vaccine confidence based on the Carolina HPV Immunization Attitudes and Beliefs Scale (CHIAS).[87] The survey also assessed what kind of pharmacy parents typically use for their child's prescription medications ("chain pharmacy," "independent pharmacy," or "pharmacy in clinic or hospital"), and how many minutes it takes parents to get to that pharmacy. Additionally, the survey included

one item assessing parents' familiarity with the pharmacists at the pharmacy they most frequent ("Not well at all" [1] to "Very Well" [3]). For demographic and health characteristics for the parent's index child (reported by the parent), the survey assessed sex, age, race and ethnicity, HPV vaccinations status ("0 doses" or "≥1 dose"), and previous use of an alternative vaccination setting (defined as the child previously vaccinated at a pharmacy, school, or health department).

Statistical analyses

All analyses and missing data procedures were conducted in Stata 13.1. All statistical tests were two-tailed with critical α=.05. We used Huber-White sandwich estimators to account for possible non-normality in the distribution of the errors in the regression models,[111] and report standardized β-coefficients for the multiple regression models.

Analyses. First, we tested the equality of proportions to identify the different percentages of parents who believed a pharmacy or a doctor's office was better at one of the seven vaccine delivery features, or if the two settings were the same (*hypotheses 1a* & *1b*). Percentages of parents' responses endorsing doctor's office and pharmacy were different if they deviated from .5 (or 50%) based on the test statistic. Next, we evaluated how parents' willingness to get HPV vaccine from pharmacists varied by the importance parents placed on the seven vaccine delivery features when deciding to get their children vaccinated at either a pharmacy or doctor's office (*hypothesis 2*). We used a *t*-test to discern if mean willingness (outcome) differed between the two categories of vaccine delivery features (predictor: "health care environment" versus "patient accessibility"). We then conducted two analyses of variance (ANOVA) to ascertain if mean willingness to get HPV vaccine from pharmacists varied within each category's vaccine delivery features.

For our third analysis, we evaluated how parents' beliefs about the relative advantages of pharmacies and doctors' offices in adolescent vaccine delivery were associated with willingness to get HPV vaccine from pharmacists (*Hypothesis 3*). We examined bivariate associations between parents' willingness to get HPV vaccine with the relative advantage composite score and several other sociodemographic characteristics. All statistically significant correlates were combined in a multiple regression model. Lastly in an exploratory analysis, we evaluated how sociodemographic characteristics of parents and adolescents correlated with parents' beliefs about the relative advantages of pharmacies and doctors' offices in adolescent vaccine delivery using the composite variable we previously described (Appendix VI and Appendix VII). Similarly, we first examined bivariate associations and then combined all statistically significant correlates in a multiple regression model.

Missing data procedure. Missing cases for each variable used for the analyses ranged from zero to two percent. We used multiple imputation by chained equations to estimate plausible values for missing data,[152] and augmented regression procedures to avoid perfect prediction for incomplete categorical variables.[153] A total of 20 imputed datasets were generated and merged. We compared regression coefficients using complete case analysis (n=1,404) with the imputed dataset (n=1,500) as a sensitivity analysis to check for biases. We found very little differences between the multiple regression models (Appendix VIII). As such, the regression results reported are from the imputed dataset.

RESULTS

Parents' evaluation of adolescent vaccine delivery features

The majority of parents believed doctors' offices were better at adolescent vaccine delivery features related to the health care environment, while at the same time, believed pharmacies were better at adolescent vaccine delivery features related to patient accessibility (Table 7.2). Specifically, the majority of parents believed doctors' offices were better at providing privacy during vaccination (77%), being a safer place for vaccination (70%), and having more welcoming staff (50%), while very few parents believed pharmacies were better at these features (providing privacy: 3%; safer place: 1%; more welcoming staff: 4%). All proportion tests showed significant differences between the proportion of parents who selected a doctor's office and the proportion who selected a pharmacy on these three items ($p < .001$).

By comparison, the majority of parents believed pharmacies were better for getting children vaccinated without an appointment (70%), having more convenient hours for vaccination (59%), taking less time for vaccination (50%), and telling the cost of vaccinations before administration (47%), while fewer parents believed doctors' offices were better at these features (no appointment: 17%; more convenient hours 19%; taking less time: 30%; telling the vaccination cost: 18%). All proportion tests showed significant differences between the proportion of parents who selected a doctor's office and the proportion who selected a pharmacy on these three items ($p < .001$).

Willingness to get HPV vaccine by importance placed on vaccine delivery features

71% of parents identified vaccine delivery features related to the health care environment as being the most important consideration when choosing between a doctor's office or pharmacy to get their child an adolescent vaccine (Table 7.2). The majority of parents (87%) indicated the

most important consideration was the safety of the setting, followed by privacy, getting vaccinations without an appointment, and convenient hours. Few parents (13%) said the most important considerations were taking less time to get their children vaccinated, explaining vaccination cost before administration, and having welcoming staff.

44% of parents were either probably or definitely willing to get HPV vaccine from an immunizing pharmacist ($\bar{x}$=2.31, SD=.93). Parents who placed the greatest importance on a vaccine delivery feature related to the health care environment had lower willingness to get HPV vaccine for their children from pharmacists (mean=2.14, SD=.89) compared to parents who placed the greatest importance on a vaccine delivery feature related to patient accessibility (mean=2.72, SD=.91; p<.001). No differences in willingness appeared among parents who selected vaccine delivery features within the health care environment category as their most important considerations (F=2.52; p=.08). Similarly, no differences in willingness appeared among parents who selected vaccine delivery features within the patient accessibility category as their most important considerations (F=.19; p=.90).

Correlates of willingness to get HPV vaccine from pharmacists

Willingness was higher among parents who believed there were more relative advantages in pharmacies (β=.29; p<.001; Table 7.3). Willingness was also higher among parents who were more familiar with their pharmacists (β=.13; p<.001), and had their children previously vaccinated in an alternative setting (β=.13; p<.001). Similarly, willingness was also higher parents who reported higher HPV vaccine confidence (β=.09; p<.001), had children who had at least one dose of HPV vaccine (β=.10; p<.001), and had children whose race was categorized as other or multiracial (β=.09; p<.001). Finally, willingness was lower among parents who usually went to independent pharmacies for their children's prescription medications (β=-.06; p=.013).

DISCUSSION

To the best of our knowledge, this is the first study to directly compare parents' beliefs about the vaccine delivery processes of pharmacies and doctors' offices. Ultimately, the goal in making pharmacy-located adolescent vaccination more appealing to parents is to improve opportunities for adolescent vaccines, particularly HPV, and to create a perception of pharmacies as a setting that can be trusted in complementing adolescent vaccination efforts. This study applied DOI Theory to distinguish pharmacies from doctors' offices on discrete vaccine delivery features. We found evidence that supported all our hypotheses, suggesting that framing the vaccine delivery process in pharmacies in terms of its relative advantages could be a fruitful way to increase parents' interest in pharmacy vaccination services.

Parents believed pharmacies excel at issues of patient accessibility in adolescent vaccine delivery, particularly at having more convenient hours and vaccinating without an appointment, consistent with *Hypothesis 1a* and *2*. These findings track with parents' sentiments about alternative vaccination settings, in general, convenience for vaccinations.[5,60]Additionally, parents endorsed these two features the most among those who considered patient accessibility the most important consideration for getting their children vaccines between a pharmacy and doctor's office. Pharmacies that offer adolescent vaccination services should focus their advertisements on these two aspects of patient accessibility to make the services more appealing to parents.

Our findings also showed that parents believed doctor's offices were better at vaccine delivery when considering issues of the health care environment, consistent with *Hypothesis 1*b and *2*. Pharmacies will need to improve perceptions of safety and privacy to increase their likely use as an adolescent vaccination setting, since parents selected them as the two most important

considerations for where to get their children vaccinated. Parents' prioritization of safety and privacy expand upon the general safety and privacy concerns with alternative settings found in previous studies.[6,58] We are unable to illuminate specific details of what parents believe constitutes a safe and private place for vaccinations, but possibly could include a clean space that is well equipped in case of adverse events, or one that accommodates anonymity during vaccination. Investigating these details is a potential avenue for future quality improvement research. Nevertheless, pharmacies that attend to desirable vaccine delivery attributes that are found in doctors' offices may increase the its appeal as a vaccination setting, and improve parents' overall image of pharmacies as a trusted place for broader health care needs.

Care delivery indicators played the most important role in parents' willingness to get HPV vaccine from pharmacist compared to HPV vaccine and sociodemographic indicators. Willingness was strongly associated with how doctors' offices and pharmacies were perceived by their relative advantages in vaccine delivery, consistent with *Hypothesis 3*. This follows DOI,[109] suggesting that pharmacies should stress the range of potential advantages parents currently perceive them to have over doctor's offices to encourage more rapid adoption of pharmacy-located HPV vaccination. What was also striking was how willingness varied based on whether parents placed the greatest importance in vaccine delivery on the health care environment or patient accessibility. Together these two associations show that not only do parents need to perceive there are more relative advantages in pharmacy-located adolescent vaccinations over doctor's offices, but parents may also be more prone to adopt pharmacy-located adolescent vaccinations if the relative advantages (or enhancements) they see are relevant to their vaccine decision making. Similar to previous studies evaluating acceptability, convenience, and comfort with alternative vaccination settings,[6,60,142] we found that parents'

familiarity with pharmacists or having children who have been vaccinated in alternative settings had higher willingness to get their children HPV vaccine from pharmacists, implying that trust with vaccine providers and the setting itself are important factors for vaccine decision making. Furthermore, consumer data show that less than half of patients speak with pharmacists about their medications,[137] making a case for pharmacists to improve their patient-provider communication as a means to increase parents' trust in them as adolescent vaccinators.

Our study had notable strengths, including a large national sample of parents and novel items comparing the vaccine delivery process between pharmacies and doctors' offices informed by DOI Theory. This study was limited by the use of a cross-sectional design, which allowed us to infer associations of parents' willingness to get HPV vaccine from pharmacists, but not the direction of these associations. Outcomes were self-reported, which can lead to response bias in certain survey questions such as their children's vaccination history, or lead to an overestimation of willingness to get HPV vaccine from pharmacists. The interpretation of our findings is also limited by the lack of adolescent and health care provider perspective of the vaccine delivery process, which would have strengthened the relevance of our findings for improving pharmacy-based vaccinations. While the study focused on several provider-level characteristics of vaccine delivery, other features of vaccine delivery maybe important to parents' willingness to get HPV vaccine from pharmacists were not tested, such as potentially prohibitive out-of-pocket costs.[34] Finally, there may be other aspects of DOI Theory that are relevant to pharmacy-based adolescent vaccinations such as "observability"[109] that we were unable to assess in our study. For example, some pharmacists who provide HPV vaccine have reported vaccinating all their eligible employees and own children as a means to publicize and normalize the service to clientele.[154]

CONCLUSION

Pharmacies present a promising complement to primary care clinics in adolescent HPV vaccination efforts due to their substantial reach within communities. An estimated 250 million visits are made to a pharmacy each week in the United States,[135] and around 93% of people live within five miles of a pharmacy.[38] In our study, we found that a large minority of parents would be willing to go to pharmacists for their children's HPV vaccinations, demonstrating at the very least an openness to participating in these programs if they were made available. However, to achieve high adoption of pharmacy-based vaccinations, pharmacies must capitalize on their perceived advantages over doctors' offices, such as vaccinating without appointments or having convenient operating hours, while also attending to vaccine delivery features parents believe to be superior at doctors' offices such as safety and privacy during vaccination.

TABLE 7.1 SAMPLE DEMOGRAPHIC CHARACTERISTICS (*N*=1,500)

	n or mean	(%) or (SD)
Parent Characteristics		
Sex		
Male	665	(44)
Female	835	(56)
Age (mean years)	43.9	(7.84)
Race/Ethnicity		
Non-Hispanic White	1,058	(70)
Non-Hispanic Black	134	(9)
Hispanic	212	(14)
Other/multiracial	98	(7)
Education		
High school degree or less	573	(38)
Some college or more	927	(62)
HPV vaccine confidence (mean score)	3.31	(.72)
Pharmacy type used for child's prescriptions		
Retail chain pharmacy	1,213	(81)
Independent pharmacy	155	(10)
Pharmacy in clinic or hospital	124	(8)
Parent's familiarity with pharmacist		
Not well at all	905	(61)
Moderately well	478	(32)
Very well	108	(7)
Child Characteristics		
Sex		
Male	761	(51)
Female	739	(49)
Age (mean years)	14.0	(2.01)
Race		
White	1,172	(79)
Black	159	(11)
Other	140	(10)
Ethnicity		
Non-Hispanic	1,232	(83)
Hispanic	258	(17)
HPV vaccination status		
0 doses	805	(54)
≥1 dose	694	(46)
Child vaccinated in alternative settings		
No	991	(66)
Yes	509	(34)

Household Characteristics		
Household income		
$0 - $35,000	328	(22)
$35,000 - $74,999	468	(31)
$75,000 or more	704	(47)
Urbanicity		
Non-metropolitan statistical area	234	(16)
Metropolitan statistical area	1,266	(84)
Region		
Northeast	261	(17)
Midwest	393	(26)
South	496	(33)
West	350	(23)
Distanced lived from pharmacy used for child's prescriptions (mean time in minutes)	11.7	(11.7)
Distanced lived from child's doctor's office (mean time in minutes)	17.7	(12.9)

Note. Frequencies for specific characteristics may not total to 1,500 participants due to missing responses.

TABLE 7.2 WILLINGNESS TO GET HPV VACCINE FROM PHARMACISTS BY IMPORTANCE PLACED ON VACCINE DELIVERY FEATURES

Vaccine delivery feature	*n*	Means (SD)
Health care environment[a]	**1,050**	**2.14 (.89)**
Provide privacy[b]	146	1.99 (.83)
Safe place[b]	856	2.17 (.90)
Welcoming staff[b]	48	2.10 (.81)
Patient accessibility[a]	**424**	**2.72 (.91)**
No appointment[c]	143	2.76 (.99)
Convenient hours[c]	136	2.69 (.90)
Tells you vaccination cost[c]	59	2.73 (.81)
Takes less time[c]	86	2.69 (.88)

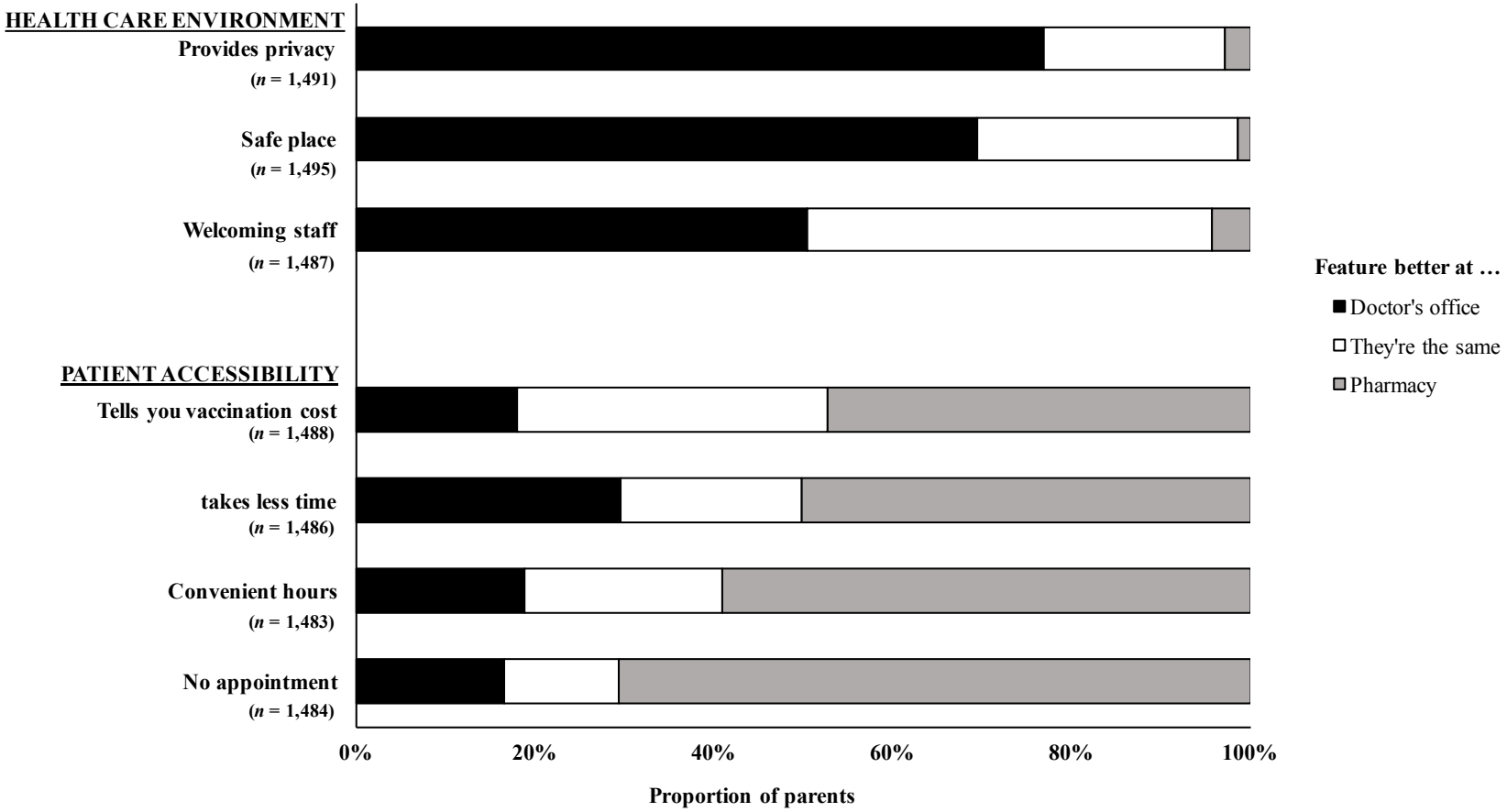
Note. Total sample is 1,474 parents. [a] *t*-test was statistically significant ($p<.001$); [b] One-way ANOVA was not statistically significant ($p = .08$); [c] One-way ANOVA was not statistically significant ($p = .90$)

TABLE 7.3 CORRELATES OF WILLINGNESS TO GET HPV VACCINE FROM PHARMACISTS (*N*=1,500)

	Bivariate β	Multivariable β
Care delivery indicators		
Relative advantage composite score	.35***	.29***
Importance placed on vaccine delivery feature related to …		
Health care environment	*ref*	-
Patient accessibility	.28***	.20***
Parent's familiarity with pharmacists	.14***	.13***
Child vaccinated in alternative settings		
No	*ref*	-
Yes	.21***	.13***
Pharmacy type used for child's prescriptions		
Retail chain pharmacy	*ref*	-
Independent pharmacy	-.05	-.06*
Pharmacy in clinic or hospital	-.05	.01
HPV vaccine indicators		
Parent's HPV vaccine confidence	.16***	.09***
Child's HPV vaccination status		
0 doses	*ref*	-
≥1 dose	.12***	.10***
Sociodemographic characteristics		
Parent's age	.06*	.01
Child's age	.09***	.04
Child's race		
White	*ref*	-
Black	-.04	-.01
Other/multiracial	.09*	.09***

Note. Table shows only associations significant in bivariate analyses except for pharmacy type. Variables that were not significant in bivariate analyses: Distance lived from pharmacy, distance lived from doctor's office, primary health care decision maker, parent sex, Parent race/ethnicity, parent education, child sex, child's ethnicity, household income, urbanicity, and region of residents. β-coefficients are standardized regression coefficients.
*p<.05; ***p<.001

FIGURE 7.1 PARENTS' EVALUATION OF ADOLESCENT VACCINE DELIVERY FEATURES



CHAPTER EIGHT. STUDY THREE: IMPACT OF PHARMACISTS ON THE GEOGRAPHIC DISTRIBUTION OF VACCINE PROVIDERS

INTRODUCTION

HPV vaccination surveillance studies have noted geographic variation in vaccine coverage. Several of these studies[1,63,115,120,134] have shown variation in vaccine coverage across states and regions. Additionally, a growing body of state-specific studies[62,116,119,155] have also identified substantial within-state variation in vaccine coverage. The geographic disparities in cancer incidence[117,124] and mortality[124] that potentially result from spatial patterns of HPV vaccination and screening suggest that spatial targeting of public health interventions may reduce geographic disparities. As an example, high cervical cancer burden in Appalachia is associated with low HPV vaccination coverage,[125] a pattern that is repeated in analyses of state-level data.[156] One way of understanding how these geographic disparities may arise is through understanding the distribution of health care workers available to a population as a way to measure health care access.

The Behavioral Model of Health Care Utilization describes factors that enable health care utilization such as vaccination.[122] Many of these enabling factors are at the individual level, such as higher income and having health insurance.[122] Other enabling factors are at the community level, such as a neighborhood having more health care facilities and providers.[122] Typically, in HPV vaccination research, most measures of health care examine access to and interactions with primary care providers such as pediatricians and family medicine physicians. This makes sense

as the vast majority of adolescent vaccinations are given in practices with these two specialties.[33] However, a 2010 study found a large portion of families with children have limited access to a primary care physician despite the substantial increase in physicians who see children in the United States.[157] The potential maldistribution of primary care physicians taken together with evidence of lower health care use among adolescents[30-32] may warrant additional modes of accessing care to improve vaccination coverage.

Between 2014 and 2015, The President's Cancer Panel and the National Vaccine Advisory Committee recommended expanding HPV vaccine provision in pharmacies to help improve access and opportunities for HPV vaccination.[3,4] While community pharmacists typically do not provide adolescent vaccines, including HPV vaccine, they have a potentially meaningful role in expanding access in states that allow pharmacists to administer HPV vaccine to adolescents. This may be particularly germane in states like California and Texas where populations are dispersed across large geographic areas. The purpose of this study is to characterize the geographic distribution of primary care physicians who typically provide HPV vaccination in one state, Texas, and evaluate whether community pharmacists can improve access to HPV vaccination services in primary health care shortage areas.

Some evidence suggests that people live closer to pharmacies than they do to their primary care providers. The National Association of Chain Drug Stores reported that 93% of U.S. residents live within five miles of a community pharmacy.[38] The AVIP study showed that parents were closer to pharmacies where they usually go for their children's prescriptions as compared to their children's doctors' offices (Table 5.1). The vast majority of pharmacies also have substantial retail operations which may allow them to be commercially successful in areas where primary care practices would struggle financially. As such, we hypothesized that primary

care physicians are more spatially clustered than pharmacists (*Hypothesis 1*). Furthermore, if pharmacists are more dispersed geographically than primary care physicians, this dispersion may be especially important for high-need areas. That is, pharmacists may be able to increase access to vaccination services in areas with poor primary care provider coverage. As such, we also hypothesized that the number of areas with adequate health care provider coverage increases if pharmacists are included with primary care physicians as adolescent vaccine providers (*Hypothesis 2*). While other important health care professionals such as nurse practitioners and physician assistants also likely provide adolescent vaccines in Texas, we were unable to obtain sufficiently accurate practice address location or practice specialty information to include these providers in our study. Therefore, our study focuses on primary care physicians and community pharmacists who have the potential to provide HPV vaccine.

METHODS

Data sources and procedures

State selection. We focused our study on one state since pharmacy practice laws governing a pharmacist's authority to vaccinate are state specific. We selected Texas based on inclusion and exclusion criteria we applied to the 48 contiguous states in the U.S., as well as the availability of necessary data to conduct our analyses. The two main inclusion criteria for states were 1) allowing pharmacists to vaccinate adolescents as young as 11 with HPV vaccine, and 2) having high participation rates among adolescents in the state immunization information system. Our exclusion criteria for state selection were 1) higher than national average HPV vaccination rates for boys and girls, and 2) small pharmacy work force. Based on these criteria, we selected Texas because it has a large population that is geographically dispersed, a large pharmacy work

force that could potentially provide HPV vaccine, and had high quality immunization data that could be used for future follow-up studies that relate neighborhood vaccination coverage with access to vaccine providers.

Primary care physicians. Physician workforce data are publicly available from the Texas Medical Board (available at: http://store.tmb.state.tx.us/). Our dataset included physicians licensed by December 2016, and contained information about each physician's sex, race and ethnicity, license status and registration dates, medical degree type, graduation year, primary and secondary specialties, practice type and setting, and full-time equivalent status. Four physicians (one pediatrician, one gynecologist, and two family medicine physicians) advised on the inclusion criteria used to identify primary care physicians from this dataset who are likely to provide adolescent vaccines. Inclusion criteria comprised of physicians who had an active practice license, a verifiable practice address in Texas that could be geocoded, and had a primary specialty in family medicine, general practice, obstetrics and gynecology, pediatrics, public health and preventive medicine, or urgent care medicine (Appendix IX). The final analytic sample had 12,307 primary care physicians. The majority of physicians were white (69%), non-Hispanic (90%), held a doctor of medicine degree (88%), and practiced 40 or more hours per week (71%; Table 8.1). About half of the sample were male (51%), family medicine doctors (48%), and practiced in a partnership or group (47%).

Community pharmacists. Pharmacist workforce data are publicly available from the Texas Board of Pharmacy (available at: http://www.pharmacy.texas.gov/dbsearch/tables.asp). Our dataset included pharmacists licensed by December 2016, and contained information about each pharmacist's sex, race and ethnicity, license status and registration dates, pharmacy degree type, graduation year, and practice setting. Pharmacists were included in the analytic sample if

they had an active practice license, had a verifiable practice address in Texas that could be geocoded, and identified a community pharmacy as their employment type (Appendix IX). The final analytic sample had 11,131 pharmacists. About half of pharmacists were male (47%), white (46%), and held a doctor of pharmacy degree (51%, Table 8.1). The majority of pharmacists practiced in a retail chain pharmacy (73%)

Texas census tracts. We collected census tract geographic boundaries and demographic characteristics for Texas from the U.S. Census Bureau: 2016 TIGER/Line® shapefiles (census.gov/geo/maps-data/data/tiger-data.html). We used the 2010 Decennial Census for Texas population counts for each census tract. Texas has 5,254 census tracts with populations ranging from zero to 33,201 people (mean=4,786, SD=2,433).

Geocoding procedures. First, we geocoded the physicians and pharmacists' location as points using their given practice addresses. Next, in order to get counts of physicians and pharmacists at each geographic areal unit, the points representing the providers were joined to the shapefile containing the census tracts' geographic boundaries and demographic characteristics. Only points that lay within the boundaries of each areal unit were counted as being contained within that unit. This process was conducted in ESRI ArcGIS 10.5 (Redlands, CA).

Statistical analyses

Spatial clustering of providers. First, we evaluated the extent of spatial clustering (spatial autocorrelation) of physicians and pharmacists in Texas with Moran's *I*,[129] using census tracts as the units of analysis. Moran's *I* is a global test statistic that provides a summary over the entire study area of the level of spatial similarity observed among neighboring observations, [130] such as the number of physicians and pharmacists in census tracts. The formula for Moran's *I* is:

$$I = \left[\frac{n}{\left(\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\right)}\right]\frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\,(y_i - \bar{y})(y_j - \bar{y})}{\sum_{i=1}^{n}(y_i - \bar{y})^2}$$

Where n is the number of census tracts, y_i and y_j are the number of physicians or pharmacists in locations i and j, w_{ij} is the neighbor spatial weight, $(y_i - \bar{y})(y_j - \bar{y})$ is the covariance term, and $\sum_{i=1}^{n}(y_i - \bar{y})^2$ scales I to the overall variance in the dataset.

We calculated spatial weights matrices using three different methods as a means to verify the robustness of our analysis. We used a contiguity neighbor method that used a first order queen criterion to identify adjacent observations to be included as "neighbors," and use row standardization so that different census tracts are comparable to one another. We also recalculated the row standardized spatial weights matrix using inverse distance bands (thresholds), so the impact of providers in one census tract on another census tract decreased with distance. We used two approaches to calculate the inverse distance. The first inverse distance approach (designated "approach one") set a threshold of 8,047 meters (5 miles) since 93% of U.S. residents live within five miles of a pharmacy.[38] If the distance from the centroid of one census tract to its nearest neighboring census tract was greater than 8,047 meters (e.g., a spatial outlier), we then specified a nearest neighbor parameter of at least one.[158] The second inverse distance approach (designated "approach two") allowed the spatial statistic software to maximize the inverse distance threshold so that all census tracts had at least one neighbor.[158] We expected that as the method of creating the spatial weight matrix became more inclusive for identifying neighbors (i.e., moving from continuity neighbors to inverse distance), the estimated value of Moran's *I* would decrease. For the two inverse distance methods, we also calculated Moran's *I* using both Euclidean and Manhattan distances, since Euclidean distances tend to

underestimate road distances and travel times, while Manhattan distances tend to overestimate both.[159]

The interpretation of the Moran's *I* test statistic is similar to the Pearson's product-moment correlation coefficient in that values range from -1 to 1. The null hypothesis is that the calculated value of Moran's *I* is not different from the expected value (i.e., no spatial autocorrelation):

$$E(I) = -\frac{1}{n-1}$$

Where *n* is the number of census tracts. Values of *I* greater than the *E*(*I*) indicate positive autocorrelation (spatial clustering), while values of *I* less than the *E*(*I*) indicate negative autocorrelation (dispersion). To adjust for the tendencies of areas with larger populations to have more providers, we used rates of providers in each census tract for the Moran's *I* statistical test by dividing the number of providers in each tract by the population in each census tract. Based on Hypothesis 1, we predicted that Moran's *I* will be higher for the rate of physicians than the rate of pharmacists. Since Moran's I is highly dependent on the unit of analysis, we conducted a sensitivity analysis by recalculating the test statistic at the county-level. We expected that Moran's *I* would decrease as the units of analysis are aggregated.

Provider rate change with pharmacist inclusion. Next, we descriptively analyzed how census tracts' provider rates changed with the inclusion of pharmacists as a way to determine whether pharmacists can help improve access to HPV vaccination in areas with primary care health professional shortages. Primary care health professional shortage areas (HPSAs) are defined as having one or fewer full-time-equivalent primary care physician per 3,500 people living in a geographic area.[160] Using the previously calculated physician and pharmacist rates, we standardized the rates per 3,500 people. We then added the two rates to get an overall

provider rate per 3,500 people. To address skewness, we winsorized (top coded) outlying provider rates to a value of 30 or more providers per 3,500 people (i.e., at or above 99th percentile). To evaluate if HPSAs moved to adequate provider coverage with the inclusion of pharmacists, we created two dichotomous variables. The first variable indicated whether a census tract had inadequate coverage (coded "0") if the physician to population ratio was less than or equal to 1:3,500, or had adequate coverage (coded "1") if the physician to population ratio was greater than 1:3,500. The second variable used the same coding scheme, but for physician and pharmacist to population ratio less than or equal to 1:3,500 (inadequate coverage coded "0") or greater than 1:3,500 (adequate coverage coded "1"). We then examined the percentage of census tracts that shifted to adequate provider coverage when pharmacists were included in the provider rate.

We performed several additional analyses. First, we conducted paired *t*-tests to compare the mean provider rates that only included physicians with rates that included both physicians and pharmacists. Second, we conducted sign tests to evaluate whether median provider rate increased when pharmacists were included along with physicians. Third, we stratified analyses by urban and rural census tracts using the 2010 Census classification, where tracts with a population greater than 2,500 were designated as urban areas (e.g., "urbanized areas" or "urban clusters").[161] We report provider rates at interquartile cutoffs to show how pharmacists change vaccine provider rates at the 25th, 50th, and 75th percentiles. Finally, we generated choropleth maps to visually depict where provider rates increased in Texas when pharmacists were included along with physicians in the rate calculations.

The Moran's *I* test statistic and choropleth map generation were conducted in ESRI ArcGIS 10.5. Data cleaning, manipulation, and statistical tests were conducted in Stata 13.1

(College Station, TX). All analyses used two-tailed statistical tests with a critical α=.05.

RESULTS

Spatial clustering of providers

In analyses at the census tract level, high physician rates tended to be located near other census tracts with high rates (i.e., spatial clustering). In analyses at the level of census tracts, physician rates exhibited spatial clustering in five of five analyses (median *I*=.04; Table 8.2). Spatial clustering was detectable using the contiguity neighbor method (*I*=.11, p<.001) and both inverse distance methods using Euclidian (approach one: *I*=.032, *p*<.001 approach two: *I*=.009, *p*<.001) and Manhattan distance calculations (approach one: *I*=.040, p<.001; approach two: *I*=.015, *p*<.001). However, pharmacist rates did not indicate any form of spatial dependence at the census tract level using any of the analytic approaches (median *I*=.00).

In analyses at the county level, despite having positive Moran's *I*s, physician rates did not show any spatial dependence using any of the analytic approaches (median *I*=.03). Pharmacist rates showed spatial clustering at the county level in two of five analyses (median *I*=.06). Spatial clustering was detectible using both inverse distance methods estimated by Manhattan distance calculations (Approach one: *I*=.095, *p*=.046; Approach two: *I*=.063, *p*=.033).

Provider rate change with pharmacist inclusion

Adequate provider coverage with only primary care physicians was present in 33% of census tracts (1,720/5,254). When pharmacists were included, 55% of census tracts (2,867/5,254) had adequate provider coverage. Thus, among census tracts with inadequate provider coverage, 32% shifted to adequate coverage (1,147/3,534). A visualization of this shift appears in choropleth maps in Figure 8.1, where black (or grey) areas represent tracts with

adequate (or inadequate) provider coverage before and after including pharmacists. Among urban census tracts, 35% shifted towards adequate coverage with the inclusion of pharmacists (1,055/3013), while 18% of census tracts designated as rural shifted towards adequate coverage with the inclusion of pharmacists (92/521).

Mean provider rates increased when comparing physician-only rates with physician and pharmacist rates in both urban and rural census tracts (urban: t=-44.3, p<.001; rural: t=-11.8, p<.001; Table 8.3). The 25th percentile provider rates remained unchanged with the inclusion of pharmacists across the urban and rural stratifications. The median (50th percentile) rates increased from zero to 1.32 providers per 3,500 people (p<.001) with the inclusion of pharmacists, and the urban census tract rate increased from zero to 1.39 providers per 3,5000 people (p<.001). However, the median rate among the rural tracts remained unchanged with the inclusion of pharmacists. Additionally, the 75th percentile provider rates all increased with the inclusion of pharmacists (Table 3). In urban areas, 2,413 census tracts had an increase in provider rate when pharmacists were included (n=4,508, p<.001), while in rural areas, 223 census tracts had had an increase in provider rate when pharmacists were included (n=746; p<.001). A visualization of this rate change appears in choropleth maps in Figure 8.2, where darker blue areas represent areas with more providers per 3,500 people.

DISCUSSION

The President's Cancer Panel and the National Vaccine Advisory Committee prioritized the inclusion of community pharmacists as vaccinators to increase opportunities for HPV vaccination for adolescents.[3,4] One way pharmacists may improve vaccination opportunities is by increasing geographic access to adolescent vaccination services. Our study findings suggest that

community pharmacists could improve health care provider coverage for vaccine delivery above and beyond what primary care physicians alone offer within communities. Pharmacists tended to be more geographically dispersed across census tracts than primary care physicians, and as a result were able to increase the availability of health care providers in areas with inadequate primary care provider coverage. However, we also recognize that travel impedance is not the only barrier to adolescent vaccination. If health care legislation extends pharmacists' role to include adolescent vaccinations, pharmacists may have to address issues of in-network provider status by insurance companies to compensate pharmacists as vaccine providers,[34,49] as well as allay any concerns medical organizations[51-55] may have to the role pharmacists may play in furnishing adolescent vaccines. Pharmacies must also create a sustainable business case for providing adolescent vaccination services, and address vaccine delivery issues within their own practice settings to make them more appealing for parents and adolescents. To the best of our knowledge, our study is the first to directly compare the geographic distribution of primary care physicians with the distribution of community pharmacists, and it provides a preliminary step to further assess how pharmacists can alleviate geographic barriers to HPV vaccination.

Primary care physicians spatially clustered at the level of census tracts while pharmacists did not, providing support for *Hypothesis 1*. Economic processes may partially explain the different spatial patterns observed between the distribution of physicians and pharmacists. First, economies of scale, whereby the cost of rendering services reduces as the amount of services increases, may incentivize physicians to group together in larger practices, geographically clustering them. A recent study of primary care found that larger practices had smaller ratio of non-physician staff (including administrative staff, RNs, and PAs) per physician, likely because physicians can share this resource.[162] Second, as primary care remuneration structures shift from

fee-for-service to value-based, primary care practices may be compelled to be more integrative with other providers in order to address health care needs of patient, and meet quality metrics set forth for compensation.[163] Third, physicians have stronger network ties to other physicians who share similar patient panel characteristics.[164,165] Since medical practices tend to provide a limited number of services by virtue of practice specialization (i.e., practices may tend not to overlap in scope), it would be reasonable to believe that they would gain financially by being able to refer patients to each other as a way to increase their patient caseload to achieve economies of scale. As such, physicians who create formal referral networks are likely to be geographically close to each other.[164]

Compared to physicians in our study, the relative geographic dispersion of pharmacists may be primarily facilitated by economies of scope, whereby the cost of rendering services at pharmacies decreases with an increase in the diversity of services provided.[166] Pharmacies are typically attached to retail outlets like grocery and department stores, achieving profitability by selling variety of products and services. This retail emphasis in turn could incentivize pharmacy businesses, and thus the location of pharmacists who practice there, to be geographically dispersed to avoid competition with each other, and located closer to where consumers work and live for easier access. Additionally, the diversification of products and services provided at a pharmacy business, particularly in retail chain operations, can allow them to remain fiscally solvent despite potential losses that can occur due to poor reimbursement from insurance providers for pharmacy services. While both economies of scale and scope provide compelling hypotheses for how spatial patterns arise for these two health care provider types, there is a real paucity of research that provide an empirical basis for these assertions, particularly for the pharmacy workforce. Additionally, economies of scale and scope are two processes that are not

mutually exclusive, and both physician and pharmacy practices may pursue both methods to achieve economic efficiency.

Pharmacists were also able to improve health care provider coverage, consistent with *Hypothesis 2*. While both urban and rural areas appeared to have an increase in provider coverage as pharmacists were included, this effect was more pronounced in urban areas, where nearly twice as many urban census tracts moved to adequate provider coverage compared to rural census tracts. Additionally, based on interquartile cutoffs, we saw larger increases in provider rates in both urban and rural areas that already had some physicians. One reason for these patterns of increased provider adequacy in certain census tracts is the consequence of an ecological Matthew effect, where areas that already have economic advantage (e.g., at least some amount of access to primary care providers) will continue to accumulate other resources at a faster rate (e.g., the availability of pharmacists in those area), widening disparities with disadvantaged areas that do not exhibit the same growth.[167] A previous study conducted by Rosenthal and colleagues found that residents in metropolitan areas in 23 states were more likely to have geographic access to physicians compared to residents in rural areas using three different measures of access: physician-to-population ratios, distance traveled, and caseload per physician.[168] This preferential location of physicians in more urban areas may also be true for pharmacists. Pharmacists, like physicians, may tend to provide care in areas with larger population growth and community wealth.[168] However, as urban markets become saturated, the retail model that increasingly drives pharmacy businesses may encourage them to spill over to markets with lower demands such as rural areas, called the "sand pile" hypothesis,[168] as Rosenthal and colleagues found when modeling geographic access to physician over time. Future studies evaluating the migration of pharmacists across geographic boundaries may improve our

understanding of economic motivators for pharmacist practice location decisions and services they provide. This in turn, could help policy makers develop incentives for pharmacists to provide certain medical services in disadvantaged areas to alleviate geographic disparities in health care access. Additionally, since pharmacists tend to improve coverage where there are already some primary care physicians, identifying other public health strategies may be required to insure access to vaccination services in areas that do not have any health care providers.

The method of analyzing spatial dependence is fundamentally important for the interpretation of our findings. We calculated Moran's *I* using three different methods for generating spatial weights. Our findings were robust to the different methods employed, but as expected, we observed that spatial dependence decreased as we used increasingly more inclusive methods for identifying neighbors to generate the spatial weight matrices. Since we are primarily interested in how hypothetical HPV vaccination access would change if community pharmacists started providing the vaccine along with primary care physicians, we would want to select a method for identifying spatial neighbors that could rationally approximate likely geographic access of these providers. As a result, the contiguity neighbor method using a first order queen approach is likely too restrictive in identifying neighbors, since people living in urban areas can easily cross several census tracts to access a health care provide who administers HPV vaccine. Conversely, an inverse distance the sets a distance threshold too large (84 km or 52 mi as in approach two in Table 2) will be too inclusive in identifying neighbors, as people living in urban areas are likely not traveling great distances to access vaccination services. Therefore, our inverse distance approach, where we set the distance threshold to five miles and applies a nearest neighbor parameter for census tracts that were spatial outliers, was the most appropriate for calculating Moran's *I*.

The unit of analysis (census tracts vs counties) substantially affected our findings, as shown by our sensitivity analysis. Analyses for counties showed no spatial dependence for either physician or pharmacist rates using Euclidean distance calculations, but spatial dependence for pharmacist rates using Manhattan distance calculations. However, as noted earlier in our methods, Manhattan distance calculations tends to overestimate drive distance and time, and could exaggerate distance traveled between counties. Euclidean distances may be more appropriate for county level analyses based on a visualization of Texas highways and roads across county lines (www.texas-map.org/road-map.htm). County level analysis of provider rates, and potentially vaccination rates, may be reasonable in rural areas where census tracts may approximate the sizes of counties, and rural residents are likely willing to travel longer distances for health care services.[169] Our findings could suggest that while pharmacists may be somewhat spatially clustered in rural areas, the lack of spatial clustering of primary care physicians may be an indicator that physicians are better positioned to provide adolescent vaccination services in rural areas. However, using counties as units of analysis may not be appropriate in urban areas, where residents are far less likely to travel long distances to access care, and health care barriers move from being one of travel impedance (e.g., distance and time) to one more dependent on socioeconomic factors like income and insurance status.[168,169] Therefore, when assessing health care service availability and accessibility, using smaller units of analysis facilitates the granularity that may be needed to evaluate different issues of health care access faced in rural and urban areas. Based on our findings from this sensitivity analysis, the challenges faced in rural areas in accessing HPV vaccination may not be adequately addressed by the availability of community pharmacists, as mentioned earlier, and thus, other public health strategies may be necessary to improve access to vaccination services in those areas.

Strengths of our study include use of a comprehensive and accurate list of primary care physicians and community pharmacists from the Texas Medical Board and Board of Pharmacy. We also used geospatial analysis to understand the patterns of these two provider types, a novel method in evaluating health care work force that takes into account the spatial dependence of our observations. Additionally, we used census tracts as units of analysis to evaluate provider location and rates, which are both geographically and economically meaningful units as opposed to zip code tabulation areas, which are not rational geographic markers and can lead to representational error in spatial analyses.[133] Notwithstanding, our study findings should be interpreted in light of several limitations. Our study assumed that all included primary care physicians and community pharmacists either provide, or have the potential to provide HPV vaccine, while in reality many of these providers may not be providing this vaccination service. Additionally, we were unable to model the geographic distribution of nurse practitioners and physician assistants who also play an significant role in adolescent vaccinations. As such, the true effect that pharmacists have in improving the adequacy of provider coverage may be smaller areas of our study. Finally, while we adjusted the number of providers in each census tract by population as a method of measuring adequate provider coverage, several other ways exist for measuring potential and realized access to providers by using distance lived to providers, public transit access, caseload per provider, and other sociodemographic indicators (e.g., cultural, language, or financial) that do not derive health care access barriers to distance alone. Examining these alternative approaches is an important area for future research.

CONCLUSION

Community pharmacists could help to meaningfully improve the adequacy of health care providers who can administer HPV vaccination due to their substantial reach and availability in communities.[34,49] Our study was descriptive in nature, and future workforce studies should account for individual and community factors that may be associated with provider locations. Additionally, future studies that correlate provider workforce availability with vaccination coverage can help elucidate how geographic patterns in HPV vaccination may occur, and also help identify areas for targeted public health interventions to address vaccination disparities. This may further the policy case to include pharmacists as adolescent vaccine providers, especially if future studies find evidence that pharmacists are well positioned to furnish care for medically underserved or vulnerable populations.

TABLE 8.1 TEXAS PRIMARY CARE PHYSICIAN (*N*=12,307) AND COMMUNITY PHARMACIST (*N*=11,131) CHARACTERISTICS

	n or avg	(% or SD)
Physician characteristics		
Sex		
Male	6,219	(51)
Female	6,085	(49)
Race		
White	8,471	(69)
Asian or Pacific Islander	2,092	(17)
Black	905	(7)
Other	839	(7)
Ethnicity		
Non-Hispanic	11,067	(90)
Hispanic	1,240	(10)
Degree		
Doctor of medicine	10,829	(88)
Doctor of osteopathic medicine	1,478	(12)
Specialty		
Family medicine	5,906	(48)
Pediatrics	3,574	(29)
Obstetrics & gynecology	2,348	(19)
General practice	373	(3)
Urgent care medicine	80	(<1)
Public health & preventive medicine	26	(<1)
Average years since graduation	23	(22)
Practice setting		
Partnership & group	5,781	(47)
Solo	2,787	(23)
Direct medical care	1,605	(13)
Hospital	1,426	(12)
Medical school	541	(4)
Military	95	(<1)
Health management organization	51	(<1)
Public health service	21	(<1)
Practice hours per week		
40 hours or more	8,782	(71)
20-39 hours	2,866	(23)
11-19 hours	338	(3)

1-10 hours	271	(2)
Not applicable	50	(<1)
Pharmacist characteristics		
Sex		
Male	5,213	(47)
Female	5,899	(53)
Race & ethnicity		
White	5,078	(46)
Asian or Pacific Islander	2,505	(22)
Black	1,900	(17)
Hispanic	1,205	(11)
Other	228	(2)
Not specified	215	(2)
Degree		
Doctor of pharmacy	5,575	(51)
Bachelor of science	5,460	(49)
Average years since graduation	20	(14)
Practice setting		
Retail chain pharmacy	8,100	(73)
Independently owned pharmacy	2,820	(25)
Government facility pharmacy	211	(2)

Note. Frequencies for specific characteristics may not total 12,307 physicians or 11,131 pharmacists due to missing data.

TABLE 8.2 GLOBAL TEST OF SPATIAL AUTOCORRELATION OF PHYSICIAN AND PHARMACIST RATES: MORAN'S *I*

	Physicians				**Pharmacists**			
	Euclidean		Manhattan		Euclidean		Manhattan	
	Moran's *I*	*p*	Moran's *I*	*p*	Moran's *I*	*p*	Moran's I	*p*
Census tract								
Contiguity neighbors[a]	**.11**	**<.001**	-	-	-.0005	.50	-	-
Inverse-distance (approach one)[b]	**.032**	**<.001**	**.040**	**<.001**	-.0002	.91	-.0002	.17
Inverse-distance (approach two)[c]	**.009**	**<.001**	**.015**	**<.001**	-.0004	.13	-.0004	.10
County								
Contiguity neighbors[a]	.045	.19	-	-	.044	.20	-	-
Inverse-distance (approach one)[b]	.034	.34	.036	.42	.050	.17	**.095**	**.046**
Inverse-distance (approach two)[c]	.016	.52	.023	.40	.057	.05	**.063**	**.033**

Note. The expected value of Moran's I for 5,254 census tracts is -.00019. The expected value of Moran's I for 254 counties is -.0039.

[a]Neighbors were assigned using first-order queen method. Contiguity neighbor method does not depend on Euclidean and Manhattan distance calculations.

[b]Distance bands set to 8,047 meters for census tracts and 73,468 meters for counties. A minimum of one identified neighbor was specified in cases where the distance measured from the centroid of a census tract (or county) to nearest neighboring census tract (or county) was >8,047 meters for census tracts and >73,468 meters for counties.

[c]Distance bands was optimized to 84.25 km (Euclidean; census tract), 97.60 km (Euclidean, counties) and 118.69 km (Manhattan; census tracts and counties) due to very large census tracts and counties in Western Texas.

TABLE 8.3 VACCINE PROVIDERS PER CENSUS TRACT (RATER PER 3,500 PEOPLE)

		Provider rate at each percentile		
	Mean (SD)[a]	25th percentile	50th percentile	75th percentile
Physicians				
Overall	1.73 (4.19)	0	0	1.59
Urban	1.64 (3.83)	0	0	1.56
Rural	2.31 (5.89)	0	0	1.72
Physicians & pharmacists				
Overall	3.38 (6.13)	0	1.32	4.08
Urban	3.23 (5.41)	0	1.39	4.05
Rural	4.38 (9.33)	0	0	4.36

Note. Based on analyses of data for 5,254 census tracts (4,508 urban and 746 rural). Census tracts are designated urban areas if they have at least 2,500 people based on the 2010 Census Urban and Rural Classifications.

[a]Means are based on provider rates where outliers were winsorized to 30 providers per 3,500 people.

FIGURE 8.1 ADEQUACY OF PROVIDER COVERAGE BY CENSUS TRACT

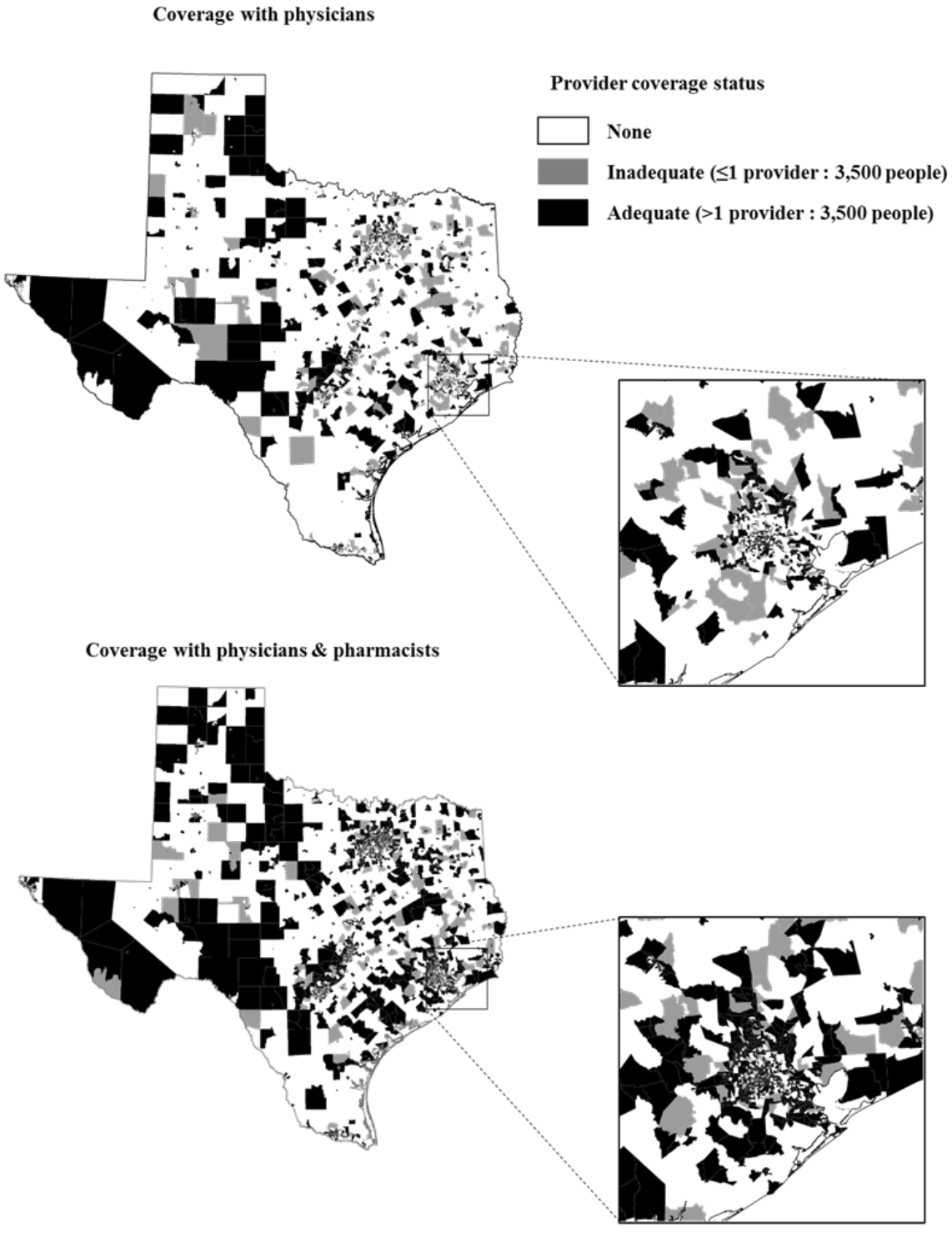
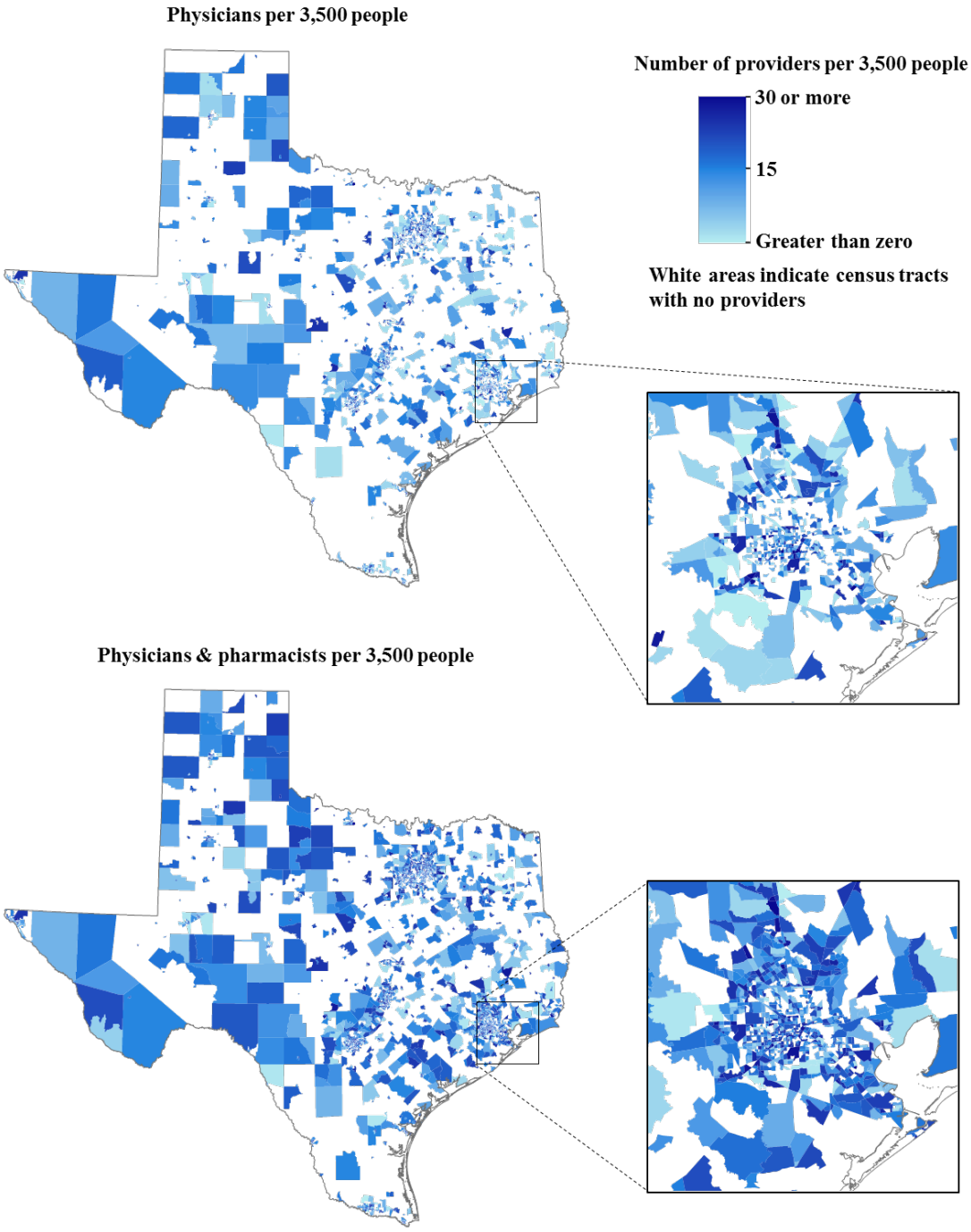


FIGURE 8.2 RATE OF PROVIDERS PER 3,500 PEOPLE BY CENSUS TRACTS



CHAPTER NINE. DISCUSSION

OVERVIEW

The structure in which the United States provides health care is changing. Addressing current and future population health needs is predicated on the ability to rapidly train (or even retrain) and deploy health professionals that can easily work within practice models that are patient-centered. With that in mind, delivery of some health care services must expand beyond traditional medical settings into new delivery channels,[170] with the objectives of providing patients quality health care with greater access, more convenience, and lower costs. This is particularly true for low-cost services like vaccination that can be realistically provided outside of doctors' offices with comparable quality of care. As a case study of this concept, my dissertation examined pharmacists' preparedness to address poor HPV vaccination rates in U.S. adolescents.

The President's Cancer Panel and National Vaccine Advisory Committee included pharmacists as potential vaccine providers within their strategic frameworks to improve HPV vaccination rates for U.S. adolescents.[3,4] Since 1994, pharmacists have played an increasingly large role in immunizations that protect the public against infectious disease.[35] Pharmacists are established immunizers for adult,[43] and have tremendous potential reach within communities; consumers make an estimated 250 million visits to pharmacies each week,[135] and about 93% of U.S. residents live within five miles of a community pharmacy.[38] Pharmacies also have longer

operating hours and are easier to access within communities compared to traditional medical settings when considering vaccination services.[44,46-48] A recent systematic review and meta-analysis of 36 studies found that pharmacists were able to increase vaccination coverage when they were involved in the immunization process compared to vaccination efforts conducted by traditional medical settings that did not include pharmacists.[171] As such, this dissertation aimed to understand the intrapersonal, provider, and structural factors related to pharmacies as vaccination settings that might motivate parents to obtain pharmacist-provided HPV vaccinations for their children.

SUMMARY OF FINDINGS

To address my first specific aim, I examined the relationship between the type of pharmacy parents use and their willingness to have pharmacists administer HPV vaccine to their children. Parents who typically used independent pharmacies had a lower willingness to get their children vaccinated from pharmacists compared with parents who typically used retail chain pharmacies. Additionally, parents' perceived service quality at the pharmacy and their feelings of overall satisfaction with services at the pharmacy mediated this relationship; higher perceptions of service quality were associated with a higher feeling of satisfaction, which in turn was associated with a higher vaccination willingness. While only a third of parents knew their pharmacists, parents' who were familiar with their pharmacists were more willing to have pharmacists administer HPV vaccine to their children. This measure may have been a proxy for parents' perceptions of trust or safety with their pharmacists.

To address my second specific aim, I evaluated how parents perceived relative advantages of vaccine delivery in pharmacies compared to doctors' offices, and how perceived

relative advantages of vaccine delivery are associated with parents' willingness to get their children HPV vaccine from pharmacists. Parents believed pharmacies excelled in adolescent vaccine delivery when considering issues of patient accessibility, such as taking less time and convenient vaccination hours. Parents also believed doctors' offices were superior in adolescent vaccine delivery when considering issues of the health care environment, such as safety and privacy. Parents who perceived more relative advantages in vaccine delivery in pharmacies were more willing to get HPV vaccine from pharmacists. Additionally, parents who placed the greatest importance on vaccine delivery features related to patient accessibility were more willing to get HPV vaccine from pharmacists compared to parents who placed the greatest importance on features related to the health care environment.

Finally, to address my third specific aim, I evaluated whether pharmacists could improve access to HPV vaccination services in areas that may be considered primary health care shortage areas. In geospatial analysis of Texas, the rate of primary care physicians spatially clustered while the rate of community pharmacists did not at the census tract level. In my analysis of provider rate changes with pharmacist inclusion, pharmacists were able to improve health care provider coverage across census tracts. Of note, while both urban and rural areas appeared to have an increase in provider coverage as pharmacists were included along with primary care physicians, this effect was more pronounced in urban areas, where nearly twice as many urban census tracts moved to adequate provider coverage compared to rural census tracts.

PUBLIC HEALTH IMPLICATIONS

The dissertation findings contribute to HPV vaccination research in two important ways. First, findings related to my first two specific aims establish an empirical basis for improving the

quality of pharmacy practice as it relates to adolescent vaccinations. These studies help deepen our knowledge for factors that may influence parents to use pharmacy-based adolescent vaccination programs for their children. For specific aim one, I found that a parents' willingness to get their children HPV vaccine from pharmacists varied by the type of pharmacy they typically go to for their children's medications. Pharmacies that wish to engage established and new patients to participate in new adolescent vaccination services can potentially do so by improving the perceptions of service quality at the point of care. Additionally, for specific aim two, I found that while parents believed pharmacies were superior to doctors' offices when it came to improving patient accessibility for adolescent vaccine delivery, parents also placed greater importance on delivery features that related to safety and privacy, two areas where parents believed doctor's offices were superior to pharmacies. As such, pharmacies must improve their image as a health care setting in order for them to be viewed as a more acceptable place for adolescent preventive care.

The second way my dissertation contributes to HPV vaccination research is by providing a starting point to investigate how pharmacists can improve opportunities for HPV vaccination by addressing potential geographic disparities that exist in primary care. Parents and their children who face greater barriers to accessing a primary care provider may benefit from additional points of cares within their communities that make it convenient for them to access preventive services. In specific aim three, I found that pharmacists were able to improve provider rates in areas where there was a potentially inadequate number of primary care providers. This in turn serves communities' health needs by allowing families the option to get their adolescent children vaccinated in settings that are potentially more convenient than primary care clinics.

Including pharmacists as adolescent vaccine providers also makes better use of an existing health workforce with experience as immunizers.

FUTURE RESEARCH

Future studies should attempt to measure parents' actual use of adolescent vaccination services for their children at pharmacies rather than behavioral willingness or intention to vaccinate. I used behavioral willingness (parents' willingness to get their children HPV vaccine from pharmacists) as the primary outcome in studies related to my first two research aims primarily because so few parents have ever engaged in pharmacy-located (or pharmacist-administered) vaccinations for their adolescent children. Unlike behavioral intention, behavioral willingness requires little precontemplation of the behavior or its consequences,[172-174] and is conducive to measure likely behavior in hypothetical situations. As such, measuring willingness was reasonable as the vast majority of my study subjects had never engaged in pharmacist-administered vaccinations, nor had they likely thought to have their children vaccinated by pharmacists. Behavioral willingness is highly correlated with behavioral intention,[172,173] and both constructs are validated proximal antecedents for a wide variety of behaviors.[175-178] While it is true that behavioral intentions overestimate actual behavior,[175,179] and likely so does behavioral willingness, the correlated of willingness and behavior may be similar. Future studies should focus on evaluating parents and adolescents' realized use of vaccination services, and the motivating factors that lead to their use, to guide quality improvement efforts in pharmacy-located vaccinations.

Another future direction for pharmacy-located HPV vaccination research is to evaluate how the pharmacy workforce can address vaccination disparities within communities. My third

study was limited by only looking at how provider rates changed when community pharmacists were included. However, the study does provide a compelling justification to further assess if the addition of community pharmacists can actually increase uptake of vaccines in adolescents. To the best of my knowledge, few studies have looked at the geographic distribution of pharmacists, or relate how the distribution of the pharmacy workforce can address particular health care needs like poor vaccination rates. [180-183] As shown in study three, analyses using global information systems can explicitly and accurately model workforce distributions, and could be a fruitful way of developing spatial econometric models that relate sociodemographic characteristics with the availability and accessibility of health care workforce like pharmacists, as well as health outcomes like vaccination rates. This in turn, can help public health practitioners develop and deploy targeted strategies that improve vaccination rates in particularly vulnerable communities.

APPENDIX I. HEDVALL & PALTSCHIK'S DEFINITIONS OF THE 10 SERVICE QUALITY COMPONENTS AND THEIR CORRESPONDING DIMENSIONS

Service quality constructs	Definitions	Dimensions
Credibility	Trustworthiness and honesty of the pharmacist. It involves having the customer's best interest at heart	Commitment
Reliability	Dispensing the medicine accurately, correctly priced and in the time promised to the customer	
Security	The freedom from risk or doubt that confidential information about the customer's medicines and health status will go beyond the pharmacy.	Confidentiality
Understanding/knowing the customer	Making the effort to understand his/her needs, finding out his/her specific requirements and giving individual attention.	
Accessibility	Approachability and ease of contact. Ideally, the pharmacy is easy to reach, the opening hours are convenient, the products well displayed, the items in the self-service sector easy to find and the pharmacy is easily contactable by phone.	Milieu
Tangibles	physical attributes of the pharmacy, such as the size of the premises, equipment furnishings and whether there is a comfortable place to wait while prescriptions are being made up.	
Communication	The customer is informed about prescription and non-prescription medicines, other products, dosages, side-effects, contraindications, questions concerning health and related matters, prices of services and products in a language the consumers understand. Such information is given orally and/or in writing.	Professionalism
Competence	The pharmacist's possession of the skills and knowledge necessary to perform his or her duties in the pharmacy.	
Courtesy	Politeness, respect, consideration and friendliness	
Responsiveness	The willingness and readiness to perform the service required by the customer. It also includes having an available stock of all the medicines required.	

Note. Adapted from Hedvall, MB & Paltschik, M. 1991.

APPENDIX II. AIM ONE AND TWO MEASURES

Aim 1 variables			
Variable type	**Construct**	**Item**	**Response scale**
Predictor	Pharmacy type	Think about the pharmacy you would usually go to if you needed to get [CHILD'S NAME] prescription medications. This pharmacy is …	1 = A chain pharmacy (like CVS or Walgreens) 2 = A pharmacy in a grocery store (like Kroger or Safeway) 3 = A pharmacy in a big box store (like Target or Walmart) 4 = A pharmacy in a clinic or hospital where [CHILD'S NAME] receives medical care 5 = An independent pharmacy
	Prompt	**The next questions are about the pharmacists and the pharmacy where you would usually get [CHILD'S NAME] prescription medications.** **Say how much you agree or disagree with the next statements.**	
Mediator 1 (v_1)	Professionalism	When I have problems, the pharmacist is sympathetic and reassuring.	1 = Strongly disagree 2 = Somewhat disagree 3 = Neither disagree or agree 4 = Somewhat agree 5 = Strongly agree
Mediator 1 (v_2)	Professionalism	The pharmacist responds to my requests promptly.	1 = Strongly disagree 2 = Somewhat disagree 3 = Neither disagree or agree 4 = Somewhat agree 5 = Strongly agree

Mediator 1 (v_3)	Professionalism	The pharmacist gives me personal attention.	1 = Strongly disagree 2 = Somewhat disagree 3 = Neither disagree or agree 4 = Somewhat agree 5 = Strongly agree
Mediator 2 (v_4)	Confidentiality	I can trust the pharmacist.	1 = Strongly disagree 2 = Somewhat disagree 3 = Neither disagree or agree 4 = Somewhat agree 5 = Strongly agree
Mediator 2 (v_5)	Confidentiality	I feel safe in my interactions with the pharmacist.	1 = Strongly disagree 2 = Somewhat disagree 3 = Neither disagree or agree 4 = Somewhat agree 5 = Strongly agree
Mediator 3 (v_6)	Milieu	The pharmacist is well dressed and appear neat.	1 = Strongly disagree 2 = Somewhat disagree 3 = Neither disagree or agree 4 = Somewhat agree 5 = Strongly agree
Mediator 3 (v_7)	Milieu	This pharmacy has operating hours convenient to me.	1 = Strongly disagree 2 = Somewhat disagree 3 = Neither disagree or agree 4 = Somewhat agree 5 = Strongly agree
Mediator 3 (v_8)	Milieu	This pharmacy is visually appealing.	1 = Strongly disagree 2 = Somewhat disagree 3 = Neither disagree or agree 4 = Somewhat agree 5 = Strongly agree

Mediator 3 (v_9)	Milieu	This pharmacy's appearance is what I would expect from a place that provides quality health care.	1 = Strongly disagree 2 = Somewhat disagree 3 = Neither disagree or agree 4 = Somewhat agree 5 = Strongly agree
Mediator 4	Satisfaction	Overall, how satisfied are you with the health services you have received at the pharmacy where you usually get [CHILD'S NAME] prescription medications?	1 = Completely dissatisfied 2 = Mostly dissatisfied 3 = Somewhat dissatisfied 4 = Neither satisfied or dissatisfied 5 = Somewhat satisfied 6 = Mostly satisfied 7 = Completely satisfied
Aim 2 variables			
Variable type	**Construct**	**Item**	**Response scale**
		Imagine [CHILD'S NAME] needed a vaccine such as tetanus booster, meningitis vaccine, or HPV vaccine. Also imagine these vaccines are available at pharmacies and doctor's offices. Would a pharmacy or a doctor's office …	
Predictor (IV_1)	Safe place	… Be a safer place to get [CHILD'S NAME] vaccinated?	1=Pharmacy 2=Doctor's office 3=They're the same
Predictor (IV_2)	Less time	… Take less time to get [CHILD'S NAME] vaccinated?	1=Pharmacy 2=Doctor's office 3=They're the same
Predictor (IV_3)	No appointment	… Be more likely to vaccinate [CHILD'S NAME] without an appointment?	1=Pharmacy 2=Doctor's office 3=They're the same

Predictor (IV_4)	Convenient hours	… Have more convenient hours to get [CHILD'S NAME] vaccinated?	1=Pharmacy 2=Doctor's office 3=They're the same
Predictor (IV_5)	Know cost	… Be more likely to tell you the cost of the vaccine before giving it to [CHILD'S NAME]?	1=Pharmacy 2=Doctor's office 3=They're the same
Predictor (IV_6)	Privacy	… Be more likely to provide privacy while [CHILD'S NAME] is vaccinated?	1=Pharmacy 2=Doctor's office 3=They're the same
Predictor (IV_7)	Welcoming	… Be more likely to have staff who are welcoming?	1=Pharmacy 2=Doctor's office 3=They're the same
Predictor (IV_8)	Importance	Which of these is most important when choosing between a pharmacy and a doctor's office as a place to get [CHILD'S NAME] vaccinated?	1 = Be a safe place to get vaccinated 2= Take less time to get vaccinated 3 = Not require an appointment 4 = Have more convenient hours of operation 5 = Tell you the cost of the vaccine before giving it 6 = Provide privacy while getting vaccinated 7 = Have staff who are welcoming

Aim 1 and 2 outcome variable			
Variable type	**Construct**	**Item**	**Response scale**
Dependent variable (DV)	Vaccination willingness	Imagine you and [CHILD'S NAME] decided to get the HPV vaccine for [HIM/HER]. How willing would you be to have [CHILD'S NAME] receive it from an immunizing pharmacist?	1 = Definitely not willing 2 = Probably not willing 3 = Probably willing 4 = Definitely willing
Aim 1 and 2 covariates			
Variable type	**Construct**	**Item**	**Response scale**
Possible covariate (CV8)	Vaccine confidence	Say how much you agree or disagree with the next statements. Vaccines are necessary to protect the health of children [CHILD'S NAME]'s age.	1 = Strongly disagree 2 = Somewhat disagree 3 = Neither disagree or agree 4 = Somewhat agree 5 = Strongly agree
Possible covariate (CV9)	Vaccine confidence	Vaccines do a good job in preventing the diseases they are intended to prevent.	1 = Strongly disagree 2 = Somewhat disagree 3 = Neither disagree or agree 4 = Somewhat agree 5 = Strongly agree
Possible covariate (CV10)	Vaccine confidence	Vaccines are safe.	1 = Strongly disagree 2 = Somewhat disagree 3 = Neither disagree or agree 4 = Somewhat agree 5 = Strongly agree
Possible covariate (CV11)	Vaccine confidence	If I do not vaccinate [CHILD'S NAME], [HE/SHE] may get a disease such as meningitis and cause other teenagers or adults also to get the disease.	1 = Strongly disagree 2 = Somewhat disagree 3 = Neither disagree or agree 4 = Somewhat agree 5 = Strongly agree

Possible covariate (CV12)	Perceived parental vaccine importance	I feel that the tetanus booster for [CHILD'S NAME] is …	1 = Not important 2 = Slightly important 3 = Moderately important 4 = Very important 5 = Extremely important
Possible covariate (CV13)	Perceived parental vaccine importance	I feel that the meningitis vaccine for [CHILD'S NAME] is …	1 = Not important 2 = Slightly important 3 = Moderately important 4 = Very important 5 = Extremely important
Possible covariate (CV14)	Perceived parental vaccine importance	I feel that the HPV vaccine for [CHILD'S NAME] is …	1 = Not important 2 = Slightly important 3 = Moderately important 4 = Very important 5 = Extremely important
Possible covariate (CV15)	Alternative settings	Many children get vaccines at places other than their doctor's office. Has [CHILD'S NAME] ever received a vaccine at a … (Check all that apply.)	1 = Pharmacy 2 = School 3 = Health department 4 = None of these
Possible covariate (CV16)	Vaccines received	Which vaccines has [CHILD'S NAME] received at a pharmacy? (Check all that apply.)	1 = Tetanus booster 2 = Meningitis vaccine 3 = HPV vaccine 4 = Flu vaccine 5 = Another vaccine
Possible covariate (CV17)	Ethnicity	Is [CHILD'S NAME] Hispanic or [ETHNICITY]? [IF A32 = 1 "MALE", THEN "ETHNICITY" = "Latino"] [IF A32 = 2 "FEMALE", THEN "ETHNICITY" = "Latina"]	0 = No 1 = Yes

Possible covariate (CV18)	Race	What is [CHILD'S NAME]'s race or ethnicity? (Check all that apply.)	1 = White 2 = Black or African American 3 = Asian 4 = Native Hawaiian or Pacific Islander 5 = American Indian or Alaska Native 6 = Other, please specify: [open ended]
Possible covariate (CV19)	Perceived health	In general, would you say [CHILD'S NAME]'s health is:	1 = Excellent 2 = Very good 3 = Good 4 = Fair 5 = Poor
Possible covariate (CV20)	Decision-making	In your household, who is the main person who makes decisions about [CHILD'S NAME]'s health care?	1 = You 2 = Your spouse or partner 3 = [CHILD'S NAME] 4 = Someone else

APPENDIX III. LATENT AND OBSERVED VARIABLES USED IN THE MEASUREMENT AND STRUCTURAL MODELS

Measures	Indicator wording	Factor loading
Latent variables		
Professionalism	I_1: When I have problems, the pharmacist is sympathetic and reassuring.	.86
Coefficient-ω = .88	I_2: The pharmacist responds to my requests promptly.	.89
	I_3: The pharmacist gives me personal attention.	.85
Confidentiality	I_4: I can trust the pharmacist.	.93
Coefficient-ω = .82	I_5: I feel safe in my interactions with the pharmacist.	.95
Milieu	I_6: The pharmacist is well dressed and appear neat.	.78
Coefficient-ω = .75	I_7: This pharmacy has operating hours convenient to me.	.75
	I_8: This pharmacy is visually appealing.[a]	.81
	I_9: This pharmacy's appearance is what I would expect from a place that provides quality health care.[a]	.82
HPV vaccine confidence	The HPV vaccine might cause lasting health problems.	.74
Coefficient-ω = .70	The HPV vaccine is being pushed to make money for drug companies.	.87
	I don't have enough information about the HPV vaccine to decide whether to give it to [CHILD'S NAME].	.44
	The HPV vaccine is effective in preventing cervical cancer.	.41
	It would be hard to find a provider or clinic where I can afford HPV vaccine for [CHILD'S NAME].	.27
Observed variables		
Pharmacy type[b]	Think about the pharmacy you would usually go to if you needed to get [CHILD'S NAME] prescription medications. This pharmacy is … — A chain pharmacy (like CVS or Walgreens) , A pharmacy in a grocery store (like Kroger or Safeway), A pharmacy in a big box store (like Target or Walmart), A pharmacy in a clinic or hospital where [CHILD'S NAME] receives medical care, An independent pharmacy	N/A

Overall satisfaction	Overall, how satisfied are you with the health services you have received at the pharmacy where you usually get [CHILD'S NAME] prescription medications? —Completely dissatisfied, Mostly dissatisfied, Somewhat dissatisfied, Neither satisfied or dissatisfied, Somewhat satisfied, Mostly satisfied, Completely satisfied	N/A
Willingness to get HPV vaccine from a pharmacist	Imagine you and [CHILD'S NAME] decided to get the HPV vaccine for [HIM/HER]. How willing would you be to have [CHILD'S NAME] receive it from an immunizing pharmacist? — Definitely not willing, Probably not willing, Probably willing, Definitely willing	N/A
Index child's age	How old is [CHILD'S NAME]? — 11 years old, 12 years old, 13 years old, 14 years old, 15 years old, 16 years old, 17 years old	N/A
Index child's race/ethnicity[c]	What is [CHILD'S NAME]'s race or ethnicity? — White, Black or African American, Asian, Native Hawaiian or Pacific Islander, American Indian or Alaska Native, Other, please specify: [open ended]	N/A
Index child vaccinated in an alternative setting[d]	Many children get vaccines at places other than their doctor's office. Has [CHILD'S NAME] ever received a vaccine at a … — Pharmacy, School, Health department, None of these	N/A
Familiarity with pharmacists	How well do you know the pharmacists who work at this pharmacy? — Not well at all, Moderately well, Very well	N/A

Note. Loading factors are standardized. N/A = Not applicable. Response scales are 1-5, Strongly disagree to strongly agree unless otherwise noted in the table.

[a] Indicators' errors were correlated.

[b] Pharmacy type variable in SEM was categorized to 0 = Retail chain pharmacy (chain pharmacy, grocery store pharmacy, big box pharmacy), 1 = Pharmacy in a clinic or hospital, 2 = Independent pharmacy.

[c] Child's race/ethnicity indicator in SEM was categorized to 0 = White, 1= Black or African American, 2 = Other.

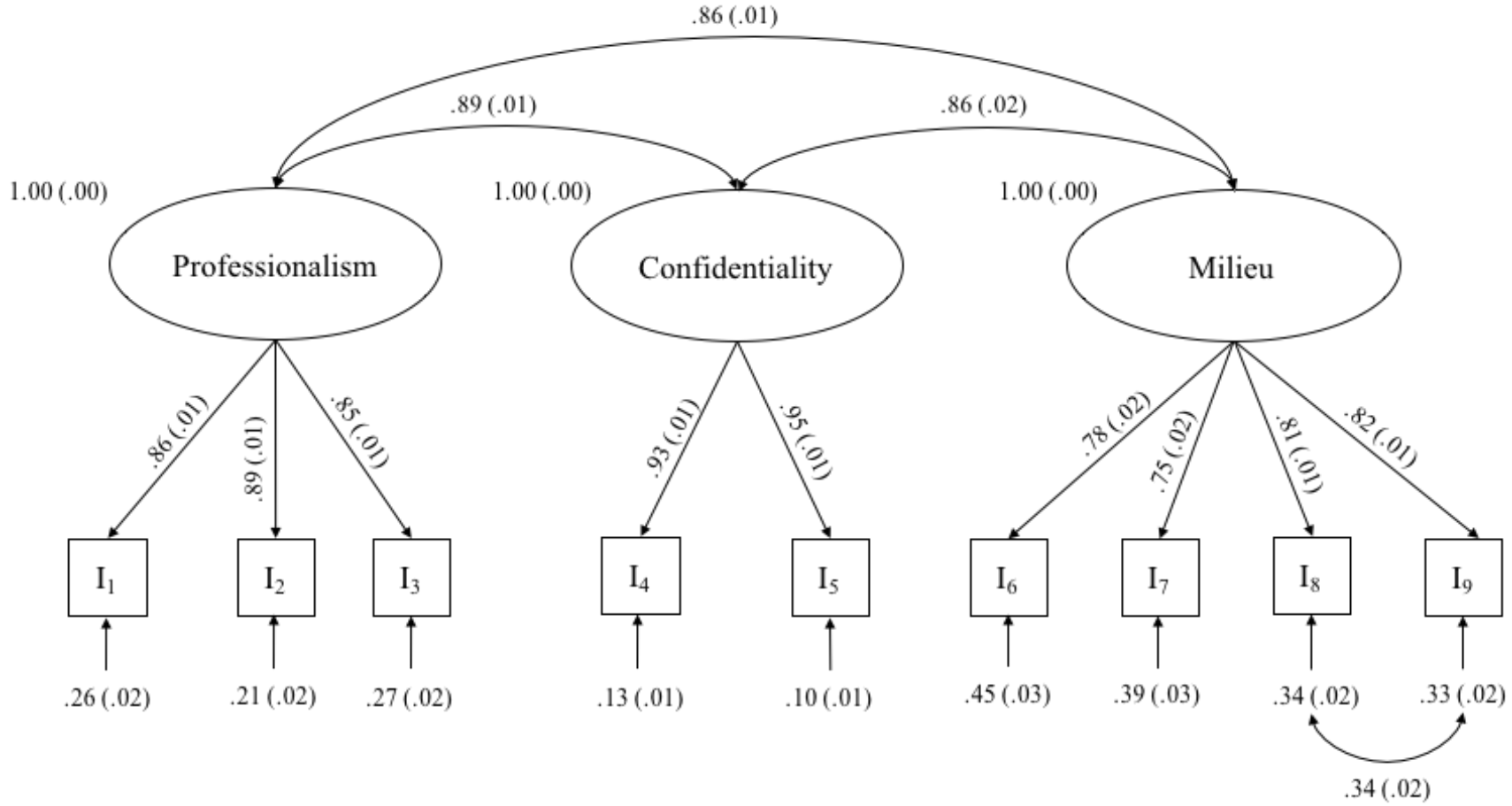
[d] Alternative setting indicator in SEM was categorized as 0 = Never vaccinated in alternative setting, 1 = Vaccinated in alternative setting.

APPENDIX IV. GLOBAL FIT MEASURES FOR MEASUREMENT MODELS AND STRUCTURAL EQUATION MODELS

	χ^2	*p*	*df*	RMSEA	CFI	TLI	BIC*
Measurement model[a]							
Single-factor model	567	<.001	27	.115	.90	.87	369
Three-factor model	99	<.001	24	.046	.99	.98	-76
Three-factor model with correlated errors	55	<.001	23	.031	.99	.99	-113
Structural Equation Model[b]							
Hypothesized model	616	<.001	175	.041	.968	.955	-664
Complete mediation	631	<.001	177	.041	.968	.955	-664
Direct effects only	594	<.001	170	.041	.970	.957	-650

Note. [a]χ^2 reported for measurement models are scaled for maximum likelihood robust (MLR) estimations.
[b]Fit statistics for structural equation models are based on maximum likelihood with bootstrapped resampling estimations.
*Schwarz's BIC.

APPENDIX V. MEASUREMENT MODEL OF PERCEIVED SERVICE QUALITY AT A PHARMACY



Note. Indicator notation corresponds to those found in Table 2. Goodness of fit tests: χ^2= 55; RMSEA = .031; CFI = .99; TLI = .99.

APPENDIX VI. STUDY TWO EXPLORATORY ANALYSIS

RESULTS

The mean relative advantage composite score was -.06 (SD=.44). 42% of parents believed there were more relative advantages in vaccine delivery in pharmacies compared to doctors' offices (composite score > 0). Parents who believed there were more relative advantages in pharmacies placed the greatest importance on vaccine delivery features related to patient accessibility (β=.20; p<.001). Parents who also believed there were more relative advantages in pharmacies had their children previously vaccinated in an alternative setting (β=.10; p<.001), reported higher HPV vaccine confidence (β=.08; p=.003), and had household incomes of $35,000 to $74,999 ($\beta$=.09; p=.01) or $75,000 or more ($\beta$=.09; p=.026). Parents who believed there were more relative advantages in doctors' offices lived farther away from the pharmacy they use for their children's prescription medications (β=-.08; p=.001), usually go to pharmacies in clinics or hospitals for their children's prescription medications (β=-.15; p<.001), had children who had at least one dose of HPV vaccine (β=-.10; p<.001), and identified as either non-Hispanic Black (β=-.12; p<.001) or Hispanic (β=-.14; p<.001).

DISCUSSION

We found parents' importance placed on patient accessibility to be positively related to parents' beliefs about the relative advantages between pharmacies and doctors' offices, again suggesting that beliefs about relative advantages between pharmacies and doctor's offices, and the saliency of these relative advantages to parents' vaccine decision making should be jointly considered when evaluating vaccine quality improvement efforts in pharmacies. Our analysis also revealed a negative association between distanced lived to the pharmacy and relative advantage beliefs, which implies that living farther away from the pharmacy would make it less accessible or convenient to use for vaccination, the attributes that pharmacies excel at over

doctors' offices. It also makes sense that parents who typically use pharmacies in clinics or hospitals would believe there were more relative advantages at doctors' offices considering both settings are located near each other. Interestingly, parents who identified as non-Hispanic Black or Hispanic saw more relative advantages in doctors' offices compared to parents who identified as White. These racial and ethnic differences may be similarly related to documented medical mistrust with physicians,[150] although our study was not designed to address this issue with perceptions about pharmacies or pharmacists, directly. Future studies that characterize the beliefs, attitudes, and adolescent vaccination behaviors in pharmacies among racial and ethnic minorities could help identify ways pharmacies can provide more culturally appropriate care.

APPENDIX VII. CORRELATES OF RELATIVE ADVANTAGES IN VACCINE DELIVERY

	Bivariate β	Multivariable β
Care delivery indicators		
Importance placed on vaccine delivery feature related to …		
Health care environment	*ref*	-
Patient accessibility	.28***	.20***
Child vaccinated in alternative settings		
No	*ref*	-
Yes	.10***	.10***
Distanced lived from pharmacy used for child's prescriptions	-.13***	-.08**
Pharmacy type used for child's prescriptions		
Retail chain pharmacy	*ref*	-
Independent pharmacy	-.04	-.05
Pharmacy in clinic or hospital	-.17***	-.15***
HPV vaccine indicators		
Parent's HPV vaccine confidence	.07*	.08*
HPV vaccination status		
0 doses	*ref*	-
≥1 dose	-.10***	-.10***
Sociodemographic characteristics		
Parent sex		
Male	*ref*	-
Female	-.07*	-.04
Parent age	.08*	.03
Parent education		
High school degree or less	*ref*	-
Some college or more	.11***	.04
Parent race & ethnicity		
Non-Hispanic white	*ref*	-
Non-Hispanic black	-.15***	-.12***
Non-Hispanic other/multiracial	-.05	-.03
Hispanic	-.17***	-.14***
Household income		
Less than $35,000	*ref*	-
$35,000 - $74,999	.13***	.09*
$75,000 or more	.21***	.09*

Note. Table shows only associations significant in bivariate analyses. Variables not significant in bivariate analyses: Familiarity with pharmacists, distance lived from doctor's office, Primary

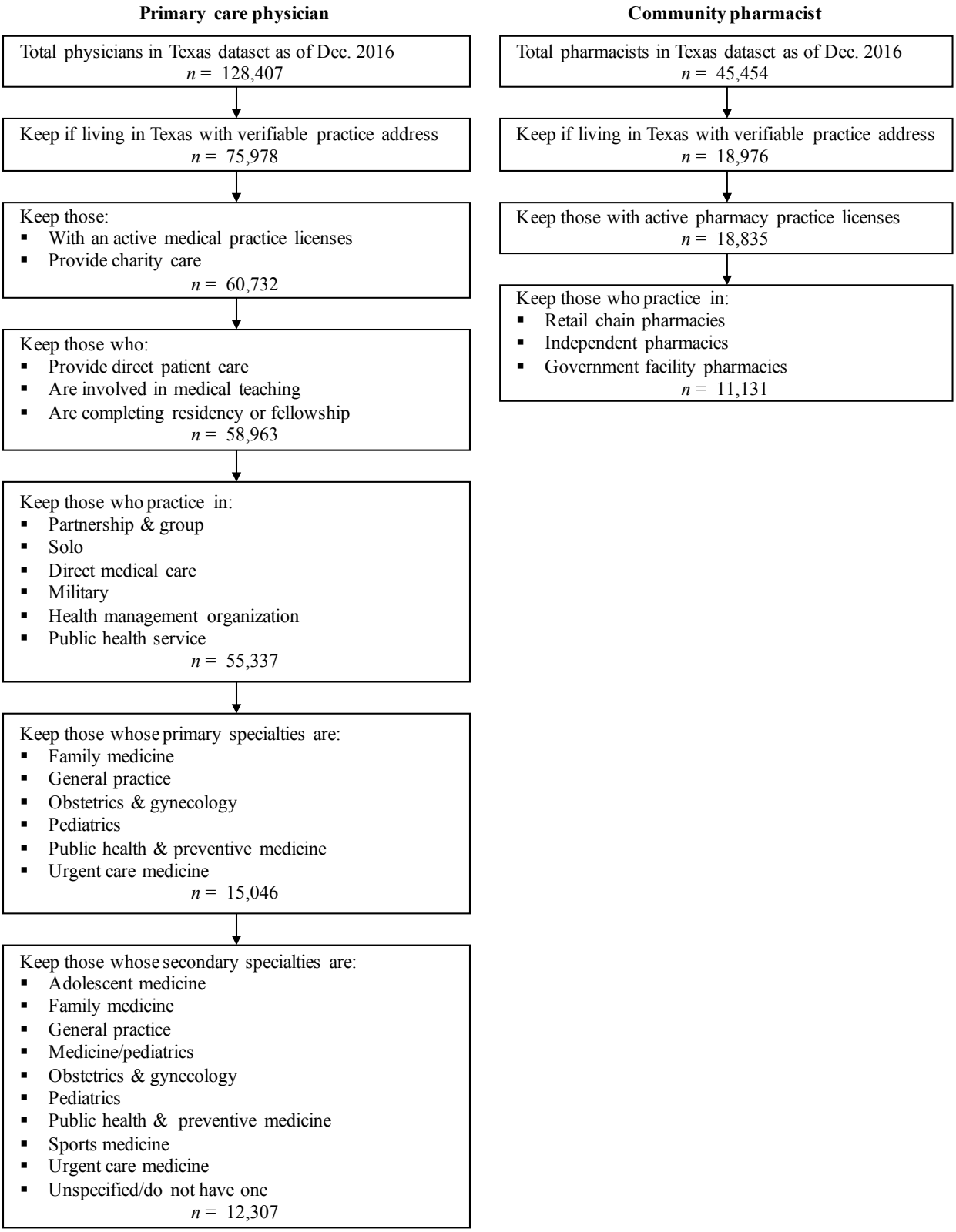
health care decision maker, child sex, child age, child race/ethnicity, urbanicity, region of residence. β-coefficients are standardized regression coefficients. * $p<.05$; ***$p<.001$

APPENDIX VIII. COMPLETE CASE VERSUS IMPUTED DATASET ANALYSIS: CORRELATES OF WILLINGNESS TO GET HPV VACCINE FROM IMMUNIZING PHARMACISTS

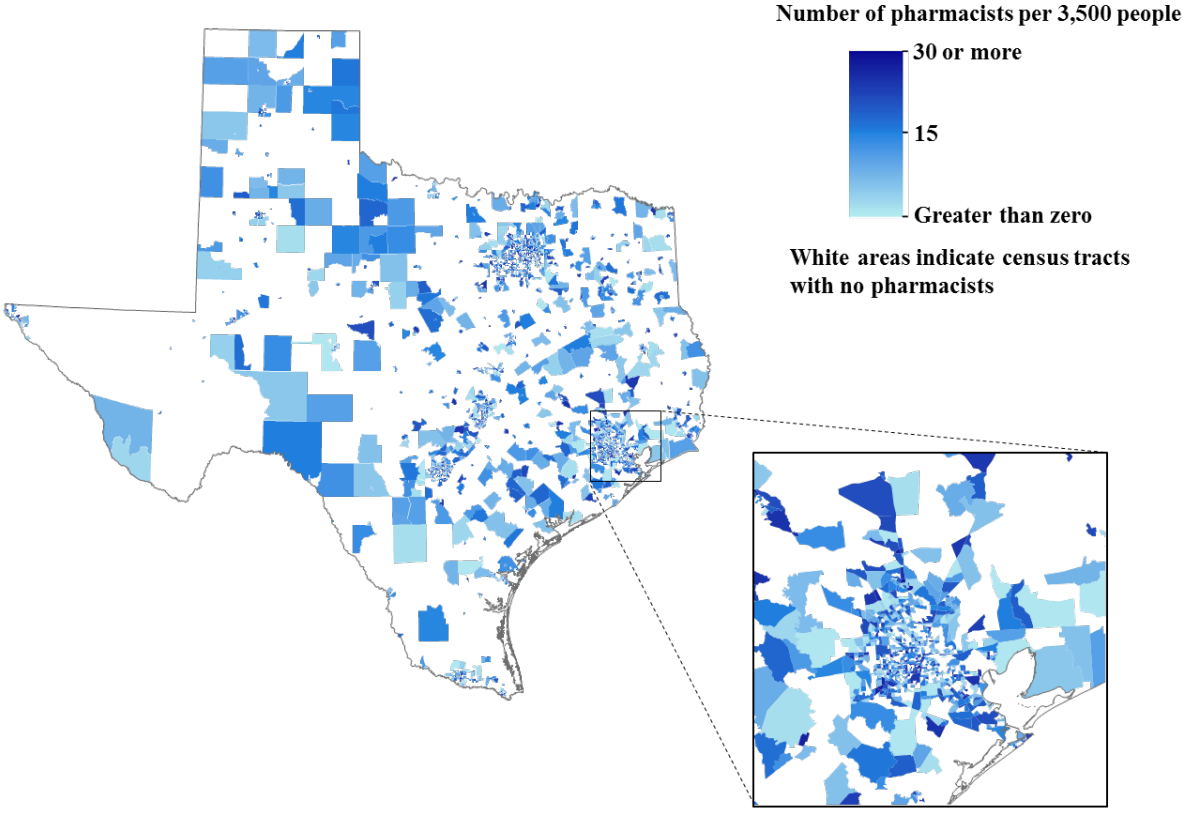
	Complete case multivariable analysis β (n = 1,404)	Multiple imputation multivariable analysis β (n = 1,500)
Care delivery indicators		
Relative advantage composite score	.29***	.29***
Importance placed on vaccine delivery feature related to …		
Health care environment	*ref*	*ref*
Patient accessibility	.21***	.20***
Parent's familiarity with pharmacist	.12***	.13***
Child vaccinated in alternative settings		
No	*ref*	*ref*
Yes	.13***	.13***
Pharmacy type used for child's prescriptions		
Retail chain pharmacy	*ref*	*ref*
Independent pharmacy	-.05	-.06*
Pharmacy in clinic or hospital	.02	.01
HPV vaccine indicators		
Parent's HPV vaccine confidence	.10***	.09***
Child's HPV vaccination status		
0 doses	*ref*	*ref*
≥1 dose	.09***	.10***
Sociodemographic characteristics		
Parent's age	.01	.01
Child's age	.04	.04
Child's race		
White	*Ref*	*ref*
Black	-.02	-.01
Other	.09***	.09***

Note. β-coefficients are standardized regression coefficients.
* p<.05; ***p<.001

APPENDIX IX. FLOW DIAGRAM OF INCLUSION CRITERIA



APPENDIX X. RATE OF PHARMACISTS PER 3,500 PEOPLE BY CENSUS TRACTS



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