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Original Article

A Behavioral Economic Approach to Improving Human Papillomavirus Vaccination

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A B S T R A C T

Purpose: The objectives of this study were to measure the impact of a behavioral economic intervention on human papillomavirus (HPV) vaccine initiation and series completion rates for adolescents and to measure the impact of the intervention on the receipt of a nonincentivized influenza vaccine.
Methods: We conducted a quasi-randomized trial to compare the impact of an escalating delayed cash incentive (intervention), compared with usual care (control), on HPV vaccination initiation and series completion rates among adolescents (11–17 years) at an urban medical center. We measured HPV vaccine initiation and completion rates during the 12 months after enrollment and subsequent influenza vaccination rates for 24 months after enrollment.
Results: A total of 85 participants were actively enrolled in the intervention arm and 103 were passively enrolled in the control arm. Participants were predominantly publically insured African-American and Hispanic adolescents. The majority (75%) of the intervention group received one or more doses of the HPV vaccine, with 36% completing the three-dose series, compared with 47% of the control group receiving one or more doses and only 13% completing the series. The odds of HPV *p*-value vaccine initiation (odds ratio 4.19 [95% confidence interval 1.84–10.10], $p < .01$) and HPV vaccine series completion (OR 4.16 [95% confidence interval 1.64–11.28], $p < .01$) were greater among the intervention group compared with the control group. There was no difference in influenza vaccination rates between the intervention group and the control group during the 2013–2014 season ($p = .138$) and during the 2014–2015 influenza season (p value .683).
Conclusions: An incentive-based approach to HPV vaccination was effective in increasing vaccine initiation and series dose completion.

IMPLICATIONS AND CONTRIBUTION

Improving human papillomavirus (HPV) vaccination rates would substantially reduce the incidence of HPV-related disease and HPV vaccination rates lag behind other adolescent vaccines. An incentive-based approach to HPV vaccination was effective in increasing vaccine initiation and series dose completion. The incentive-based approach did not adversely impact the receipt of non-incentivized vaccines.

Human papillomavirus (HPV) is the most common sexually transmitted infection in the U.S. [1–3] and has been found to be the cause of nearly all cervical intraepithelial neoplasias in adolescent girls [4,5], and multiple head and neck cancers [6,7] and anal cancers in both adolescent boys and girls [8]. Despite recommendations for universal vaccination against HPV for both adolescent boys and girls, only 42% of adolescent girls and 28% of adolescent boys aged 13–17-years have completed the

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three-dose HPV vaccine series in 2015 [9]. Based on studies of vaccine efficacy against cervical and anal preneoplastic disease, improving HPV vaccination rates would substantially reduce the incidence of HPV-related disease [10–12]. HPV prevention through vaccination is critical in decreasing the burden of cancer due to this ubiquitous infection.

Health-care decision making is often fraught with pitfalls that lead to poor health outcomes. Drawing from findings in decision psychology, the field of behavioral economics seeks to understand how human social, cognitive, and emotional factors affect decision making [13]. Principles of behavioral economics can be used to "nudge" behaviors to healthier choices and to improve health outcomes while maintaining individual decision-making autonomy [14]. For example, the concept of present bias refers to the tendency to place greater value on present costs and benefits, compared to future benefits, even if future benefits are optimal [15]. Discussing the opportunity to prevent HPV-related cancer with an adolescent or a parent is unlikely to change behavior as cancer is an intangible future outcome compared to an immediate immunization. Loss aversion is the psychological tendency to strongly prefer avoiding a loss more than acquiring a gain [16]. Behavioral economic models have been successfully used to incentivize healthier food selection among children, tobacco cessation among college students and adults, weight loss, and HPV vaccination for older adolescents (16–18 years) [17–21]. However, these behavioral economic theories have not previously been used to incentivize cancer prevention through HPV vaccination of younger adolescents.

The present study aimed to measure the impact of a behavioral economic intervention on HPV vaccination rates among adolescent patients in an urban medical center. The intervention consisted of a virtual savings account that accrued escalating funds after receipt of the first two doses of the HPV vaccine, and participants received the accrued funds only upon completion of the third dose. In addition, influenza vaccination rates were measured to determine if providing an incentive decreases (crowds out) intrinsic motivation for nonincentivized vaccination behavior.

Methods

Study design

We conducted a quasi-randomized trial between October 2013 and November 2014 to compare the impact of an escalating delayed cash incentive (intervention), compared to usual care (control), on HPV vaccination initiation and series completion rates among adolescents at an urban medical center. At the time of enrollment, parents in the intervention group were given a virtual personal deposit account with the following terms: at the time the first dose of HPV vaccine is received, $25 is deposited into the account; at the time the second dose of HPV vaccine is received, another $25 is deposited into the account; and upon receipt of the third dose, the participant is given the $50 in cash. Participants received a tangible document, resembling a bank account statement, showing the deposit after each dose of the vaccine. The amount of the incentive was determined by reviewing the cost-effectiveness evidence for HPV vaccination. Adding $50 (incentive) to the cost of the vaccine would not change the acceptability of the cost-effectiveness ratio based on recent economic models [22–24].

During the consent process, the participants were told that HPV vaccine three-dose completion had to be within 12 months of their enrollment date into the study, and all doses of the HPV vaccine had to be administered at the clinic where the study enrollment occurred. If a participant did not complete the three-dose series within a 12-month period, all accrued funds were forfeited. All HPV vaccines on the market are a series of three doses over a 6-month period. The time frame for series dose completion for the present study was a year to provide flexibility as each dose requires a visit to the clinic.

If an intervention group participant missed a scheduled clinic visit that could have resulted in an HPV vaccination, based on the time since the last dose, the participant was mailed a letter. Rather than reminding the participants how much they will receive if they completed the study (a typical research study reminder letter), the letters served to leverage loss aversion by reminding the participants how much money they will *lose* if HPV vaccination is not completed within the 12-month period.

To understand if an extrinsic incentive (cash) to receive the HPV vaccine impacts individual intrinsic motivation for subsequent (nonincentivized) vaccines, we measured influenza vaccination behavior for two consecutive years, the year during the trial and the year after the completion of the trial, for every participant. We measured influenza vaccines administered and documented within the health-care system where the study was conducted. The protocol was approved by the Institutional Review Board at the University of Illinois at Chicago.

Sample and recruitment

Adolescents, 11-17-years of age, were recruited along with a parent or a guardian, from a general pediatric clinic at a large academic medical center from October 2013 to November 2014. Adolescent-parent dyads were actively recruited 3 days of the week to participate in the intervention arm of the study. Recruitment days were randomly selected each week. The participants were eligible to enroll in the intervention arm if they had no previous HPV vaccination and had the ability to speak and read English. Both the parent and the adolescent were informed of the incentive structure of the study. The control group was enrolled from a convenience sample of matched adolescents who had not received HPV vaccine and were seen in the clinic on nonrecruitment days (2 days/week) (Figure 1). The control group had no exposure to research staff. Physicians and staff in the clinic were not informed as to which adolescents enrolled in the study; however, participants were free to discuss the study with the physicians if they chose to do so.

Statistical analysis

Our primary outcome was the HPV vaccine series dose completion; secondary outcomes included the receipt of any doses of HPV vaccine and the receipt of any doses of influenza vaccine. Descriptive statistics for continuous variables were expressed as mean ± standard deviation; categorical variables were presented as frequency and proportion. All statistical tests were two sided. For baseline characteristics, two-sample *t*-test or nonparametric Wilcoxon rank-sum test was used as appropriate for continuous variables, chi-square or Fisher exact test was used as appropriate for categorical variables to test the difference between the intervention and the control groups. The primary intervention outcomes were coded as three binary HPV vaccination series