Life Course Indicator: Human Papillomavirus (HPV) Immunization

The Life Course Metrics Project

As MCH programs begin to develop new programming guided by a life course framework, measures are needed to determine the success of their approaches. In response to the need for standardized metrics for the life course approach, AMCHP launched a project designed to identify and promote a set of indicators that can be used to measure progress using the life course approach to improve maternal and child health. This project was funded with support from the W.K. Kellogg Foundation.

Using an RFA process, AMCHP selected seven state teams, Florida, Iowa, Louisiana, Massachusetts, Michigan, Nebraska and North Carolina, to propose, screen, select and develop potential life course indicators across four domains: Capacity, Outcomes, Services, and Risk. The first round of indicators, proposed both by the teams and members of the public included 413 indicators for consideration. The teams distilled the 413 proposed indicators down to 104 indicators that were written up according to three data and five life course criteria for final selection.

In June of 2013, state teams selected 59 indicators for the final set. The indicators were put out for public comment in July 2013, and the final set was released in the Fall of 2013.

Basic Indicator Information

Name of indicator: Human Papillomavirus (HPV) Immunization (LC-36 A/B)

Brief description: The proportion of adolescents ages 13-17 and the proportion of young adults ages 18-26 who receive the evidence-based clinical preventive service HPV vaccine

Indicator category: Health care access and quality

Indicator domain: Service/Capacity

Numerator:

a. 13-17 year olds (males and females) who received the complete series of HPV vaccine
b. 18-26 year olds (males and females) who received the complete series of HPV vaccine

Denominator:

a. Total 13-17 year old children
b. Total 18-26 year old adults

Potential modifiers: age, sex, race/ethnicity, poverty status, urbanicity, health insurance status

Data source:

a. National Immunization Survey-Teen (NIS-Teen)
b. National Health Interview Survey (NHIS)

Notes on calculation: The numerator from the NIS-Teen is the number of 13-17 year olds (males and females) who received the complete series of HPV vaccine, three doses of vaccine. The numerator from the NHIS is the number of 18-26 year olds (males and females) who received the complete series of HPV vaccine, three doses of vaccine. Analysts who use the raw datasets should apply the appropriate survey weights to generate the final estimates.

Similar measures in other indicator sets:

a. HP 2020 Focus area IID-11.4; NQF measure 1959
b. None

Life Course Criteria

Introduction

Most cases of invasive cervical cancer are caused by persistent human papillomavirus (HPV) infection, a common virus transmitted from one individual to another during sexual activity. These cases are highly preventable if the patient has access to regular screening tests and follow-up and vaccination to protect against HPV. The Advisory Committee for Immunization Practices (ACIP) recommends that all girls and boys who are 11 or 12 years old get three doses of HPV vaccine (Gardasil or Cervarix, the two FDA-approved HPV vaccines), and HPV vaccines are recommended for all teen girls and women through age 26 and all teen boys and men through age 21 who did not get the vaccine when they were younger (catch-up vaccines)(CDC, 2013). Today, it is estimated that 79 million persons in the United States are infected with HPV, and approximately 14 million will become newly infected each year (Satterwhite et al., 2013). In addition to the morbidity and mortality associated with persistent HPV infection causing cervical cancer, HPV infection is associated with significant detriments in health-related quality of life, and the economic burden of this sexually transmitted virus is second only to human immunodeficiency virus. The median age of cervical cancer diagnosis is 48 years of age. Adherence to the ACIP guidelines for early HPV vaccination for adolescent girls and boys is a simple, cost-effective preventive measure to reduce the lifetime risk of cervical cancer morbidity and mortality. Increasing vaccination coverage rates will require a multi-level approach of physician education and parent engagement, and interventions from the policy level (e.g. school vaccine requirements) through to innovative partnerships with community organizations, including schools.

Implications for equity

While significant improvements have been made in the United States with regard to the decreasing incidence and mortality rates of cervical cancer (CDC, 2012), large disparities still exist between different groups of women, not only in incidence and mortality but also in screening and prevention (del Carmen, & Avila-Wallace, 2013). HPV-associated cervical cancer incidence rates are higher among black women (9.9 per 100,000) as compared to white women (7.4 per 100,000); and women of Hispanic ethnicity have cervical cancer incidence rates of approximately 11.3 per 100,000, compared to 7.4 per 100,000 for non-Hispanic women (Watson, Saraiya, Benard, et al, 2008; Jemal, Thun, Ries et al, 2008).

Despite recommendations for routine HPV vaccinations among adolescents, only 49 percent of adolescent girls aged 13 through 17, and less than two percent of adolescent boys in the United States have received one or more doses of the HPV vaccine (Etter, Zimet, & Rickert, 2012). Monitoring and evaluating HPV vaccine uptake and completion rates as part of this indicator will provide an opportunity to discern possible disparities affecting women and men of different racial/ethnic groups and income levels. A study by Niccolai, Mehta, & Hadler (2011) suggested that non-Hispanic black and Hispanic teens between the ages of 13 and 17, who received at least one dose of HPV vaccine, were significantly less likely to complete their HPV vaccine series, than non-Hispanic white teens. Additionally, lower income adolescents and young women were at higher risk of not initiating or completing their vaccination series (Niccolai, Mehta, and Hadler, 2011; Wei, Moore, & Green, 2013). Despite HPV vaccination being covered by Medicaid, provider-based studies have shown lower rates of HPV vaccine uptake among young female patients covered by Medicaid (Vadaparampil et al., 2013). Other factors associated with low initiation rates are not having a regular provider and not having received childhood immunizations (Wei et al, 2013; Kessels, Marshall, Watson, et al., 2012). Despite the widespread availability of the HPV vaccine, knowledge of, and clinician recommendation for the HPV vaccine is lower among lower income and racial minority women. (Polonijo, Carpiano, 2013; Mehta, Julian, Meek, Sosa, Bilinski, Hariri, Markowitz, Hadler, & Niccolai, 2012).

Researchers identify reduced access to screening or follow up care as part of the explanation for the disparity in cervical cancer incidence as well as vaccine initiation and other preventive measures (Benard et al, 2005). Socioeconomic position also has been linked with cervical cancer mortality and late stage diagnosis. By evaluating temporal trends in age-adjusted cervical cancer mortality rates by individual education level between 1993 and 2007, Simard and colleagues (2012) found that the decreases in cervical cancer mortality rates were smaller for women with lower versus higher levels of education, in turn leading to a widening of the disparity in mortality by socioeconomic status. The team suggested that 74 percent of all cervical cancer deaths in 2007 would have been averted if no educational disparities existed. These data suggest inequity in both access to and utilization of HPV vaccination as well as outcomes from cervical cancer.

Public health impact

In 2012, there were an estimated 12,170 new invasive cervical cancer cases and over 4,200 cancer-related deaths in the United States, making cervical cancer the third most common form of female-related malignancy (del Carmen & Avila-Wallace, 2013). It is estimated that as many as 80 percent of females and 50 percent of males in the United States will contract HPV throughout their lives (Alexander, Daley, Dempsey, 2012), with 79 million persons in the United States infected with HPV today and approximately 14 million becoming newly infected each year (Satterwhite et al., 2013).

A July 2013 Morbidity and Mortality Weekly Report (MMWR) posited that while decades may be required for the impact of HPV vaccination to be well documented, short-term outcomes can be measured. For example, despite low uptake of the vaccine, Markowitz and colleagues found that within four years of the introduction of the HPV vaccine (the period of 2007-2010), prevalence of HPV types targeted by the vaccine decreased over 50 percent (from 11.5 percent to 5.1 percent) for females aged 14 to 19 years (2013). These short-term findings are promising, given the economic and health-related quality of life burden of cervical HPV disease. Fleurence and colleagues conducted a systematic review and found that the annual health care costs of HPV-related conditions in the United States range from $2.25-$4.6 billion (2005 dollars) and the annual burden of cervical cancer ranges from $181.5-$393 million (2005 dollars), making the economic burden of this sexually transmitted virus second only to human immunodeficiency virus. Furthermore, the authors looked at a range of health-related quality of life outcomes and their association with three factors: abnormal Pap smear test, HPV infection, and cervical cancer. The authors found studies suggesting associations across a range of outcomes related to emotional function (e.g. anxiety/worry, depression), body image or self-esteem (e.g. desirability, self-confidence), sexual function (e.g. reduced sexual contact, relationship with partner), and physical function (e.g. role limitations). The most recurrent themes were anxiety, distress, and detriment in sexual functioning (2007). Given this information, the potential public health impact of increasing HPV vaccination rates can be significant, both in terms of reduced morbidity and mortality from cervical cancer but also reducing the disease's economic burden and detriments to quality of life.

Leverage or realign resources

Extensive studies indicate that universal utilization of HPV vaccine among indicated at-risk populations does not only result in health gains, but also in health care cost savings associated with cervical cancer treatment (Tully, Anonychuk, Sanchez, Galvani, & Bauch, 2012; Westra, Rozenbaum, Rogoza, et al, 2011). Several studies have documented the efficacy and safety of both Pap Smears and HPV vaccine to prevent and increase early detection of cervical cancer (Etter, Zimet, & Rickert, 2012). It has been suggested that culturally-competent and integrated outreach efforts to increase knowledge and improve attitudes towards the HPV vaccine should be implemented in order to bridge the knowledge divide affecting those with differential access to educational resources or a regular health care provider (Kontos, Emmons, Puleo, & Viswanath, 2012; Daley, 2011). Researchers also have indicated the need to address providers themselves as a means to reduce inequalities in HPV vaccine initiation and series completion (Vadaparampil, Staras, Malo, et al., 2013; Daley, Vamos, Buhi, et al, 2010), recognizing tremendous missed opportunities in the doctor's office for raising awareness of the HPV vaccine and messaging the importance of receiving all doses.

The responsibility for improving vaccine coverage rates does not lie solely among health care professionals. Parents have been identified as a preferred source of information about HPV vaccination by adolescent girls (Mullins et al., 2013), indicating that parent discussions with their children about HPV and the benefits of vaccination are critical to improve series initiation and completion. Other key partners in improving vaccine coverage rates may include the following:

- Legislators: According to the National Council of State Legislatures, in 2007, at least 24 states and the District of Columbia introduced legislation to specifically mandate the HPV vaccine for school, and as of June 13, 2013, 8 states had proposed HPV-related legislation for the 2013-2014 sessions. A table of state action is currently available at the following location: ncsl.org/issues-research/health/hpv-vaccine-state-legislation-and-statutes.aspx.
- School-based health centers: Research indicates that school-based health centers can be effective in administering the complete series of HPV vaccines to adolescents, compared to community health centers, despite serving a primarily uninsured or underinsured population (Frederico et al., 2010).
- Schools and Extramural Programs (e.g. after-school programs and other school-sponsored activities): Hayes and colleagues (2013) investigated lessons learned from extramural programs across the United States that partnered with schools to increase HPV vaccination rates (among other immunizations). These efforts are based on the notion that school-located programs are a valuable complement to clinical care because of the infrequency with which adolescents visit their physicians. Funding for such programs remains a challenge, as these programs

often don't have adequate mechanisms for billing private insurers and Medicaid, and thus rely upon grant funds and other sources with limited sustainability. McRee and colleagues (2013) investigated the acceptability of alternative settings for HPV vaccine delivery among parents and adolescent males, and found that comfort with these settings correlated with parent perception of greater barriers to HPV vaccination, if the parent or son had not recently visited their health care providers or had previously received vaccines at school, and if sons perceived that their peers were more accepting of the HPV vaccine.

Predict an individual's health and wellness and/or that of their offspring

HPV has been identified as a necessary causal factor in the development of cervical cancer (Daley, 1998; Crosbie, Kitchener, 2012; MMWR, 2012). It is a sexually transmitted infection associated with sexual health practices, including the effective use of condoms during every sex act, and has implications for individual health (and partner sexual health) at the outset of sexual activity. While most HPV infections clear the body within the first two years, some will progress and develop into cancer several years later (MMWR, 2012). The median age of cervical cancer diagnosis is 48 years of age (CDC, 2011). The widespread use of safe and effective HPV vaccines is a significant determinant of lifelong health for women who may be at risk of developing the third most common malignancy among women. Additionally, a link between HPV infection and other types of cancer has been suggested, including vulvar, vaginal, penile, anal, and oropharyngeal cancers (Hu & Goldie, 2008; Meyers, 2008; CDC, 2012). These cancers affect the health trajectories of both men and women.

Data Criteria

Data availability

NIS and NIS-Teen

The National Immunization Survey (NIS) and National Immunization Survey-Teen (NIS-Teen) are both part of a study in which data are collected by interviewing households in all 50 States, the District of Columbia, and selected areas for oversampling, to determine vaccine coverage rates among children 19-35 months of age (NIS) and adolescents aged 13-17 years (NIS-Teen). The interviews are conducted by telephone (previously landline telephone numbers only, with cell phone numbers added in 2011) with households selected at random, followed by a mailed survey to immunization providers. Parent/guardian respondents provide vaccination and sociodemographic information on children or adolescents in their care. Teen data files are available starting with 2008. The NIS and NIS-Teen are conducted jointly by the National Center for Immunizations and Respiratory Diseases and the National Center for Health Statistics, Centers for Disease Control and Prevention (CDC).

The NIS-Teen includes meningococcal conjugate vaccine (MCV4), tetanus, diphtheria, acellular pertussis (Tdap), and human papillomavirus (HPV). Survey data are used to calculate vaccine coverage rates based on the recommended number of doses to be up to date, as recommended by the Advisory Committee on Immunization Practices (ACIP). Data on vaccination coverage from NIS-Teen are published annually through the CDC Morbidity and Mortality Weekly Report. State level data from 2011 is currently available (users can download the dataset and SAS and R input statements from the CDC website at cdc.gov/nchs/nis/data_files_teen.htm), and 2012 data on HPV vaccination in adolescent girls was published in July 2013 (CDC, 2013).

NHIS

The National Health Interview Survey (NHIS) is a cross-sectional household interview survey that has been in use in the United States since 1957. Sampling and interviewing are continuous throughout each year. Data are collected in-person by U.S. Census Bureau interviewers (CDC, 2012). The National Cancer Institute (NCI) chose the NHIS to periodically identify trends in cancer-related health behaviors in the U.S. population, by adding the Cancer Control Supplement (CCS), which has been administered every five years since 2000 (National Cancer Institute, 2011). Additionally, the National Center for Immunizations and Respiratory Diseases at CDC sponsors an immunization supplement that includes HPV vaccination coverage (currently included in the Adults Health Care Access and Utilization Section) and is collected annually. NHIS includes data related to HPV vaccination among 18-26 year olds, including whether an individual in the household has ever received an HPV vaccination, the number of HPV vaccinations received, and the age at which the first vaccination was received. NHIS data files through 2012 and SAS, SPSS, Stata input statements are available online at cdc.gov/nchs/nhis/nhis_2012_data_release.htm).

Data quality

For both the NIS and the NIS-Teen, parents and guardians are asked for consent for a second phase of the study in which the child or adolescent's pediatrician is contacted. The provider receives an immunization history questionnaire to fill out for the selected child; this information is used to ensure the accuracy and precision of the vaccination coverage estimates. CDC publishes a NIS "Guide to Quality Control Procedures" that describes the procedures used to ensure the quality of the data through all phases of the sampling, data collection, and processing. The data are weighted to reduce potential biases from non-response and non-coverage. In addition to households with an eligible child that do not respond to the survey, an additional source of potential error is a household that responds but does not have complete provider information. Item non-response for the NIS is typically very low. However, for data elements used in weighting, the hot-deck method of imputation is used. Although in one year a total of about 14,000 data elements are imputed, these account for only 0.08 percent of all data items in the file. Dorell and colleagues assessed the validity of parent-reported adolescent vaccination histories by analyzing data from the 2008 NIS-Teen. Of all vaccines, the net reporting bias between parent-reported estimates and provider-reported estimates was lowest for at least one dose of HPV4 or at least three doses of HPV4, with kappa statistics of 0.920 and 0.865 respectively (the highest kappa values compared with the other adolescent-administered vaccines) (Dorell et al., 2011).

For the NHIS, the sampling plan follows a multistage area probability design that allows for representative sampling of households and non-institutionalized group quarters. The NHIS sample is drawn from each State and the District of Columbia. The current NHIS sample design features oversampling of Blacks, Hispanics and Asians. Survey participation is voluntary and confidential. The annual response rate of NHIS is approximately 90 percent of the eligible households in the sample. The NHIS sample may be too small to provide State level data with acceptable precision for each State. Therefore, states should combine years to obtain selected estimates. Information specific to the validity of the HPV measure in the NHIS is not available at this time, however a previous assessment of the validity of estimates of vaccine coverage for children aged 19-35 months showed that both the NIS and NHIS produce similar results, despite one being conducted in-person and another via telephone (Bartlett et al, 2001).If the delay for combining multiple years of data from the NHIS is too long, BRFSS could be used as a data source. BRFSS is considered a valid and reliable resource. Researchers can find a list of studies that have examined the validity and reliability of BRFSS on the CDC BRFSS website at: cdc.gov/brfss/publications/mvr.htm. Both surveys are administered post-vaccination so that responses may be subject to recall bias.

Simplicity of indicator

This indicator is relatively simple to explain and understand. State coverage estimates (for both ≥ one dose and ≥ three doses) are made available through the supporting agency, and data files for subgroup analyses are readily available on the agency websites. The indicator aligns with the Healthy People 2020 goal of increasing the vaccination coverage level of three doses of human papillomavirus (HPV) vaccine for females age 13 to 15 years to a target of 80 percent, easing challenges associated with justifying the public health need for such an indicator.

References

Alexander, K., Daley, A.M., & Dempsey, A.F. (2012). Rationale for reducing the spread of human papilloma virus in adolescents: strategies to improve outcomes (CME multimedia activity). J Adolesc Health, 50(5).

American Cancer Society (2011). Cancer Facts & Figures 2011. Accessed at: http://www.cancer.org.ezproxy.bu.edu/acs/groups/content/@epidemiologysurveilance/documents/document/acspc-029771.pdf

Bartlett, D.L., Ezzati-Rice, T.M., Stokley, S., Zhao, Z. (2001). Comparison of NIS and NHIS/NIPRCS vaccination coverage estimates. National Immunization Survey. National Health Interview Survey/National Immunization Provider Record Check Study. *Am J Prev Med.* 20(4 Suppl): 25-7.

Benard, V.B., Lawson, H.W., Eheman, C.R., Anderson, C., Helsel, W. (2005). Adherence to guidelines for follow-up of low-grade cytologic abnormalities among medically underserved women. *Obstet Gynecol.* 105(6):1323–8.

Brankovic, I., Verdonk, P., & Klinge, I. (2013). Applying a gender lens on human papillomavirus infection: cervical screening, HPV DNA testing, and HPV vaccination. *Int J Equity Health*, 12: 14.

Centers for Disease Control and Prevention (2011). Cervical cancer rates by race and ethnicity. Accessed at: http://www.cdc.gov/features/dscervicalcancer/

Centers for Disease Control and Prevention (2012). About the National Health Interview Survey. Accessed at: http://www.cdc.gov/nchs/nhis/about_nhis.htm

Centers for Disease Control and Prevention (2012). Gynecologic Cancers – Cervical Cancer Statistics. Accessed at http://www.cdc.gov/cancer/cervical/statistics/.

Centers for Disease Control and Prevention (2012). HPV-Associated Cancers Diagnosis by Age. Accessed at http://www.cdc.gov/cancer/hpv/statistics/age.htm

Centers for Disease Control and Prevention (2013). Teen Vaccination Coverage – 2011 National Immunization Survey (NIS) - Teen. Accessed at: http://www.cdc.gov/vaccines/who/teens/vaccination-coverage.html#nis-tables

Crosbie, E.J., Kitchener, H.C. (2012). Human papillomavirus as a target for management, prevention, and therapy. *Int J Hyperthermia*, 28(6): 478-488.

Daley, A.M. (2011). Providing adolescent-friendly HPV education. *Nurse Pract*, 36(11):35-40.

Daley, E.M. (1998). Clinical update on the role of HPV and cervical cancer. *Cancer Nursing*, 21(1): 31-35.

Daley, E., Perrin, K., Vamos, C., Hernandez, N., Anstey, E., Baker, E., Kolar, S., & Ebbert, J. (2013). Confusion about Pap smears: lack of knowledge among high-risk women. *J Womens Health*, 22(1): 67-74.

Daley, E.M., Vamos, C.A., Buhi, e.r., Kolar, S.K., McDermott, R.J., Hernandez, N., & Fuhrmann, H.J. (2010). Influences on human papillomavirus vaccination status among female college students. *J Womens Health*, 19(10).

Del Carmen, M.G., & Avila-Wallace, M. (2013). Effect of health care disparities on screening. *Clin Obstet Gynecol*, 56 (1): 65-75.

Dorell, C.G., Jain, N., Yankey D (2011). Validity of parent-reported vaccination status for adolescents aged 13–17 years: National Immunization Survey-Teen, 2008. *Public Health Rep.* 126(Suppl 2): 60-69.

Etter, D.J., Zimet, G.D., & Rickert, V.I. (2012). Human papillomavirus vaccine in adolescent women: a 2012 update. *Curr Opin Obstet Gynecol*, 24(5): 305-310.

Fleurence, R.L., Dixon, J.M., Milanova, T.F., Beusterien, K.M. (2007). Review of the economic and quality-of-life burden of cervical human papillomavirus disease. *Am J Obstet Gynecol.* 196(3): 206-12.

Frederico, S.G., Abrams, L., Everhard, R.M., Melinkovich, P., Hambridge, S.J. (2010). Addressing adolescent immunization disparities: a retrospective analysis of school-based health center immunization delivery. *Am J Public Health.* 100(9): 1630-4.

Hayes, K.A., Entzel, P., Berger, W., Caskey, R.R., Shlay, J.C., Stubbs, B.W., Smith, J.S., Brewer, N.T. (2013) Early lessons learned from extramural school programs that offer HPV vaccine. *J Sch Health.* 83(2): 119-26.

Hoyo C, Yarnall KSH, Skinner CS et al (2005) Pain predicts non-adherence to pap smear screening among middle-aged African American women. *Preventive Medicine* 41:439–445.

Hu, D., & Goldie, S. (2008). The economic burden of noncervical human papillomavirus disease in the United States. *Am J Obstet Gynecol*, 198(5): 500.e1-7.

Jemal A, Thun M, Ries L et al (2008) Annual report to the nation on the status of cancer, 1975–2005, featuring trends in lung cancer, tobacco use, and tobacco control. *J Natl Cancer Inst* 100(23):1672–1694.

Jennings-Dozier, K (1999) Predicting intentions to obtain a Pap smear among African American and Latina Women: Testing the theory of planned behavior. *Nurs Res* 48(4):198–205.

Kessels, S.J., Marshall, H.S., Watson, M., Braunack-Mayer, A.J., Reuzel, R., Tooher, R.L. (2012). Factors associated with HPV vaccine uptake in teenage girls: a systematic review. *Vaccine*, 30(24): 3546-3556.

Kontos, E.Z., Emmons, K.M., Puleo, E., & Viswanath, K. (2012). Contribution of communication inequalities to disparities in human papillomavirus vaccine awareness and knowledge. *Am J Public Health*, 102(10): 1911-1920.

Mehta, N.R., Julian, P.J., Meek, J.I., Sosa, L.E., Bilinski, A., Hariri, S., Markowitz, L.E., Hadler, J.L., & Niccolai, L.M., (2012). *Obstet Gynecol*, 119 (3): 575-581.

Markowitz, L.E, Hariri, S., Lin, C., Dunne, E.F., Stenau, M., McQuillan, G., Unger, E.R. (2013). Reduction in Human Papillomavirus (HPV) prevalence among young women following HPV vaccine introduction in the United States, National Health and Nutrition Examination Surveys, 2003-2010. *J Infect Dis*. 208(3): 385-93.

Meyers, E.R. (2008). The economic impact of HPV vaccines: not just cervical cancer. *Am J Obstet Gynecol*, 198(5): 487-488.

McRee, A.L., Reiter, P.L., Pepper, J.K., Brewer, N.T. (2013). Correlates of comfort with alternative settings for HPV vaccine delivery. *Hum Vaccin Immunother.* 9(2): 306-13.

MMWR (2013). Human papillomavirus vaccination coverage among adolescent girls, 2007-2012, and postlicensure vaccine safety monitoring, 2006-2013 - United States. *Morb Mortal Wkly Rep.* 62(29): 591-5.

MMWR (2012). Human Papillomavirus-associated cancers – United States, 2004-2008. *Morb Mortal Wkly Rep*, 61: 258-261.

Moore-Monroy, M.A., Wilkinson-Lee, A.M., Verdugo, L., et al (2012). Addressing the information gap. Developing and implementing a cervical cancer prevention education campaign grounded in principles of community-based participatory action. *Health Promot Pract,* 14(2): 274-283.

National Cancer Institute (2011). National Health Interview Survey (NHIS) Cancer Control Supplement (CCS) – Providing national surveillance in the fight against cancer. Accessed at: http://appliedresearch.cancer.gov/surveys/nhis/nhis_fact_sheet.pdf

Niccolai, L.M., Mehta, N. R., & Hadler, J.L. (2011). Racial/Ethnic and poverty disparities in human papillomavirus vaccination completion. *Am J Prev Med*, 41 (4): 428-33.

Polonijo, A.N., Carpiano, R.M. (2013). Social inequalities in adolescent human papillomavirus (HPV) vaccination: A test of fundamental cause theory. *Soc Sci Med*, 82: 115-125.

Satterwhite, C.L., Torrone, E., Meites, E., Dunne, E.F., Mahajan, R., Ocfemia, M.C., Su, J., Xu, F., Weinstock, H (2013). Sexually transmitted infections among U.S. women and men: prevalence and incidence estimates, 2008. *Sex Transm Dis.* 40(3):187–93.

Simard, E.P., Fedewa, S., Ma, J., Siegel, R., & Jemal, A. (2012). Widening socioeconomic disparities in cervical cancer mortality among women in 26 states, 1993-2007. *Cancer*, 118(20): 5110-5116.

Tully. S.P., Anonychuk, A.M., Sanchez, D.M., Galvani, A.P, & Bauch, C.T. (2012). Time for change? An economic evaluation of integrated cervical screening and HPV immunization programs in Canada. *Vaccine*, 30(2): 425-435.

Vadaparampil, S.T., Staras, S.A., Malo, T.L., Eddleton, K.Z., Christie, J., Rodriguez, M., Giuliano, A.R., & Shenkman, E.A., (2013). Provider factors associated with disparities in human papillomavirus vaccination among low-income 9- to 17-year old girls. *Cancer*, 119 (3): 621-628.

Watson M, Saraiya M, Benard V et al (2008) Burden of cervical cancer in the United States, 1998–2003. *Cancer* 113:2855–2864.

Wei, F., Moore, P.C., & Green, A.L. (2013). Geographic variability in human papillomavirus vaccination among U.S. young women. *Am J Prev Med*, 44(2): 154-157.

Westra, T.A., Rozenbaum, M.H., Rogoza, R.M., Nijman, H.W., Daemen, T., Postma, M.J., & Wilschut, J.C. (2011). Until which age should women be vaccinated against HPV infection? Recommendation based on cost-effectiveness analyses. *J Infect Dis*, 204(3): 377-384.

This publication was supported by a grant from the W.K. Kellogg Foundation. Its contents are solely the responsibility of the author and do not necessarily represent the official views of the W.K. Kellogg Foundation.

To learn more, please contact Caroline Stampfel, Senior Epidemiologist at cstampfel@amchp.org or (202) 775-0436.

Association of Maternal & Child Health Programs
2030 M Street, NW, Suite 350
Washington, DC 20036
(202) 775-0436 ▪ www.amchp.org