Time and Risk Preferences and the Use of Asthma Controller Medication

WHAT’S KNOWN ON THIS SUBJECT: College students with asthma tend to have worse health outcomes than their peers without asthma. Consistent use of controller medication could improve outcomes for these students, but a predictive model of appropriate use of controller medication is needed.

WHAT THIS STUDY ADDS: This study adds risk tolerance and time preference to previously studied factors of nonadherence with control medication. These preferences have substantial impacts on use of controller medication and the potential success of asthma education programs.

abstract

OBJECTIVES: We investigated the role of risk tolerance, time preference, and asthma-specific attitudes in adherence to asthma control medications.

METHODS: Students with persistent asthma completed an online survey on asthma beliefs, risk tolerance, and time preference ($n = 47$). The time preference questions measure the degree to which the individual discounts future outcomes and essentially prefers immediate gratification to delayed gratification. The risk tolerance questions indicate the individual’s dislike of uncertainty about outcomes. We analyzed the relationship between the independent and dependent variables.

RESULTS: Feelings of embarrassment and concern about medication, as well as risk tolerance and time preference, were found to be significant predictors of adherence to control medication in the logistic regression. Analysis of probabilities associated with different profiles shows that at high rates of risk tolerance and discounting of future outcomes, the probability of adherence is near 0 regardless of asthma-specific attitudes. Asthma attitudes have a statistically significant effect for individuals with low rates of risk tolerance and time preference.

CONCLUSIONS: The risk tolerance and time preferences of the target group should be considered when designing an asthma-intervention program. Individuals who strongly prefer immediate gratification over future benefits and are willing to tolerate uncertain outcomes are unlikely to adhere to controller medication, regardless of their asthma attitudes. In contrast, efforts to affect relevant attitudes will be most fruitful for individuals with low rates of risk tolerance and time preference. However, as we cannot extrapolate these results to a larger population, we must view them with caution. Pediatrics 2013;131:e1204–e1210

AUTHORS: Sylvia Brandt, PhD, and Brenton Dickinson, MS

“Resource Economics, and Center for Public Policy and Administration, University of Massachusetts Amherst, Amherst, Massachusetts

KEY WORDS

Asthma, health behavior, risk reduction, economic models, economic factors

ABBREVIATION

NAEPP—National Asthma Education and Prevention Program

Dr Brandt conceived of and designed the study and was responsible for survey design and collection of data, and contributed to the interpretation of statistical analysis and drafting of the article; Mr Dickinson was responsible for statistical analysis of data and drafting of the article, and contributed to the interpretation of statistical analysis; and both authors gave final approval of the version to be submitted.

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Address correspondence to Sylvia Brandt, PhD, Resource Economics and Center for Public Policy and Administration, 117 Gordon Hall, University of Massachusetts Amherst, Amherst, MA 01003. E-mail: sylvbrandt@gmail.com

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The use of controller medications is a cornerstone of the National Asthma Education and Prevention Program (NAEPP) guidelines for persistent asthma. Unfortunately, populations with the greatest asthma burden do not make full use of controller medications. A predictive model of appropriate use of controller medication is an important issue for public health, yet has remained elusive.\(^1\)\(^2\)

Analyses of the National Health Interview Survey data demonstrated that transitioning to adulthood is a risk factor for poor asthma control.\(^3\)\(^4\) Although studies of control medication adherence focus on pediatric\(^5\)\(^6\) or adult\(^7\) populations, none have targeted college students aged 18 to 22. This is troubling, because existing literature suggests that college students with asthma tend to have lower quality of life,\(^8\) lower academic achievement,\(^9\) and higher rates of depression and alcohol abuse\(^10\) than their peers without asthma. Furthermore, research shows that the human brain continues to develop through the 20s,\(^11\) with specific changes in the capacities for impulse control and risk taking.\(^12\)\(^13\)\(^14\) making a study targeting preventive behaviors in this age group of interest. Our study is unique in that it adds risk tolerance and time preference to 5 previously studied factors: personality characteristics,\(^15\) negative beliefs about asthma (embarrassment, denial, sense of unfairness),\(^16\) concern over risks of control medications,\(^17\) misunderstanding of the chronic aspect of asthma,\(^18\)\(^19\) and fear that regular use of medication can lead to addiction.\(^20\)

Economists define risk tolerance as the degree to which an individual prefers a certain dollar amount over a gamble between 2 dollar amounts. Consider 2 options: receiving $50, or playing a game in which you have a 50% chance of winning $100 and 50% chance of winning nothing. The expected earnings from either choice are $50. A risk-neutral person will be indifferent to choosing between the 2 options. A risk-averse individual will prefer the certain $50, and a risk-tolerant person will prefer the gamble.

Economists measure an individual’s time preference as the percentage at which he or she devalues future money compared with present dollars. An individual may be faced with the choice between $45 today and $50 in 1 year from now. If he or she has a high time preference, the individual prefers to have $45 today. If he or she has a low time preference, the individual will prefer to wait a year for the $50. If he or she is indifferent to the choice between $45 today and $50 a year from now, the individual time preference is 10% per year.

Economics literature suggests that risk tolerance and time preference can be important factors in health-related behavior. Smoking, drinking, and unhealthy eating habits are positively correlated with risk tolerance and time preference.\(^21\)\(^–\)\(^27\) Proactive health behaviors, such as mammograms, are negatively correlated with the same.\(^28\)\(^29\) As such, the degree to which an individual discounts the future and/or is tolerant of risk may affect asthma management.

Controller medications reduce inflammation of the lungs, but only after 4 to 6 week delay. Thus, controlling asthma symptoms by using corticosteroids is analogous to an investment today (regularly taking the medication) with future benefits (reduction in future symptoms). If a person places sufficient value on avoiding future symptoms (ie, the person’s rate of time preference is low and the person is patient), then the current investment is worthwhile. Thus, we hypothesize that high risk tolerance and time preference are associated with inconsistent use of asthma control medication. The aim of this study was to test that hypothesis using survey data of college students with asthma.

**METHODS**

**Survey Design**

We conducted 2 surveys online with students at a large, public, 4-year institution of higher education. The first survey screened respondents with 5 questions relating to typical college behaviors (eg, car ownership, frequency of exercise). Respondents who completed the screening survey received a gift card with a value of $5. Embedded in the survey was the question, “Have you been diagnosed with asthma?” Participants who answered “yes” were then asked to identify from a list which medications they took. Those who had an asthma diagnosis and an asthma-related prescription were then invited to a longer, asthma-specific survey.

The survey and protocol were approved by the university institutional review board (no. 08-192). The instructor of every class with more than 100 students was e-mailed an explanation of the study and a request that he or she forward an e-mail asking students to participate in the study. Students were assured that their professors would not know if they participated in the study, that all responses were confidential, and that their participation (or non-participation) would not affect their grades. We contacted students through departmental student mailing lists, posters in public areas, and recruitment flyers.

The survey opened with questions on asthma-specific beliefs, behaviors, medication usage, and symptoms. The second section consisted of questions to measure risk tolerance and time preference, and the third contained demographic questions. Participants in the asthma-specific survey received a gift
card of $10 for Amazon.com and, on completing the survey, were entered into a raffle for $250. In addition, they could receive up to $140 depending on chance and on their choices in the risk tolerance and time preference section.

For this analysis, we kept only those survey responses for which the individual was prescribed a control medication or had persistent symptoms that would warrant control medication. The latter group consisted of individuals who met 1 or more of the following criteria: missed work, school, or normal daily activities in the past 4 weeks because of asthma; experienced symptoms once a day or more during the past 4 weeks; woke up at night or earlier than usual because of asthma; had been to urgent care or the emergency department for asthma during the past year; or had unscheduled visits to a doctor or clinic for asthma during the past year (NAEPP criteria 2007).

Outcome Variable

Adherence was measured as the concordance between how often individuals were instructed to take their control medication and how often they actually took it. Where behavior matches prescription, adherence = 1; where it deviates, adherence = 0.

Explanatory Variables

Categorical sociodemographic variables include age (<18, 18–19, 20–21, 22–23, and >23), race/ethnicity (white non-Hispanic, Hispanic/Latino, African American, Asian, other, or decline), gender, year in school, and use (or not) of federal loans to finance school (an indicator of family financial status). Respondents were asked how strongly they agreed or disagreed with the following statements: “People can become addicted to or dependent on asthma medication”; “Having to take asthma medication regularly is embarrassing”; “I have concerns about the medications I take”; and “Having asthma is unfair.” Responses of agree or strongly agree were coded as a 1 whereas disagree or strongly disagree were coded as a 0. Previous research has identified the common misperception that asthma is an acute disease that reoccurs rather than a chronic disease with episodic exacerbations. Thus, we elicited a final attitudinal variable in asking respondents to describe asthma by choosing 1 option from a set of 5 descriptions: an illness that comes and goes; an illness that is present all of the time but has symptoms only sometimes; an illness that is present and has symptoms all the time; an illness that occurs only along with something else, like colds, flu or allergies; or an illness that comes only at a certain time of the year. We define those with a correct understanding of asthma as those who selected the description “an illness that is present all of the time but has symptoms only sometimes.”

The questions about attitudes and belief were taken from the surveys used by Oakland Kicks Asthma, a large-scale, multifaceted intervention that is part of the Controlling Asthma in American Cities Project. Oakland Kicks Asthma was developed by the American Lung Association of the East Bay and researchers at the University of California Berkeley School of Public Health. We chose this source because it was a model program in the Controlling Asthma in American Cities Project.

To elicit the individual’s time preference, we asked respondents to answer a series of questions about whether they would like to be paid X amount of dollars 6 months from now or $50 in 7 months from now. The X starts at $49 and decreases with each of 8 questions. The point at which the respondent prefers the 7-month payment represents a defined range within which lies the individual’s time preference.

Answers were categorized such that those in category 1 chose to be paid more 7 months from now for all 8 questions, whereas those in category 8 chose to be paid less 6 months from now for all 8 questions. A lower category represents a lower time preference.

Risk tolerance was similarly gauged. Respondents were given 10 questions in which to choose between 2 simple gambles. Option A was always the safest, whereas option B was an increasingly attractive but risky gamble. The point at which respondents switch from the safe option to the risky represents a defined range of risk tolerance. Those who chose the safe option all 10 times were placed in category 1, whereas those who universally chose the riskier gamble were placed in category 11. A higher category represents higher risk tolerance. The scales for both risk tolerance and time preference are analogous to a Likert scale. Thus, regression results must be interpreted not in terms of explicit units, but rather in terms of ordinal changes.

Statistical Analysis

We used the bootstrap Kolmogorov-Smirnov test with 1000 random draws to test whether the risk tolerance and time preference distributions differed according to the value of the dependent variable (adherence = 0 or adherence = 1). We then estimated a multivariate logistic regression based on results of Fisher’s Exact Tests for bivariate associations.

RESULTS

Prevalence and Beliefs

Of the 1500 screening survey respondents, 237 indicated they had been diagnosed with asthma (15.8% sample prevalence). Of those, 160 completed the secondary survey (32% nonresponse). A
total of 47 respondents had persistent asthma symptoms and/or took a control medication and completed the asthma-specific survey. Among this final sample, 19% reported having symptoms daily (“poorly controlled” by NAEPP criteria), 28% had symptoms 3 to 6 times per week (“not well controlled” by NAEPP criteria), and 16% reported having no symptoms at all (“well controlled” by NAEPP criteria) (does not sum to 100 because of rounding). Thirteen percent indicated they had woken up earlier than usual in the past month as a result of asthma symptoms; 13% reported having to visit an emergency department within the previous year for asthma symptoms. Finally, 13% reported an unscheduled doctor visit within the previous year as a result of asthma symptoms.

Most respondents were white non-Hispanic (88%, compared with 70% for the university as a whole). Forty-five percent of respondents were male, compared with 50% for the university. Two percent of respondents were freshman, 37% were sophomores, 30% were juniors, and 25% were seniors. The respective percentages for the university are 18%, 19%, 20%, and 25%. Six percent of respondents were graduate students, compared with 18% for the university. Most students (86%) selected more than 1 type of financing for their education: 51% reported scholarships, 32% private loans, and 52% federal loans.

**Asthma Attitudes**

Nearly half (44%) of respondents agreed that people can become addicted to or dependent on asthma medication. About a quarter (26%) felt that having to take asthma medication regularly is embarrassing. One-third (32%) voiced concerns about the medications they take. About half (49%) felt that having asthma is unfair. One-quarter (25%) appeared to fundamentally misunderstand the usage of their control medication. These respondents indicated that they take their control medication “as needed.”

**Risk Tolerance and Time Preferences**

The average risk tolerance and time preference categories were 4.9 and 2.6, respectively (SD = 1.9 for both). Note that whereas the highest possible risk category was 11, the most risk tolerant of respondents fell only into category 9. Category 5 was modal for risk tolerance. Time preference was bimodal (categories 1 and 4).

**Bivariate Association Between Beliefs, Preferences, and Behaviors**

The Kolmogorov-Smirnov tests showed no statistically significant associations between the distributions of risk tolerance and adherence with control medication. However, the distribution of time preferences was found to be different for those who take their control medication properly than for those who do not (P = .01). The distributions are shown in Fig 1.

**Logistic Regression**

We selected the group of independent variables with highest explanatory power in the logistic model. The final model includes 3 attitudinal variables, the federal loan indicator, and the ordinal risk tolerance and time preference category variables. The model has good explanatory power with a log-likelihood ratio test probability near 0 (see Table 1).

Feeling embarrassed about taking medication and having concerns about the medication made a respondent less likely to take his or her control medication properly. The indicator of financial need (financing school with federal loans) was negatively related to proper use of control medication. Feeling that asthma is unfair, being risk averse, and having a low time preference made a respondent more likely to take his or her medication correctly.

**Probabilities of Adherence**

The predicted probability of adherence (the standard formula for computing probabilities from logistic regression coefficients is

\[ P = \frac{1}{1 + e^{-(a + bX)}}. \]

Figure 1 shows the distribution of time preference categories by medication behavior.
where \( \alpha \) is the intercept, \( X \) is a vector of independent variable values of interest, and \( b \) is a vector of estimated coefficients corresponding to \( X \) for the typical respondent was 0.27, which is comparable to the observed proportion of respondents who reported taking control medication as intended (32%). To describe how the probability of adherence varies over the student population, we calculated the probabilities associated with 4 hypothetical respondent profiles (Table 2). We present probabilities of adherence for basic profiles to distill the effects of different variables.

The first profile is of a student with no negative attitudes about his or her asthma, minimal risk tolerance, and low time preference. This individual is likely to adhere to control medication (0.99). The second profile represents someone with the same risk tolerance and time preferences (risk averse and patient), but with negative attitudes about his or her asthma. This individual is less likely to adhere to control medication than the first (0.79 rather than 0.99). The third and fourth profiles represent the same combinations of attitudes, but with high tolerance for risk and high time preference. For these, we assigned the highest values for each measure observed in the sample. These individuals are unlikely to adhere to control medication, regardless of attitude toward asthma (0.0 for each profile).

What is striking in Table 2 is the role that risk tolerance and time preference play, relative to the role of attitude, in determining probability of adherence. Eliminating the negative attitudes toward asthma of an individual with minimal risk tolerance and time preference improves the probability of adherence by 20 percentage points. However, the same change in attitude for individuals with high risk tolerance and time preference does not improve the odds of adherence.

**DISCUSSION**

Results of the regression are largely consistent with our expectations and previous literature. The exception is the “unfair” variable for which there is no obvious compelling explanation for why the sign is positive. Three important implications for the development of effective intervention programs can be derived from this study, insofar as our results can be extrapolated to larger groups.

An asthma education program is more effective if it targets the attitudes of individuals with average or low risk tolerance and time preference. If a health professional could convince a group of 100 asthma sufferers (average in composition except that all are concerned about their medications) that their medications are safe, the number of adhering individuals would increase from 2 to 50. Similarly, finding a way to remove feelings of embarrassment surrounding medication could increase the number of adhering individuals from 12 to 35.

An asthma intervention that addresses only asthma attitudes and education will be ineffective for individuals with high risk tolerance and time preference. For these individuals, a program that provides incentives for adhering to controller medications may improve adherence in the medium run, which may translate to long-run results if the individual realizes the benefit of adherence or makes it a habit. Research on the use of financial incentives to change negative health behavior is somewhat mixed, but such a program may be effective.34,35 Our result that both economic and attitudinal variables are important in determining adherence emphasizes the need for interdisciplinary cooperation between the economics and medical fields.

**Caveats**

This survey was conducted on a convenience sample of college students. To improve participation rates, individuals who completed the surveys were given monetary payments. Although this might create sample selection issues, there is no compelling evidence that such payments change individuals’ willingness to respond to more “risky” surveys.36 Indeed, some researchers have argued that such payments reduce nonresponse bias by improving response rates in typically underrepresented groups, although the research on the relationship between payments and participation in subgroups is not consistent.37 The issue of payment for participation and sample characteristics has not been studied in the young adult population, so we

### TABLE 1 Logit Model Results for Control Medication Behavior as Dependent Variable (1 = Takes Correctly)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>9.73</td>
<td>.02</td>
</tr>
<tr>
<td>Embarrassed</td>
<td>−1.41</td>
<td>.38</td>
</tr>
<tr>
<td>Concerns</td>
<td>−4.03</td>
<td>.04</td>
</tr>
<tr>
<td>Unfair</td>
<td>2.39</td>
<td>.09</td>
</tr>
<tr>
<td>Federal loans</td>
<td>−3.12</td>
<td>.03</td>
</tr>
<tr>
<td>Risk</td>
<td>−1.37</td>
<td>.02</td>
</tr>
<tr>
<td>Time</td>
<td>−0.85</td>
<td>.03</td>
</tr>
</tbody>
</table>

### TABLE 2 Probabilities for Different Combinations of Indicators

<table>
<thead>
<tr>
<th>Variable</th>
<th>Profile 1</th>
<th>Profile 2</th>
<th>Profile 3</th>
<th>Profile 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embarrassed</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Concerns</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Unfair</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Federal loans</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Risk</td>
<td>1</td>
<td>1</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Time</td>
<td>1</td>
<td>1</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Probability</td>
<td>.98</td>
<td>.79</td>
<td>.00</td>
<td>.00</td>
</tr>
</tbody>
</table>
cannot predict how incentives could have affected the composition of our sample. Nevertheless, self-selection bias is an inherent limitation of any such study: those who chose to participate may differ systematically from those who chose not to. Our sample’s sociodemographics were not representative of the university at large. There had been no previous study of the beliefs and symptoms of the young adult population or of this university specifically. Therefore, it is not possible to test whether the sample is representative of the population of students with persistent asthma. Our results do indicate that risk tolerance and time preference significantly affect control medication behavior.

CONCLUSIONS
This study contributes to the literature on nonadherence to asthma control therapy by incorporating measures of relative risk tolerance and time preference of college student asthma sufferers. We found that being embarrassed to take asthma medication regularly leads to a lower probability of adhering to control medication prescriptions, as do concerns about one’s medication. As expected, higher risk tolerance and time preference lead to a lower probability of adherence.

An analysis of 4 hypothetical profiles reveals that the probability of adherence is near 0 for high risk tolerance and time preference regardless of attitudes. Yet for individuals who are more risk averse and discount the future less, attitudes can have an appreciable effect. Asthma intervention programs should consider individual risk tolerance and time preference.

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