Rotavirus Vaccine and Intussusception: How Much Risk Will Parents in the United States Accept to Obtain Vaccine Benefits?

Stephanie L. Sansom,1,2 Lawrence Barker,2 Phaedra S. Corso,3 Cedric Brown,2 and Robert Deuson2

Postlicensure surveillance of a newly licensed rotavirus vaccine suggested an increased risk of intussusception. Little was known about the amount of risk parents would tolerate to obtain the vaccine’s benefits or the extent to which risk would reduce the price parents would pay for the vaccine. Parents of infants aged 12 months or younger were asked to accept or reject two hypothetical vaccines associated with varying degrees of risk. Parents chose from a list the amount they would pay for two additional hypothetical vaccines, with and without a risk of intussusception. The authors conducted face-to-face surveys in September 1999 among a convenience sample of parents in three US cities. Of 405 eligible parents, 260 (64%) participated. To achieve a 90% acceptance rate, the vaccine could be associated with no more than 1,794 (95% confidence interval: 1,551, 2,025) cases of intussusception in a fully vaccinated, national cohort of infants. The median willingness to pay for three vaccine doses, when vaccination was associated with 1,400 cases of intussusception, was $36 (95% confidence interval: $28, $46) compared with $110 (95% confidence interval: $96, $126) for the risk-free vaccine. The most important aspect of this study may be the methodology to assess how parents balance the benefits and risks of childhood vaccines. Am J Epidemiol 2001;154:1077–85.

intussusception; parents; risk; rotavirus; vaccines

The widespread use of vaccines to prevent childhood infectious diseases has been hailed as one of the top public health achievements of the 20th century (1). After vaccines against smallpox, diphtheria, pertussis, poliomyelitis, measles, mumps, rubella, and Haemophilus influenzae type b were universally recommended for children in the United States, morbidity from those diseases declined dramatically (1). As the proportion of the population protected from previously common childhood disease has increased, however, concern has shifted to possible vaccine-associated side effects (2).

Despite the obvious benefits of vaccination, no vaccine is completely safe. The impact of risk on parental acceptance of new vaccines is important to ascertain. Knowledge of the extent of risk that parents are willing to assume to obtain a vaccine’s benefits is key to developing vaccine recommendations, predicting future coverage levels, and pinpointing areas where more education about vaccines is needed. An opportunity to learn how much risk from a newly licensed childhood vaccine parents will accept recently arose.

The vaccine RotaShield (Wyeth, American Home Products, Madison, New Jersey) was licensed in August 1998 to prevent rotavirus gastroenteritis, the most common cause of severe diarrhea in infants and young children in the United States. The Centers for Disease Control and Prevention’s Advisory Committee on Immunization Practices recommended the three-dose, oral vaccine for infants (3, 4). Soon after vaccination, surveillance indicated a higher-than-expected rate of intussusception, a type of bowel obstruction in which one segment of bowel becomes enfolded within another. A baseline rate of intussusception, prior to RotaShield’s licensure, was estimated at approximately 5 per 10,000 infant-years (5). While epidemiologic studies were being conducted to evaluate the existence and magnitude of the potential association (6, 7), we initiated this study to learn how great a risk of intussusception parents would accept to protect their children against rotavirus diarrhea. We also investigated parents’ willingness to pay for hypothetical rotavirus vaccines, with and without a risk of intussusception, to quantify the value parents placed on the vaccine’s benefits.

MATERIALS AND METHODS

We used a cross-sectional convenience sample to conduct a survey of English-speaking parents or guardians of children aged 12 months or younger in Knoxville, Tennessee; Columbus, Ohio; and Denver, Colorado. We chose cities from the Southeast, Midwest, and West for geographic representativeness. We conducted the survey at day-care centers, pediatric clinics, public health departments, retail
stores, and shopping malls in an effort to interview parents from a variety of socioeconomic groups. The study took place from September 12 through September 24, 1999. Prior to conducting the survey, we obtained approval from the Centers for Disease Control and Prevention’s Institutional Review Board. Each participant received a consent form and gave verbal consent. To provide parents with sufficient background, we gave each a one-page fact sheet describing rotavirus, rotavirus vaccine, and intussusception to read before the interview began. Parents also were given tables of the average length-of-stay and hospitalization costs associated with rotavirus diarrhea and intussusception and of the expected morbidity and mortality associated with rotavirus diarrhea and intussusception, with and without vaccination (8–14). During 15-minute face-to-face interviews, we collected demographic information on participants and their households, as well as answers to our structured interview on risk acceptance and willingness to pay. Before we fielded the survey, it was reviewed by experts in survey design and pretested on several parents of infants to determine if they understood each question’s content. Revisions were made to the survey and to the background materials based on parents’ feedback. (Survey available at http://www.aje.oupjournals.org).

Risk acceptance questions

Because we had no prior knowledge of risk acceptance or of the magnitude of association between RotaShield and intussusception, we queried parents about a broad range of risk: from 490 to 5,900 cases of vaccine-related intussusception annually in a fully vaccinated cohort of US infants, above an estimated baseline incidence of intussusception of 1,950 cases a year. This range translates into a subset of the risk range. During the survey, inter-

| TABLE 1. An example of benefits and risks of hypothetical rotavirus vaccines used to measure parental risk acceptance in a 1999 survey of parents of infants and expectant parents in three US cities |
|-----------------|-----------------|-----------------|-----------------|-----------------|
|                  | Without vaccine | With risk-free  | With risky vaccine |                  |
|                  |                 | vaccine         | Vaccine A         | Vaccine B        | Vaccine C       |
| Diarrhea         | 2,700,000       | 1,400,000       | 1,400,000         | 1,400,000        | 1,400,000       |
| Blocked bowel    |                 |                 | 2,300             | 2,800            | 490             |
| Hospital stay    | 50,000          | 7,500           | 9,800             | 10,300           | 7,990           |
| Surgery          |                 |                 | 470               | 570              | 100             |
| Death            | 20              | 3               | 17                | 20               | 6               |

Am J Epidemiol Vol. 154, No. 11, 2001
two given risks. For parents who rejected both given risks, the true acceptable risk was assumed to lie between the smaller of the two risks and zero. For parents who accepted both given risks, their true acceptable risk was assumed to lie between the larger of the two risks and infinity.

Willingness-to-pay questions

In contrast to the risk acceptance questions, for which we randomized parents into three groups and queried each group about a different set of risks, we asked all parents the same willingness-to-pay questions. We first described a vaccine with a hypothetical risk of 2,800 cases of vaccine-related intussusception a year among a fully vaccinated cohort of infants. Interviewers told parents that this “vaccine 1” was available for free. The interviewers then described “vaccine 2,” an improved vaccine with the same benefits of “vaccine 1” and half its risk of intussusception (1,400 cases of intussusception among a fully vaccinated cohort of infants). Because the willingness-to-pay questions followed the risk acceptance questions on the survey, we chose a risk level of 1,400 cases to avoid asking parents to state the price they would pay for a vaccine associated with a degree of risk they might have rejected in a previous question. The interviewers asked parents to choose from a list of prices the amount they would be willing to pay for all three doses of “vaccine 2.” Parents were asked to consider their household income when selecting an amount and to assume that insurance would not cover vaccine costs. Last, interviewers presented the parents with “vaccine 3,” a hypothetical rotavirus vaccine with the same efficacy as “vaccine 1” and “vaccine 2” but no risk of intussusception. Interviewers asked parents to select the amount they would pay for “vaccine 3.”

For both willingness-to-pay questions, parents chose from a list of prices ranging, in $50 increments, from “$0” to “$300.” The range was constructed to include typical vaccine prices in the private market, that is, from $25 to $75 a dose, including administration fees. We used a list, rather than asking parents to accept or reject a particular price, to simplify the elicitation process (17). Because the price that parents indicated may have only approximated the actual amount they would be willing to pay, we assumed that, for each response, the amount specified on the list identified a range bounding maximum willingness to pay. To illustrate, if a parent selected $100 as a response category, willingness to pay was inferred to fall on the interval between $75 and $125. Willingness to pay was inferred to fall on the interval between $0 and $25 for parents who selected $0 as a response category. Some parents indicated unspecified values in excess of $300. For those parents, willingness to pay was inferred to fall on the interval between $300 and infinity. Some parents chose to specify values not on the list (e.g., $15). For those parents, the price they were willing to pay was inferred to fall between one dollar less and one dollar more than the specified amount.

Analytical techniques

The “accept-reject” format of our risk acceptance survey is called dichotomous choice with follow-up, and it is used to establish a range, or interval, of acceptable risk (18, 19). We estimated the acceptable number of cases of intussusception, with and without demographic factors as covariates, by analyzing the data as a simple random sample and by using a maximum likelihood interval-censored model (PROC LIFEREG, SAS version 6.12; SAS Institute, Inc., Cary, North Carolina). Because we assumed that willingness-to-pay responses represented a range of true maximum willingness to pay for vaccine, we used an interval model to estimate the median and mean willingness to pay. Normal, logistic, log-normal, log-logistic, and Weibull models were considered. The normal distribution fit the risk acceptance data best, and the Weibull distribution best fit the willingness-to-pay data.

In both the risk acceptance and willingness-to-pay analyses, we discarded factors if no levels within the factors (i.e., different categories of age) were associated with a p value of 0.20 or smaller in bivariate analysis. We retained all other factors. We chose this relatively large threshold for factor retention (p value of ≤ 0.20) to increase the chance of retaining factors with real, but weak, impacts on risk and price acceptability. Within factors we combined adjacent levels for which estimates were almost identical to promote model simplicity; for example, we partitioned education more finely for the cost model than for the risk acceptance model. We did not consider interactions because of the small sample size and the large number of potential interactions.

RESULTS

Of the 405 parents determined eligible for the survey, 260 (64 percent) agreed to participate. Participation rates varied by city: 89 percent in Columbus, 38 percent in Denver, and 72 percent in Knoxville. Of all the persons who agreed to participate, 20 completed neither the risk acceptance nor willingness-to-pay portions of the survey and were excluded from analysis. We additionally excluded willingness-to-pay responses from 15 participants who indicated willingness to pay a positive amount of money for “vaccine 2,” associated with 1,400 cases of intussusception, after having rejected a vaccine with a risk of 490 cases in the risk acceptance question. A number of other participants answered some, but not all, of the risk acceptance or willingness-to-pay questions. A total of 221 responses to the risk acceptance questions were analyzed, as were 188 responses to the question about willingness to pay for the riskier “vaccine 2” and 213 responses to willingness to pay for the risk-free “vaccine 3.”

Participant demographics

Among participants, 93 percent were female, 7 percent were male, and all identified themselves as parents, not guardians. Although we did not conduct a random sample, we compared the females in our sample with characteristics of US females of child-bearing years (20–22). Females in our sample were similar to the US population of females of child-bearing years in terms of race, Hispanic ethnicity, education, and marital status. The participants tended to be younger than US females of child-bearing age (45 percent were 24 years or younger compared with 31 percent of the
US population). They had a lower annual household income than did the US population (52 percent had incomes lower than $30,000 compared with 29 percent of the US population; 12 percent had incomes greater than $60,000 compared with 37 percent of the US population).

### Risk acceptance

To be acceptable to 50 percent of our sample, we found that the vaccine could be associated with no more than 2,897 cases of intussusception among a fully vaccinated cohort of infants in univariate analysis (table 2). To be acceptable to 90 percent of our sample, the vaccine could be associated with no more than 1,794 cases of vaccine-associated intussusception. The vaccine acceptable to 50 percent of sampled parents was associated with 579 surgeries and 17 additional deaths. The vaccine acceptable to 90 percent of sampled parents was associated with 359 surgeries and 11 additional deaths.

Variables that did not correlate with risk acceptance at the 0.20 level in bivariate analysis and that were excluded from the multivariate model were use of day care, being Hispanic or Black, presence of at least one other child in the household under the age of 5 years, and parent’s gender and marital status. In the multivariate model (table 3), factors significant at the \( p \leq 0.05 \) level included age, education, and income. The data indicated an inverse relation between annual household income and risk acceptance. Parents with annual household incomes from $45,000 to $60,000 accepted 575 fewer cases of intussusception than did the reference group (annual household income from $15,000 to $30,000), and parents with incomes greater than $60,000 accepted 748 fewer cases. For the factors age and education, the trends were unclear. For example, parents younger than 20 years and parents aged 25–29 years indicated less risk acceptance than did the parents aged 20–24 years. Parents with a high school diploma or less education and parents with a college degree or more education indicated greater risk acceptance than did parents with some college.

### Willingness to pay

We estimated that the median, mean, and modal willingness to pay for three doses of a rotavirus vaccine with no risk of intussusception was $110, $145, and $42, respectively. The median, mean, and modal willingness to pay for a vaccine associated with a risk of 1,400 cases of intussusception a year was $36, $77, and $0, respectively.

### TABLE 2. Univariate analysis of vaccine-related benefits and risks acceptable to 50% and 90% of parents surveyed in three US cities (\( n = 221 \), 1999)

<table>
<thead>
<tr>
<th>Incidence among US infants by age 5 years (no.)</th>
<th>Without vaccine</th>
<th>With risk-free vaccine</th>
<th>With risky vaccine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2,700,000</td>
<td>1,400,000</td>
<td>1,400,000</td>
</tr>
<tr>
<td>Diarrhea</td>
<td></td>
<td></td>
<td>1,400,000</td>
</tr>
<tr>
<td>Blocked bowel</td>
<td>2,897</td>
<td>2,777, 3,016</td>
<td>1,794</td>
</tr>
<tr>
<td>Hospital stay</td>
<td>50,000</td>
<td>7,500</td>
<td>10,397</td>
</tr>
<tr>
<td>Surgery</td>
<td>579</td>
<td>359</td>
<td>9,292</td>
</tr>
<tr>
<td>Death</td>
<td>20</td>
<td>3</td>
<td>20</td>
</tr>
</tbody>
</table>

* CI, confidence interval.

### TABLE 3. Multivariate analysis of acceptable number of cases of intussusception to 50% of parents surveyed in three US cities (\( n = 221 \), 1999)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>95% CI*</th>
<th>( p ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept†</td>
<td>3,144</td>
<td>2,822, 3,465</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;20</td>
<td>–483</td>
<td>–665, –102</td>
<td>0.01</td>
</tr>
<tr>
<td>20–24</td>
<td>Reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25–29</td>
<td>–344</td>
<td>–668, –20</td>
<td>0.03</td>
</tr>
<tr>
<td>30–34</td>
<td>–304</td>
<td>–693, 85</td>
<td>0.13</td>
</tr>
<tr>
<td>≥35</td>
<td>–318</td>
<td>–699, –64</td>
<td>0.10</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school diploma or less</td>
<td>319</td>
<td>33, 605</td>
<td>0.03</td>
</tr>
<tr>
<td>Some college</td>
<td>Reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Completed at least a bachelor’s degree</td>
<td>367</td>
<td>3, 732</td>
<td>0.05</td>
</tr>
<tr>
<td>Decline</td>
<td>73</td>
<td>–1,161, 1,263</td>
<td>0.90</td>
</tr>
<tr>
<td>Income ($)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;15,000</td>
<td>–258</td>
<td>–580, 63</td>
<td>0.12</td>
</tr>
<tr>
<td>15,000–30,000</td>
<td>Reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30,001–45,000</td>
<td>–104</td>
<td>–491, 282</td>
<td>0.59</td>
</tr>
<tr>
<td>45,001–60,000</td>
<td>–575</td>
<td>–1,048, –101</td>
<td>0.02</td>
</tr>
<tr>
<td>&gt;60,000</td>
<td>–748</td>
<td>–1,196, –299</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Decline</td>
<td>–198</td>
<td>–560, 164</td>
<td>0.28</td>
</tr>
<tr>
<td>City</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Columbus, Ohio</td>
<td>–127</td>
<td>–389, 135</td>
<td>0.34</td>
</tr>
<tr>
<td>Denver, Colorado</td>
<td>264</td>
<td>–53, 580</td>
<td>0.10</td>
</tr>
<tr>
<td>Knoxville, Tennessee</td>
<td>Reference</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* CI, confidence interval.

† The intercept is the median risk acceptable to the reference class, that is, persons who are 20–24 years, with some college education but no bachelor’s degree, a household income of $15,000–$30,000, and living in Knoxville. To determine the median risk acceptable for persons whose characteristics vary from those in the reference class, coefficients are added. For example, the median number of cases acceptable to someone younger than 20, but otherwise like the reference class, would be 3,144 – 483 = 2,661.
Characteristics of the risk-free and risky vaccines are shown in table 4.

In the case of both vaccines, the modal willingness to pay is smaller than the median, which is smaller than the mean. This is explained by the distribution of acceptable prices, which is right-skewed and concentrated near the lower end (figures 1 and 2). Of the 188 parents who responded to the question about the vaccine associated with 1,400 cases of intussusception, 80 (43 percent) reported a willingness to pay of zero, and two (1 percent) reported a willingness to pay of more than $300. Of the 214 parents who responded to the question about the vaccine associated with 1,400 cases of intussusception, 80 (43 percent) reported a willingness to pay of zero, and two (1 percent) reported a willingness to pay of more than $300.

Variables not associated with willingness to pay at the 0.20 level and excluded from the multivariate models were use of day care, being Hispanic or Black, presence of at least one other child in the household under the age of 5 years, and the parent’s gender and marital status. In the model (table 5), factors significant at the \( p \leq 0.05 \) level included age, education, income, and city. Regarding the risk-free vaccine, parents with household incomes greater than $45,000 were willing to pay significantly more than those in the reference group (household incomes from $15,000 to $30,000). Parents with less than a high school education were willing to pay significantly more than those in the reference group, and parents older than 35 years were willing to pay significantly less than those in the reference group. Less variation was seen in the amount parents were willing to pay for the risky vaccine, although parents with less than a high school education again were willing to pay significantly more than the reference group.

**DISCUSSION**

This study provides a methodology for assessing the extent to which parents will accept risk from a new vaccine. Its results suggest that, when presented with a comparison of a rotavirus vaccine’s risks and benefits, parents are willing to accept limited risk to receive the vaccine’s protection. Parents also reported a willingness to pay for a rotavirus vaccine with a small risk of intussusception, although the...

---

TABLE 4. Morbidity and mortality associated with two hypothetical rotavirus vaccines, one with no risk of intussusception and one with a risk of intussusception, in three US cities, 1999

<table>
<thead>
<tr>
<th>Incidence among US infants by age 5 years (no.)</th>
<th>Without vaccine</th>
<th>Risk-free vaccine (&quot;vaccine 3&quot;)</th>
<th>Risky vaccine (&quot;vaccine 2&quot;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diarrhea</td>
<td>2,700,000</td>
<td>1,400,000</td>
<td>1,400,000</td>
</tr>
<tr>
<td>Blocked bowel</td>
<td>50,000</td>
<td>1,400</td>
<td>7,500</td>
</tr>
<tr>
<td>Hospital stay</td>
<td>20</td>
<td>3</td>
<td>285</td>
</tr>
<tr>
<td>Surgery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* The median willingness-to-pay sums were $110 (95% confidence interval: $96, $125; \( n = 214 \)) and $36 (95% confidence interval: $28, $46; \( n = 188 \)) for risk-free vaccine and risky vaccine, respectively.

---

**FIGURE 1.** Distribution of willingness-to-pay responses for a vaccine association with no cases of intussusception among a survey of parents (\( n = 214 \)) in three US cities, 1999. Dollar amounts are provided as intervals to include responses other than those listed on the payment card.
amount was substantially less than what they indicated they would pay for a risk-free vaccine.

To achieve a 90 percent acceptance rate (a typical target for recommended childhood vaccines), we found that parents would accept no more than 1,794 cases of vaccine-related intussusception a year in a national cohort of infants. This incidence corresponds to 359 surgeries and 14 deaths, 11 of which could be vaccine associated. Fourteen deaths are about a third of the estimated 20 deaths that would occur from rotavirus gastroenteritis if no infants were vaccinated. Other studies of parental attitudes toward vaccination have demonstrated a tendency toward errors of omission rather than commission, that is, a preference for disease-related morbidity and mortality over that associated with vaccination (23–25). Our findings are consistent with these studies.

A case-control study that examined the association between RotaShield and intussusception and was published after our study was conducted estimated that, among a fully vaccinated cohort of 3.9 million US infants, 425–835 cases of vaccine-attributable intussusception would occur (6). Based on our findings, this risk of intussusception would have been acceptable to the majority of parents in exchange for the vaccine’s benefits. Because the Advisory Committee on Immunization Practices suspended and then withdrew recommendations for the use of the vaccine before the magnitude of its association with intussusception was established, it is not possible to determine the real impact the established risk would have had on coverage rates.

Parents in our study indicated that they would pay, at the median, $110 for three doses of a risk-free rotavirus vaccine or $36.67 a dose (while on the market, the vaccine’s price was $38 a dose (26)). The “risky” vaccine, associated with 1,400 cases a year of intussusception, approximates the amount of vaccine-associated intussusception acceptable to 90 percent of our sample. The median price that parents indicated they were willing to pay was $36 for three doses, or $12 a dose, about one third of the amount that they indicated they would spend on the risk-free vaccine. These findings illustrate that, although parents indicate some acceptance of a risky vaccine, they may assign it limited monetary value, possibly even lower than the cost of producing and distributing the vaccine. Parents’ individual monetary values can be summed to obtain an estimate of the vaccine’s societal benefit, as expressed in dollars, and compared with the vaccine’s costs. This parental, or consumer, perspective on costs and benefits can serve as an additional tool for vaccine policymakers, supplementing the public health approach of weighing morbidity and mortality in a population, with and without vaccination.

Among demographic covariates including age, education, household income, and city, income had the most clearly interpretable association with risk acceptance and willingness to pay. For risk acceptance, higher incomes were associated with significantly reduced acceptance compared with the reference group: 18 percent fewer intussusception cases for those with household incomes from $45,000 to $60,000, and 24 percent fewer cases for those with incomes greater than $60,000. Parents from higher-income households might be more easily able to miss work to care for a sick child, to arrange for other care providers, or to have better health insurance for their child. All these reasons could place parents from higher-income households in a better
position than those from low-income households to assume the greater, but less serious, risk that their unvaccinated child will become ill from rotavirus gastroenteritis.

Parents from households with incomes from $45,000 to $60,000 indicated a willingness to pay more for both the risk-free and the riskier vaccine than did parents in the reference group with household incomes from $15,000 to $30,000. The positive association between household income and willingness to pay reflects findings from other studies (27, 28).

Although we tried to accurately describe the risk and consequences of rotavirus gastroenteritis and intussusception, a different portrayal may have generated different results. For instance, the case-control analysis by Murphy et al. (6) of the association between RotaShield vaccination and intussusception, published after this study was conducted, reported an adjusted odds ratio of 21.7 of an infant’s having received a first dose of rotavirus vaccine within 3–7 days of experiencing intussusception compared with matched controls who had not received rotavirus vaccine during the referent exposure period. We chose to present the hypothetical risk of intussusception as the incidence attributable to vaccination instead of as an odds ratio for greater ease of comprehension. Similarly, we avoided comparing the probability of a single infant’s experiencing intussusception, with and without vaccination, because the probabilities are small and research suggests that small probabilities are difficult to interpret (29). Lacking data concerning the temporal association between vaccination and intussusception, we presented hypothetical annual vaccine-associated incidence. However, presentation of recently available data indicating a large increase in the risk of intussusception during the several days after vaccination, as well as higher surgery rates among infants with vaccine-related intussusception, may

### TABLE 5. Multivariate analysis of willingness to pay for retrovirus vaccines not associated ($n = 214$) and associated ($n = 188$) with a risk of intussusception among parents surveyed in three US cities, 1999

<table>
<thead>
<tr>
<th>Variable</th>
<th>Risk-free vaccine (<em>vaccine 3,</em> $n = 214$)</th>
<th>Risky vaccine (<em>vaccine 2,</em> $n = 188$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>95% CI</td>
</tr>
<tr>
<td>Intercept†</td>
<td></td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;20</td>
<td>1.18</td>
<td>0.78, 1.78</td>
</tr>
<tr>
<td>20–24 Reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25–29</td>
<td>0.98</td>
<td>0.71, 1.36</td>
</tr>
<tr>
<td>30–34</td>
<td>0.75</td>
<td>0.50, 1.11</td>
</tr>
<tr>
<td>≥35</td>
<td>0.65</td>
<td>0.44, 0.96</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No high school diploma</td>
<td>1.47</td>
<td>1.02, 2.11</td>
</tr>
<tr>
<td>High school diploma</td>
<td>0.92</td>
<td>0.67, 1.25</td>
</tr>
<tr>
<td>Some college</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>Bachelor’s degree</td>
<td>1.04</td>
<td>0.71, 1.54</td>
</tr>
<tr>
<td>Postgraduate degree</td>
<td>0.77</td>
<td>0.45, 1.29</td>
</tr>
<tr>
<td>Decline</td>
<td>0.55</td>
<td>0.16, 1.84</td>
</tr>
<tr>
<td>Income ($)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;15,000</td>
<td>0.97</td>
<td>0.79, 1.35</td>
</tr>
<tr>
<td>15,000–30,000</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>30,001–45,000</td>
<td>1.45</td>
<td>0.99, 2.13</td>
</tr>
<tr>
<td>45,001–60,000</td>
<td>2.09</td>
<td>1.29, 3.39</td>
</tr>
<tr>
<td>&gt;60,000</td>
<td>1.71</td>
<td>1.09, 2.67</td>
</tr>
<tr>
<td>Decline</td>
<td>0.79</td>
<td>0.53, 1.15</td>
</tr>
<tr>
<td>City</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Columbus, Ohio</td>
<td>0.89</td>
<td>0.64, 1.21</td>
</tr>
<tr>
<td>Denver, Colorado</td>
<td>0.94</td>
<td>0.69, 1.29</td>
</tr>
<tr>
<td>Knoxville, Tennessee</td>
<td>Reference</td>
<td></td>
</tr>
</tbody>
</table>

* CI, confidence interval.
† The intercept represents the median amount of money that members of the reference class are willing to pay: $104 (95% CI: $74, $146) and $29 (95% CI: $17, $51) for risk-free vaccine and risky vaccine, respectively. Persons in the reference class are 20–24 years, with some college education but not a bachelor’s degree, household incomes of $15,000–$30,000 a year, and living in Knoxville. Because this model was estimated as a Weibull distribution, the intercept is multiplied by the coefficients. For example, the median acceptable price for the risk-free vaccine to someone younger than 20 but otherwise like the reference class would be $104 \times (1.18) = $123. The $p$ value is used to test the null hypothesis that the parameter is 1.00.
have reduced parental risk acceptance (6). Future studies should incorporate different strategies for benefit-risk portrayal to determine the generalizability of results.

The use of a convenience sample limited to three US cities also makes our results difficult to generalize to the nation. Although our study participants appear to be representative in several important ways of US women of childbearing years, differences in our sample in parental age, gender, income, and geography prevent broad generalizations. Response rates were lowest in Denver, possibly because of its larger Spanish-speaking population. We have little data on the 36 percent of eligible parents who declined to participate. Adaptation of this methodology for use in a national, random sample would be important. Such a sample should include interviews in languages other than English and capture characteristics of eligible nonparticipants.

This study did not ask parents about outside influences on their decision to accept or reject the hypothetical vaccines. Understanding the role in parental decision making of recommendations from pediatricians and other health care providers, family, friends, or the media would be useful. Personal experience of intussusception or rotavirus gastroenteritis also could influence results. In the willingness-to-pay portion of the survey, 29 participants indicated that they would pay nothing for the risk-free vaccine even though it clearly offered substantial benefits. Future research should explore whether those who indicated unwillingness to pay for a clearly beneficial vaccine truly do not value it, or if they have misinterpreted the question.

Because of the limitations of specific findings, the most important aspect of this study may be the methodology to assess how parents balance the benefits and risks of newly licensed childhood vaccines. In an era when advocacy groups—championing or denouncing vaccination—routinely make headlines, an assessment of the attitudes of a broad spectrum of US parents may be particularly important. Such an assessment can provide decision makers with additional guidance on when to recommend a vaccine and how much, if at all, to subsidize it. Knowledge of parental attitudes can also help to predict future vaccine coverage levels and to target populations and locations where more education about a vaccine’s risks and benefits might be useful.

ACKNOWLEDGMENTS

The Centers for Disease Control and Prevention contracted with the Oak Ridge Institute for Science and Technology (ORISE), Oak Ridge, Tennessee, to help in developing the survey instrument and accompanying graphics and fact sheet, to administer the survey, and to input the responses into a data set.

The authors would like to acknowledge the Institute staff for excellent assistance in this study, in particular, Dr. Betsy Ellis, Dr. Richard Tardif, Peggy Smith, Deborah McFalls, Jeff Richmond, Phil Wallace, Susan Jacques, and a team of interviewers. Additionally, the authors would like to thank the Centers for Disease Control and Prevention’s staff, including Alan Janssen, Dr. Lance Rodewald, Dr. Susan Chu, Mary McCauley, Barry Sirotkin, Dr. Glen Nowak, Dr. Melissa Adams, and Dr. Francisco Averhoff.

REFERENCES


