Risk Compensation and Vaccination: Can Getting Vaccinated Cause People to Engage in Risky Behaviors?

Noel T. Brewer, Ph.D.
UNC School of Public Health

Cara L. Cuite, Ph.D.
Rutgers University

James E. Herrington, Ph.D.
National Institutes of Health

Neil D. Weinstein, Ph.D.
Rutgers University

ABSTRACT

Background: *Some believe that vaccinating young women against human papillomavirus (HPV) will increase their risky behavior. In more formal terms, vaccination lowers risk perception, and people compensate for their lower perceived risk by reducing other preventive behaviors.* ***Purpose:*** *We test several predictions from the risk compensation hypothesis in the context of vaccination behavior.* ***Methods:*** *We obtained a random sample of adults ($N = 705$), interviewing them by phone just as the Lyme disease vaccine first became available to the public and again 18 months later. Analyses controlled for age, sex, education, and race.* ***Results:*** *Vaccinated respondents were less likely to continue engaging in two of five protective behaviors after vaccination. The frequency of these protective behaviors did not dip below that among the unvaccinated respondents.* ***Conclusions:*** *We found some evidence of* regression *(protective behaviors dropping, after vaccination, to levels reported by the unvaccinated cohort). However, we did not find* disinhibition *(exceeding the risk taking of the unvaccinated cohort), the greater threat to public health. Although we will not know for several years what effect HPV vaccination has on other behaviors, if any, data on other vaccinations can offer critically important information in the interim.*

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INTRODUCTION

The U.S. government recently approved (1) a highly effective vaccine for preventing infection with two oncogenic types of human papillomavirus (HPV) (2), the agent that causes cervical cancer (3). The news was enthusiastically received by public health and medical professionals responsible for reducing cervical cancer deaths. At the same time, a vocal group of opponents to the vaccine renewed their opposition to its use, claiming that young women who are vaccinated would be more likely to engage in premarital sex (4). Formalizing their claim conceptually, young women may experience "sexual disinhibition": Getting vaccinated may cause them to believe they are less at risk for cervical cancer and, for this specific reason, be more likely to engage in sexual behavior than their peers, thus increasing their risk for cervical cancer and sexually transmitted infections.

Sexual disinhibition is consistent with theories of *risk compensation* (also called risk homeostasis) (5). These theories propose that people have stable preferences for a certain amount of risk and that the feeling of safety created by the initial preventive activity creates a surplus of risk that will be expended elsewhere by reducing other protective actions. The findings on the effects of seat belt use that were initially offered in support of risk compensation are controversial (6). By some measures, seat belt use and air bag provision appear to cause a minority of drivers to compensate by driving less safely (7), but their use yields a net overall benefit in terms of lower mortality, and some evidence even suggests that seat belt laws reduce driving speeds (8). Numerous studies in the field of HIV prevention offer similar contradictions. Offering injection drug users free needle exchange reduces HIV infection (9), but it does not appear to increase intravenous drug use, despite largely anecdote-based arguments to the contrary (9). Initiating antiretroviral therapy is associated with increases in sexual risk behavior in some studies but not in others; one study even showed both increases and decreases in sexual risk taking (10). Closer to the issue of adolescent behaviors, parents are more inclined to let children using safety gear engage in risky behavior (11) (not an unreasonable choice if the equipment is highly effective), but the children themselves do not appear to change their behaviors (11).

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Reprint Address: N. Brewer, Department of Health Behavior and Health Education, UNC School of Public Health, 306 Rosenau Hall CB7440, Chapel Hill, NC 27516. E-mail: ntb1@unc.edu

None of these studies examined whether changes in perceived risk mediated the effects on behavior, as suggested by the risk compensation hypothesis. In our own research, we have found that people vaccinated against Lyme disease came to believe they were less at risk than their counterparts who remained unvaccinated (12). A logical extension is that lower perceived risk among vaccinated respondents in our study might cause them to engage in risky behaviors. This could be problematic as the Lyme disease vaccine, like the HPV vaccine, is not completely effective in preventing disease.

Considering two findings that could result from risk compensation identifies its potential implications for public health. We call one finding *regression*, in which engaging in more risky activities and fewer protective behaviors as a result of vaccination merely moves people toward the risk profile of the unvaccinated cohort. We call the other finding *disinhibition*, in which vaccination leads people to engage in more risky activities and fewer protective behaviors than the unvaccinated cohort. These two possible outcomes of risk compensation have very different potentials to impact the public's health, with behavioral disinhibition posing potentially severe problems. Despite the appeal of risk compensation, the empirical literature yields no clear-cut prediction for the effects of HPV vaccination on other behavior. In fact, we are aware of no studies that examine side effects of vaccination on risky behaviors. We conducted a longitudinal study of vaccination behavior that allows us to test the longitudinal relationship between Lyme disease vaccination, risk perception, and other protective behaviors. These data address the question of whether vaccination is associated with engaging in fewer other protective behaviors and whether this reduction is characteristic of regression or disinhibition.

METHOD

The methods for our study have been reported previously (12). Using random-digit dialing, we recruited 745 adults in areas of the northeastern United States with high Lyme disease incidence, interviewing them by phone just as the Lyme disease vaccine first became available to the public in spring 1999 and again 18 months later in fall 2000. During both interviews, participants reported the Lyme-disease-protective behaviors in which they engaged. At follow-up, they also reported whether they had been vaccinated against Lyme disease. Data were dropped for 40 people whose homes did not have yards and who, for this reason, could not engage in many of the yard-related Lyme disease protective behaviors. Data were analyzed using repeated measures analyses of covariance, modeling all main effects and interactions of time with all other variables, and linear regressions predicting change in risk perception. All analyses controlled for age, sex, education, and race (coded as White or other). As reported previously, respondents were well educated, were more likely to be women (60%), had a mean age of 42 (range = 20–70), and were primarily White (94%).

RESULTS

We test five predictions, listed in Table 1, that we derived from the risk compensation hypothesis. In a previously published article, we reported that respondents with higher perceived risk at baseline were more likely to get vaccinated ($n = 42$), and as a result, their perceived risk fell to levels below their initial starting point and even below those not vaccinated ($n = 663$) (12). These findings support the behavioral motivation hypothesis and the first prediction derived from the risk compensation hypothesis, respectively.

In the analyses presented here, vaccinated persons engaged in somewhat more Lyme disease protective behaviors overall than those not vaccinated (as shown by the main effects of vaccination group for three of the behaviors studied; see Figure 1). Respondents engaged in all behaviors less often at follow-up than at baseline, except for avoiding certain areas in their yards, which they did more often (as shown by the main effect of time, ps $< .05$).[1] Most important, vaccinated respondents reduced their protective behaviors after vaccination to a greater extent than those not vaccinated for two of five behaviors studied (as shown by significant interactions of group with time, $p < .10$, for use of tick repellent and $p < .05$ for wearing light-colored clothing). However, the frequency of these two behaviors did not dip below that among the unvaccinated respondents at follow-up. There was no significant change in the other three behaviors related to vaccination. The findings partially support the second prediction of the risk compensation hypothesis and are consistent with regression but not disinhibition.

We also examined the role of changes in risk perception, although we acknowledge that our having measured risk perception, vaccination, and other behaviors at the same time limits the interpretability of these analyses. Because engaging in other protective behaviors should eliminate any vaccination-related drop in risk perception, our design allows us to make meaningful inferences only about the relation between change in risk perception and changes in other behaviors unaffected by prior vaccination. Analyses found people with larger changes in risk perception had larger drops in other behaviors between baseline and follow-up (as shown by the interactions of change in risk perception and time), but the findings were relatively weak. However, the findings were more apparent for the three behaviors depicted on the right of Figure 1 that did not show vaccination-related reductions (one $p < .05$, two

[1]Given the sample size, the study is powered to detect effect sizes of Cohen's $d \geq .14$.

TABLE 1
Hypotheses About Risk Perception and Behavior

Hypothesis	*Predictions*	*Evidence*
Behavior motivation	People with higher risk perception will be more likely to get vaccinated.	Clear support[a] (present study)
Risk compensation	1. People who get vaccinated will experience a drop in perceived risk (that is larger than unvaccinated persons).	Clear support (present study)
	2. People who get vaccinated will later engage in fewer other protective behaviors.	Partial support (present study)
	3. People who get vaccinated and experience greater drops in risk perception will engage in fewer other protective behaviors.	Weak support, but study design not well suited for testing this prediction (present study)
	4. People who engage in fewer other protective behaviors will report an increase in risk perception.	Clear support (present study)
	5. People who get vaccinated (and thus experience a drop in perceived risk) and engage in fewer other protective behaviors as a result (and thus experience an increase in risk perception) will show the little or no change in risk perception pre- and post-vaccination.	Not supported (present study)

Note. The first prediction of the risk compensation hypothesis is equivalent to the risk reappraisal hypothesis described previously by Brewer, Weinstein, Cuite, and Herrington (12). Prediction 2 could support regression or disinhibition depending on the pattern of findings.
[a] Brewer, Weinstein, Cuite, and Herrington (12) and Brewer, Chapman, Gibbons, et al. (18).

ps $< .10$) and less for the other two on the left of the figure ($p < .10$ for the behavior that had a marginally significant vaccination-related reduction). The three-way interaction was not significant for any behavior, but the small number of vaccinated persons may make this last finding inconclusive because of inadequate power. Overall, we found weak support for the third risk compensation prediction.

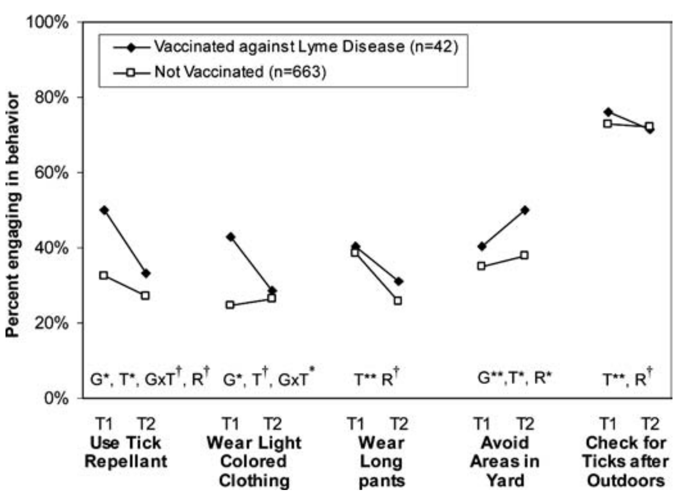

FIGURE 1 The effect of vaccination on other health behaviors. The interaction of vaccination and time (for using tick repellant and wearing light-colored clothing) indicates a reduction in these behaviors postvaccination, but vaccinated respondents remained at least as likely as unvaccinated persons to engage in these two protective behaviors. Letters above the x-axis indicate statistically significant effects. G = main effect of vaccination group; T = main effect of time; G × T = interaction of vaccination group and time (i.e., the effect of vaccination on behavior); R = interaction of time and change in risk perception. $^{\dagger}p \leq .10$. $^{*}p \leq .05$. $^{**}p < .001$.

Additional analyses examined whether reducing other behaviors mitigated the reduction in risk perception caused by vaccination. Indeed, we found that those who reported engaging in fewer protective measures overall at follow-up than at baseline experienced a smaller decrease in risk perception (standardized regression coefficient $= -.10$, $p < .05$), supporting the fourth risk compensation prediction. However, the reduction in these behaviors did not interact with having been vaccinated ($t = .85$, $p = .40$), suggesting that those who were vaccinated and reduced their other behaviors did not experience different changes of risk perception than those who were not vaccinated. This final analysis fails to support the fifth risk compensation prediction.

DISCUSSION

Although we will not know for several years what effect HPV vaccination has on other behaviors, if any, data on other vaccinations can offer critically important information in the interim. We found some support for the risk compensation hypothesis in the case of Lyme disease vaccination, although it did not affect the majority of other behaviors. The frequency of the two behaviors that showed the predicted effect remained above the nonvaccinated group, suggesting regression to the risk profile of the unvaccinated cohort but not disinhibition as we define it. We acknowledge the possibility that, had we extended the time period of our study, the falling rates for several protective behaviors among the vaccinated cohort may have continued, but this is not shown in the data we report.

The many conditions that allow risk compensation to occur as a result of getting the Lyme disease vaccination are unlikely to exist for HPV vaccination. First, young women would have to perceive themselves at risk for cervical cancer, perhaps a reasonable hypothesis given the widespread fear of cancer. Second, they would have to connect sex and HPV and cervical cancer in their minds, beliefs that do not exist for most adult women (13). Third, the adolescent girls would have to exhibit the usual relationship between perceived risk and behavior, a link that many researchers are skeptical of for this specific age group (14). Even allowing this, perceived risk is not the main driver of adolescent risk behavior, with perceived benefits and peer norms playing much more prominent roles (15). Finally, they would have to believe that the vaccine *reduces* their risk for cervical cancer because it blocks a sexually transmitted virus, a belief that has not been examined empirically among adolescents. All of these steps hold for analogous constructs relevant to Lyme disease (i.e., perceiving a risk for infection, believing that behavior leads to infection and disease, risk perception affecting risk behaviors, and believing that the vaccine is effective). Such links are unlikely to be supported by future research on HPV vaccination, and even then, whether one would find support for disinhibition or regression is unclear.

Although Lyme disease and HPV vaccination share several qualities, there are also dissimilarities. Lyme disease, although of concern to many people, is not fatal, and it does not elicit the level of fear that cancer does. Unprotected sex that can lead to HPV acquisition may be meaningfully different than the habitual or relatively deliberate Lyme disease precautions that we examined, although sexual debut is often accompanied by great deliberation, and condom use requires at least some deliberate advance planning. Vector-borne diseases such as Lyme disease exist in a different social context than sexually transmitted infections, with the latter eliciting complex reactions of shame and moral distaste. The participants in our study may be quite different from the young adult women and parents of adolescent girls who are presently the primary decision makers about HPV vaccination.

However, several similarities cause us to think that the findings we report can contribute to the current debate over HPV vaccination. Both diseases are caused by exposures that are typically volitional. More important, the Lyme disease vaccine is about 80% effective in preventing infection (16), and HPV vaccination may prevent only 70% of cervical cancers because it does not protect against many oncogenic HPV types (2,17). The imperfect effectiveness raises the concern that people who are vaccinated may misunderstand the extent to which they are protected.

A reasonable concern about the risk perception analyses we report is that changes in other behaviors should again increase perceived risk, thereby offsetting the reductions caused by vaccination. This criticism calls for other more intensive research designs that can better track changes in risk perception between the changes in various behaviors. It also highlights the many problems with existing tests of the risk compensation hypothesis: Most such studies rely on trend data that cannot address the within-subjects changes that the risk compensation hypothesis argues for and that we examine, however imperfectly, in our study.

Several aspects of our study have the potential to affect its generalizability. Relatively few people were vaccinated, making this a study of truly early adopters who may differ from those who make decisions once a vaccine has been in mainstream use for several years. Because our sample was selected at random from areas with high prevalence rates of Lyme disease, studies in locations with lower incidence of the disease could yield different results. Although the sample was representative of homeowners in the areas we studied, it overrepresented White and well-educated participants relative to the entire population. Our longitudinal findings do not eliminate rival explanations to the extent that an experiment in which people were randomly assigned to receive the vaccine would. In addition, research is needed that examines whether experimentally manipulated risk perception can affect vaccination, given that no studies that we are aware of have addressed this question (18).

In sum, we found some empirical support for the claim that vaccination would reduce other protective behaviors. However, we do not find persuasive the theoretical arguments necessary to support sexual disinhibition caused by HPV vaccination. It is far more plausible, for example, that routine cervical cancer screening (i.e., Pap testing) will show disinhibition, because many women correctly understand the link between such screening and cervical cancer. This and similar questions about the effect of vaccination on other behaviors should be addressed empirically by future research.

REFERENCES

(1) FDA: *FDA Licenses New Vaccine for Prevention of Cervical Cancer and Other Diseases in Females Caused by Human Papillomavirus*. Retrieved August 1, 2006 from http://www.fda.gov/bbs/topics/NEWS/2006/NEW01385.html

(2) Koutsky LA, Ault KA, Wheeler CM, et al.: A controlled trial of a human papillomavirus type 16 vaccine. *New England Journal of Medicine*. 2002, *347*:1645–1651.

(3) International Agency for Research on Cancer: *IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. Human Papillomaviruses*. Lyon, France: IARC Science Publications, 2006.

(4) Pollitt K: Virginity or death! *The Nation*. 2006, May 30. Retrieved February 2007 from http://www.thenation.com/doc/20050530/pollitt

(5) Wilde GJS: *Target Risk*. Toronto, Canada: PDE Publishing, 1984.

(6) O'Neill B, Williams A: Risk homeostais: A rebuttal. *Injury Prevention*. 1998, *4*:92–93.

(7) Evans WN, Graham JD: Risk reduction or risk compensation: The case of mandatory safety-belt use laws. *Journal of Risk and Uncertainty*. 1991, *4*:61–73.

(8) Lund AK, Zador P: Mandatory belt use and driver risk-taking. *Risk Analysis*. 1984, *4*:41–53.

(9) National Institutes of Health: NIH Consensus Statement. *Interventions to Prevent HIV Risk Behaviors*. 1997, *15(2)*:1–41.

(10) Wilson TE, Gore ME, Greenblatt R, et al.: Changes in sexual behavior among HIV-infected women after initiation of HAART. *American Journal of Public Health*. 2004, *94*:1141–1146.

(11) DiLillo D, Tremblay G: Maternal and child reports of behavioral compensation in response to safety equipment usage. *Journal of Pediatric Psychology*. 2001, *26*:175–184.

(12) Brewer NT, Weinstein ND, Cuite CL, Herrington J: Risk perceptions and their relation to risk behavior. *Annals of Behavioral Medicine*. 2004, *27*:125–130.

(13) Brewer NT, Fazekas KI: Predictors of HPV vaccine acceptability: A theory-informed systematic review. *Preventive Medicine* (in press).

(14) Reyna VF, Farley F: Risk and rationality in adolescent decision making-Implications for theory, practice, and public policy. *Psychological Science*. 2006, *7(1)*:1–44.

(15) Turbin MS, Jessor R, Costa FM, et al.: Protective and risk factors in health-enhancing behavior among adolescents in China and the United States: Does social context matter? *Health Psychology*. 2006, *25*:445–454.

(16) Steere AC, Sikand VK, Meurice F, et al.: Vaccination against Lyme disease with recombinant Borrelia burgdorferi outer-surface lipoprotein A with adjuvant. *New England Journal of Medicine*. 1998, *339*:209–215.

(17) Harper DM, Franco EL, Wheeler C, et al.: Efficacy of a bivalent L1 virus-like particle vaccine in prevention of infection with human papillomavirus types 16 and 18 in young women: A randomised controlled trial. *Lancet*. 2004, *364*:1757–1765.

(18) Brewer NT, Chapman GB, Gibbons FX, et al.: A meta-analysis of the relationship between risk perception and health behavior: The example of vaccination. *Health Psychology*. 2007, *26*:136–145.