

# Genomic Epidemiology of Human Papillomavirus and the Adoption of Health Belief Model to Explicate Compliance with the Prophylactic Vaccine

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## ABSTRACT

This study reviewed gene mutations associated with the human papilloma virus (HPV). For the first time the health belief model (HBM) developed by Geoffrey Hochbaum was utilized to explicate the exposure of at risk population to the viral disease. The precursors of HPV infections were identified as stemming from the phenomenological background of the under-age children and their teenage counterparts. The major parental traits include illiteracy, poverty, denial and neglecting the functions of parent-child bonding. The investigators recommended abstinence education for the under-age K-8<sup>th</sup> grade students, and the integration of the comprehensive sex education instructions for the adolescents; emphasizing the importance of abstinence from sexual intercourse before taking HPV vaccine. Compliances with abstinence from sexual intercourse are recommended for the prophylaxis to be most effective.

**KEY WORDS:** Genomic epidemiology, Human Papillomavirus (HPV) The health Belief model(HBM) abstinence and the prophylactic vaccine.

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## INTRODUCTION

Epidemiological studies have identified human papillomaviruses (HPVs) as small, double-stranded DNA viruses which infect the cutaneous and mucosal epithelial tissues in multiple ano-genital, skin regions, the trachea-bronchial and oral mucosa, principally, due to oral sexual intercourse. Scientists argue that more than 100 types are diagnosed based on the genetic sequence of the outer capsid protein L1. The other forty types infect the mucosal epithelium (CDC,2009). Reports from CDC (2009) also revealed that 90% of cervical cancers are positive for HPV- DNA and the subset of HPVs which are recognized as high-risk (HR)variant. These include HPV16 and HPV18, which are associated with cancer development (Woodman et al, 2000, Muto et al, 2012). HPV is not only one of the over 100 viruses serving as the etiological agents of warts, but also for the majority of HPVs induced warts on the face, and fingers. High frequencies of HPV are confined to the genitalia, while others are commonly identified as the causative agents of cancer of the cervix and the ano-genital regions. Predominantly, the HPVs associated with wart-like growth in the genitalia area is usually sexually transmitted.

The American Cancer Society (2008) has estimated incidence of cervical cancer disease burden in United States alone to be 11,070 cases, with 3,870 deaths. Almost 100% of these cervical cancers cases are caused by one of the 40 HPV types which infect the mucosa region. Besides, the ano-genital HPV is not only the most common sexually transmitted infection in the United States, but has a prevalence of an estimated 20million among the sexually active patients. Currently, the incidence of 6.2 million cases occur annually. Statistically, an estimated 80% of sexually active women are most likely infected in United States by age 50. The sexually active males are equally at risk of infection (CDC, 2009). Global epidemiological report on cervical cancer ranks this disease as the second most common cause of cancer death in American women, with an estimated 510,000 newly diagnosed cervical cancer with death rate of over 288,000 cases in the developing nations (Saslow, et al, 2008).

### Morbidity and Mortality of HPV, Worldwide

Modern epidemiological studies have revealed HPV as the most common STI in the world. It is estimated; at least 50% of sexually active individuals are at one time infected by at least one variant of HPV. Innovative genome mapping indicates more than 75% of HPV variants are recognized out of which 40 of them infect the urogenital area. HPV infect men and women in equal proportion, however, women are more likely to present more symptoms of the disease.

HPV is the causative agent of over 90% of all cervical cancers the second leading cause of death of women worldwide. Statistically, 1-5% of women infected with HPV usually develop malignancies. In many patients, HPV

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is associated with genital warts and about 1-2% of sexually active individuals experience visible genital warts infections. Advanced innovative genomic science continues to reveal copious scientific data on HPV. But in the resource-challenged developing nations, there is a dearth of knowledge, and so much to learn about the genomic spectrum, transmission patterns and infectivity of HPV in the developing and least-developed parts of the world (Bosch et al, 1996). In view of the lethal consequences of HPV and the associated morbidity in women of child bearing age and the ethnic disparities linked to this disease burden, the study described here was designed to:

- Assess the genomic epidemiology of HPV
- Utilize the Health Belief Model (HBM) to explicate the exposure of at risk population to HPV.
- Identify the precursors for HPV infections such as poverty, illiteracy, socio-cultural impact, denial, innate tendency for fecundity
- Utilize abstinence education to protect under-age girls (K-8<sup>th</sup>) and teach comprehensive sex education to 9<sup>th</sup>-16 grade to reduce the prevalence of HPV in the society.

### **Genomic epidemiology of hpv**

Genomic epidemiology is defined as the investigation of the actions of genetics factors in determining health and disease onset in families and population and the interplay of genetics and environmental characteristics of people. Genomic epidemiology is the link uniting the intersection between genetic and molecular epidemiology. It focuses on the determinants and distribution of diseases and injuries in human population (Ebomoyi, 2009; Mausner and Bahn, 1987)

Human papillomavirus genotype 16 (HPV-16) is the main etiological agent of cervical cancer, accounting for 50-60% of the global epidemiological data. (Bogovac et al, 2011). The genome diversity of HPV-16 has been extensively studied. Besides, molecular epidemiological analyses have shown that HPV-16 consists of several genomic variants. HPV-16 genomic variants differ in their association with cervical cancer, viral persistence and the frequency of recurrence of cervical cancer. This phenomenon could be due to haplotypes characteristics. Bernard et al (2006) have shown in populations of North and Latin America and Asia that non-Europeans HPV-16 variants are associated with stronger oncogenic potential than the European HPV-16 variants. Most HPV infections are asymptomatic and may not result in any clinical disease. The clinical manifestation of HPV infections consist of ano-genital warts, recurrent respiratory papillomatosis, cervical cancer precursors and cancers affecting the cervix, anus, vaginal, vulvar penis and periodic head and neck cancers (CDC, 2009).

Regarding transmissibility, HPV can affect both males and females and transmission can occur with any kind of sexual contact with any individual harboring the virus. The incipient stages of the virus may not present the signs and symptoms of the disease; therefore the risk of infection to unsuspecting close-sexual partners is very high. In an effort to significantly reduce the incidence of this insidious virus and avoidable mortality and morbidity associated with the various variants of HPVs, the health belief model has been outlined to explicate the prudent primary preventive approaches against this deadly disease.

### **Health Belief Model (HBM) to explicate exposure to HPV**

Modern genome epidemiologists and other health educators continue to assess logically and statistically, the theoretical models that are most applicable in explaining individual health behaviors that could maximize public health and minimize the harm associated with HPV. The most appropriate for sexually-oriented risks is the health belief model (HBM) developed by Geoffrey Hochbaum and associates (Rosenstock, 1966).

This theoretical model was developed in the 1950s to explain why medical screening programs offered by the U.S. Public Health Service were not very successful (Hochbaum, 1958). The original concept focused on how human health behaviors are determined by personal belief or perception about a given disease. To Hochbaum (1958), a person's perception is influenced by the range of intrapersonal perceptions affecting a given behavior. That perception which depends on personal factors involves the level of education, and the parental background of the individual. The person's phenomenological experience toward risk taking behaviors associated with contracting sexually transmitted infections. The major theoretical constructs are illustrated in Figure 1. The key components of the HBM consist of perceived susceptibility to a disease such as HPV.

**Susceptibility** to HPV is very high among sexually active teenagers and adults.

The degree of exposure to those incubating the virus without their knowledge that they have HPV is a major risk factor; exposing oneself to a sexual partner with lengthy sexual resume is another risk factor. The facet of human susceptibility to HPV involves falling in love with a potential spouse with HPV. This source could easily become an unavoidable source of susceptibility mostly, if there was no pre-courting or pre-marital screening.

**Perceived seriousness/threat of HPV** is based on several epidemiological indicators such as high case fatality rate associated with the disease. The incidence and prevalence of HPV which occur in epidemic proportion not only in U.S but also worldwide. Scientifically, there several variants of HPV, the disease is literally incurable, the disease is associated with the deadly cervical cancer and signs and symptoms of the disease can occur in many parts of the

body such as the mouth and neck causing ano-genital warts, recurrent respiratory papillomatosis, cervical cancer, cervical intraepithelial neoplasia and cervical cancer, anal cancer, vaginal and penile cancer(CDC, 2009) Based on the litany of diseases linked to HPV, the morbidity and mortality associated with the various variants of disease, the perceived seriousness of HPV cannot be overstated. The perceived seriousness of HPV should motivate young adolescents to consider having HPV vaccine ever before becoming sexually active so as not to compromise the effectiveness of the vaccine.

**Modifying variables** The major modifying variables intuitively identified are the demographic characteristics, socio-psychological and structural variables. Regarding the sexually active individuals, the age, gender, ethnicity are quite pertinent when sexual risks associated with HPV are considered. The under-age grade school children must be trained using the abstinence curriculum. The high school 9<sup>th</sup>-16<sup>th</sup> grade should be trained using the comprehensive sex education curriculum. The high frequency of HPV in minority ethnic community and teenage parents reinforces the need to protect under-age children from sexual promiscuity which can easily expose them to the onset of HPV and other sexually transmitted infections and unwanted pregnancies.

**Another key component of HBM is structural variable** which encompasses scientific knowledge of a disease “X” such as HPV. Self-efficacy becomes so paramount in the education and knowledge acquired by children regarding HPV and other life-threatening diseases such as HIV and other STIs. It is the literate parents; particularly mothers who assume this role in most homes where both parents are literate even, if their academic background is not necessarily in health related disciplines.

The perceived threat of HPV and their variants is quite high, because there is the high mortality and morbidity associated with cervical cancer. Besides, HPVs are incurable diseases and the cost of treating these diseases is prohibitive, mostly if one is medically isolated or without health insurance.

Professor Goeffrey Hochbaum (1958) meticulously suggested that health behavior is influenced **by cues to action**. To him, cues to action, are specific events, people, innovative discoveries that motive people to change their behaviors. Today, innovative genomic epidemiology has revealed several lethal variants of HPVs. There is the issue of HPV-associated illnesses, and recent diagnosis of a family member with HPV. Also, the federal Centers for disease control and prevention (CDC) regularly create national and global awareness about the unnecessary morbidity and mortality statistics of HPV and the ethnic disparities associated with death from this preventable disease. In fact, CDC (2009) recently developed viable vaccines that can protect under-age grade school children so long as they have not begun having sexual intercourse. This cohort of children can be protected for life from cervical cancer through HPV vaccination. There is the health education message used by community-health workers who visit homes with innovative primary preventive messages for parents of child-bearing age in the minority ethnic communities where statistics on sexually transmitted infections are very high. Apart from post cards mailed to clients by their family physicians, there is a high frequency of public health services announcement from mass media campaigns designed to protect the public. Health education programs are provided in many churches whereby volunteer health professional teach the congregation members about the availability of inexpensive screening services being performed in nearby clinics (Figure 1).

**Likelihood of action:** Using this framework, the likelihood of taking action, such as screening for HPV could be quite high. In fact, volunteering for HPV vaccine is assessed by weighing the perceived benefits of the vaccine against the ill-effects of multiple diseases associated with permissive sexual life activities with the risk of diseases and possible death from cervical cancers. On reflecting on commonsense and scientific theory, Hochbaum(1992) maintained that scientists need to be mindful about Kurt Lewin’s widely cited pronouncement that “there is nothing as practical as a good theory.”

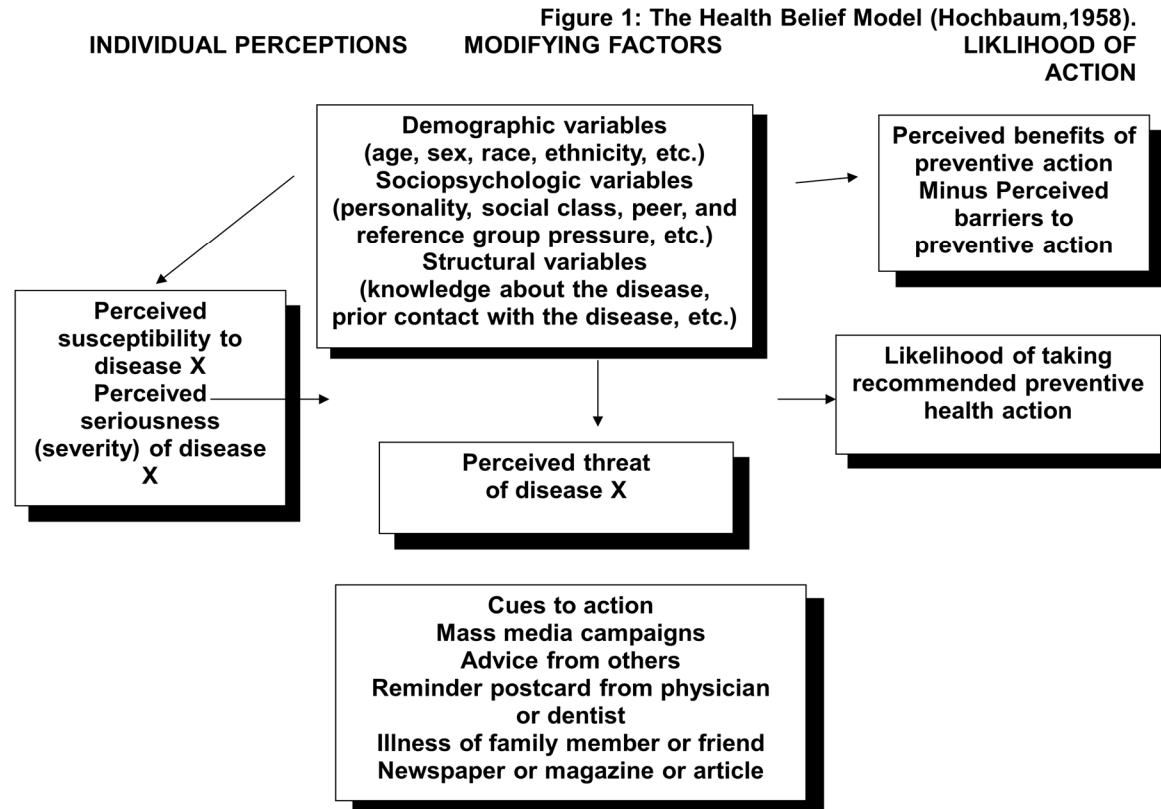
**Self-efficacy:** When the HBM was conceptualized in the 1950s, the concept of self-efficacy was not a component of the model. A plethora of studies by several socio-psychologists created the impetus to incorporate self-efficacy (Rosenstock, and Stretcher1997). Dr. Bandura (1977) integrated self-efficacy which he defined as the conviction that one can successfully execute the behavior required to produce the outcome. It is also described as one’s ability to perform a certain task or specific function. Self efficacy which Bandura(1988) later described as social cognitive theory (SCT), explained that behavior is determined by expectancies and incentives:

- (a)Expectancies about environmental cues that is, the belief about how events are connected
- (b)Expectancies about the consequences of one’s own actions (that is, opinions about how individual behavior is likely to influence outcomes) which is described as outcome expectations and
- (c) Expectancies about one’s own competence to perform the behavior needed to influence outcomes

Based on Bandura’s views, incentive (or reinforcement) is defined as the value of a particular object or outcome The outcome in this discourse, is preventing under-age children from HPV by getting them to take HPV vaccine before they become sexually active. The need to protect school-age children from HPV and other deadly STIs. (see table 1).

In personal communication with Bandura (2004), he passionately echoed how the development of self-efficacy in children is nurtured by parental nurturing, instilling confidence and a sense of self-worth in the infant to enable

the child developed based on his or her genetic endowment. The phenomenological environment and the lived experiences of the children enhance their cognitive, psychosocial and emotion growth which allows children to make valid informed choices in life about health enhancing behavior such as compliance with abstinence as the norm of the under-age pupils. In fact, compliance with HPV prophylactic vaccine to protect one's self against HPV depends on several human attributes. Intimate contact with involved and stable parents not only enhance children's self-efficacy but improves nearly every cognitive, social and emotional attributes of a large number of children (Anthes, 2012).



### Exposure factors to HPV infections

Sexual intercourse exposes most under-age school-age children to unwanted teenage fertility and a broad spectrum of sexually transmitted infections (Table1). Although most of these STIs such as *Neisseria gonorrhea*, *Chlamydia trachomatis* and *Treponema pallidum* may be receptive to prompt medical treatment, at present, there are no effective curative medical intervention against HPV and HIV. Based on CDC's (2012) data, all women are at risk of cervical cancer.

However, the disease is rare in women younger than 30 years because of the limited sexual exposure of this age cohort. In United States, recently 12,280 women were diagnosed with cervical cancer and 4,021 died from the disease. Of the incidence data of 100,000 women diagnosed with cervical cancer in 2007, the overall death rate by ethnicity, revealed 4.3/per 100,000 Blacks, 4.0 /100,000 Hispanics and the least death statistics was 2.2/100,00 of the White women (CDC, 2012). The cervical cancer associated with HPV variants affects over 11,000 women worldwide, of the approximately over 2000 African American women infected with cervical cancer each year, over 40% are most likely to experience increased death rate. Yet, cervical cancer is one of the most preventable types of cancer that can be screened for with routine pap smear and treated. The American College of Obstetricians and Gynecologists (ACOG) has recommended the importance of initiating cervical cancer screening of women before the age of 21 instead of three years after they have begun sexual intercourse when the impact of HPV vaccine becomes compromised (American Cancer Society, 2012). Having regular pap smear test is one of the tests to assist in protecting an individual against cervical cancer. However, a pap test does not diagnose HPV, but it can detect abnormal cells caused by HPV in the lining of the cervix before the cells become pre-cancers or cancers (Merck, 2012).

### Health promotion adaptation to protect K-8th graders

Health promotion is a broad concept. What most people conscientiously engage in to protect themselves and ward of ill-health falls under the rubric of *health promotion*. Mark Dignan and Patricia Carr (1987) underlined the importance of health promotion to enhance human living conditions as working toward wider awareness of personal and community health issues and modifying attitudes to facilitate behavior changes that will lead to more healthful living. For programmatic activities, O'Donnell defined health promotion as “the science and art of helping people change their lifestyle to move toward a state of optimum health.”

In his revised definition, Larry Green (1991) defined *health promotion* as “the combination of educational and environmental supports for actions and conditions of living conducive to health.. At the first International Conference on Health Promotion, he elaborated that the “behaviors in question may be those of individuals, groups, or communities, of policy makers, employers, teachers, or others whose actions control or influence the determinants of health. The purpose of health promotion is to enable people to gain greater control over the determinants of their own health.” (Green, 1991). Therefore, the sexual norm of the under-age K-8 grade is abstinence.

Table 1: Major Sexually Transmitted Infection Microbial Agents and Their Effects

Sexually Transmitted Infections	Acute Disease	Chronic Disease	Pregnancy-Associated Disease
<b>Bacterial</b>			
Neisseria gonorrhea	Urethritis Cervicitis Salpingitis	Infertility Ectopic pregnancy Chronic pelvic pain	Prematurity Septic abortion Ophthalmia neonatorum Postpartum endometritis
Chlamydia trachomatis	Urethritis Cervicitis Salpingitis	Infertility Ectopic pregnancy Chronic pelvic pain	Ophthalmia Neonatorum Pneumonia Postpartum Endometritis
Treponema Pallidum	Primary and Secondary syphilis	Neurosyphilis Cardiovascular syphilis Gumma	Prematurity (?) Spontaneous abortion Stillbirth Congenital Syphilis
Haemophilus Ducreyi	Genital ulcer	None Known	None Known
<b>Viral</b>			
Human Immunodeficiency Virus (HIV)	Mononucleosis- like syndrome	AIDS	Prematurity Stillbirth Perinatal HIV Infection
Human papilloma virus (HPV)	Genital warts	Genital cancer	Laryngeal papillomatosis
Herpes Simplex virus type 2 (HSV – 2)	Genital ulcer	Recurrent genital herpes	Congenital and Neonatal HSV
Hepatitis B virus (HBV)	Acute hepatitis	Chronic Hepatitis Cirrhosis Hepatoma Vasculitis	Prematurity Peri-natal HBV
<b>Parasitic</b>			
Trichomonas Vaginalis	Vaginitis Urethritis		Prematurity Low birth weight

Source: Adapted from Brunham and Ronald (1991). (?), Evidence is weaker than for other effects

According to Federal Abstinence Education guidelines, “ Abstinence is defined as the educational or motivation program that : A) Has as its exclusive purpose, teaching the social, psychological and health gains to be realized to be realized from abstaining from sexual activity; B) Teaches abstinence from sexual activity outside marriage as the expected standard from school age children; C) Teaches that abstinence from sexual activity is the only way to avoid out of wedlock pregnancy, sexually transmitted infections such as HPV, HIV and those listed in Table1; D) Teaches that a mutually faithful and monogamous relationship in the context of monogamous

relationship in the context of marriage is expected standard of human sexuality; E) Teaches that sexual activity out of the context of marriage is likely to have harmful psychological and physical effects F) Teaches that bearing children out-of-wedlock is likely to have harmful consequences for the child's parents and society, G) Teaches young people how to reject sexual advances and how alcohol and drug use can increase vulnerability to sexual advances and H) Teaches the importance of attaining self-sufficiency before engaging in sexual activity (Federal abstinence Education Program 1997).

In rural Colorado, this program was accepted as the best and most appropriate norm not only for K-8 graders even majority of the teenagers were most willing to cooperate with the course curriculum, unfortunately the African American high school students had vehemently rejected the program as mechanism to control their fecundity. Large sum of financial resources earmarked for the program had to be refunded to the federal funding source (Ebomoyi, Mecklin and Cooney, et al, 2009). Although several educators have criticized underlying philosophy of abstinence education program, for the under- age eight-grade children, abstinence from sexual intercourse at such a tender age has numerous and varied benefits.

The results of our comprehensive abstinence education program in Colorado revealed the following major factors which could lead to success of abstinence curriculum: Success in school is related to lower incidence of sexual activity, affirmation of abstinence, and rejection of sexual permissiveness and encouragement from family members to abstain from sex. Parents who encourage their adolescents to abstain from sex are more likely to have children who develop values that lead to affirmation of abstinence and rejection of sexual permissiveness. By far most crucial is setting goals and delay of gratification. These processes are associated with a lower incidence of sexual activity. Adolescents who delay gratification in order to achieve their goals are most likely to achieve their goals and reject sexual permissiveness than their counterparts who are unwilling or unable to set long-term goals (Ebomoyi, Mecklin, Cooney et al, 2009)

### **Comprehensive Health Education for 9<sup>th</sup> -16 graders**

Although Creswell and Newman (1993) recommended that sexual abstinence should be norm for adolescents, numerous studies in United States have shown that a substantial percentage of teenagers do engage in sexual activity. Brindis (1990) reported that premarital sex has been on the increase since 1920s and somewhat perceived as sexually acceptable. Kirby, Waszak and Ziegler (1991) found that 60% of high school students were sexually experienced. They recommended the need to introduce comprehensive sex education programs targeting younger students with authentic and valid scientific instructions about comprehensive contraceptive devices.

The introduction of comprehensive sex education in high schools will provide succinct information about HPV being very insidious, with the infections which are generally asymptomatic, and the exact extent of the disease is currently unknown. Epidemiologists and other health educators believe that the risk factors for HPV in women include sexual activities before the age of 20. Abstaining from sexual activity before the age of 20 and getting vaccinated with HPV vaccine becomes a crucial primary preventive initiative. Also, having sexual intercourse with three or more partners is another avoidable risk because of their increased sexual resume. The broad spectrum of HPVs in men has not been clearly understood even from genomic interventions and clinical analysis. Therefore, we must reiterate, that the norm of the young adolescents should be sexual abstinence because of the pathological impact, social and economic implications of unwarranted pregnancy and disruption of the adolescent social academic career.

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