

Willingness to Pay for Genetic Testing for Alzheimer's Disease: A Measure of Personal Utility

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Background: The increased availability of genetic tests for common, complex diseases, such as Alzheimer's disease (AD), raises questions about what people are willing to pay for these services. **Methods:** We studied willingness-to-pay for genetic testing in a study of AD risk assessment that included *APOE* genotype disclosure among 276 first-degree relatives of persons with AD. **Results:** Seventy-one percent reported that they would ask for such testing from their doctor if it were covered by health insurance, and 60% would ask for it even if it required self-pay. Forty-one percent were willing to pay more than \$100 for testing, and more than half would have been willing to pay for the test out of pocket. Participants who learned that they were *APOE* $\epsilon 4$ positive and those who had higher education were less likely to want testing if covered by insurance, possibly to avoid discrimination. **Conclusion:** This is the first report to examine willingness to pay for susceptibility genetic testing in a sample of participants who had actually undergone such testing. These findings reveal that some participants find valuable personal utility in genetic risk information even when such information does not have proven clinical utility.

Introduction

THERE HAS RECENTLY been an explosion of available genetic tests for both monogenic, high-penetrance disorders and for markers associated with susceptibility to common complex disorders. Some of these are now available through direct-to-consumer companies who provide panels of results for a one-time or subscription fee, and thousands of customers have purchased these services. However, little is known about the monetary value that individuals assign to genetic testing, particularly the value as measured by willingness to pay (WTP) for such tests.

WTP is a measure used in economic research to evaluate the potential success or utilization of a program or service and is defined as the maximum amount of money that an individual will contribute to equalize a utility change. WTP is also used to assess the value placed on particular healthcare options, providing insight into the self-perceived value of a test or service to an individual in the context of disposable income, education, and severity of the illness. Open-ended bidding questions, binary valuation questions, and ordinal scales are among the several ways to measure WTP.

A small body of literature has examined demographic and attitudinal factors associated with WTP for tests. For example, gender, income, risk perception, illness experiences, and health beliefs have all been found to significantly impact a person's willingness to pay for a colorectal screening test (Frew

et al., 2001). Yasunaga *et al.* (2006) showed that education about prostate screening did not change willingness to pay for prostate-specific antigen (PSA) testing, whereas income, age, and hospitalization history did play a role in WTP. A study focusing on mammography and ethnicity showed that willingness to pay significantly differed across ethnicities with a positive family history (Wagner *et al.*, 2001). Caughey *et al.* (2004) assessed demand for prenatal diagnostic testing using willingness to pay as the outcome. They showed that women older than 35 and those with high income level were more willing to pay for testing and those who considered themselves religious were less likely to pay for prenatal testing.

In the area of Alzheimer's disease (AD), survey respondents have reported willingness to pay on average between \$120 and \$500 for predictive AD testing, depending upon the accuracy and prior risk conditions of hypothetical scenarios (Neumann *et al.*, 2001, 2010). However, no studies have asked individuals about WTP for susceptibility genetic testing after they have demonstrated their interest and had an opportunity to value the experience by actually undergoing such testing. In this article, we build upon the well-documented association of *APOE* genotype with risk of AD in which one copy of the $\epsilon 4$ allele increases risk by ~3-fold and two copies increases risk by 12–15-fold (Farrer *et al.*, 1997). We examined willingness to pay for a single genetic test for AD risk, a test that was provided at no cost in the context of a randomized controlled trial with healthy, asymptomatic adult children of AD patients.

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Materials and Methods

The Risk Evaluation and Education for AD (REVEAL) Study is a series of multi-site, randomized, controlled trials using *Apolipoprotein E (APOE)* genetic testing for AD risk as a paradigm for empirically examining the health impact of genetic susceptibility testing for common diseases (Chao *et al.*, 2008; Green *et al.*, 2009). In the second of these trials, after receiving their own *APOE* genotype, participants were asked scripted questions about what they would be willing to pay for the *APOE* genetic testing.

Because study participants were asymptomatic adult children of living or deceased individuals with clinically diagnosed or autopsy confirmed AD, they already had an increased risk of AD (Green *et al.*, 2002). A total of 276 subjects were enrolled from four sites: Boston University, Case Western Reserve University, Weill Medical College of Cornell University, and Howard University. Participants completed neuropsychological testing before enrollment, and only participants without clinically significant cognitive impairment or levels of anxiety and depression were enrolled. Participants were assigned to one of two study arms before disclosure. The Extended Arm involved three visits and ~76 min of clinician time, whereas the Condensed Arm replaced the in-person education session with a mailed brochure and took ~33 min. Preliminary results of this trial have been reported elsewhere (Szymaniak *et al.*, 2009). Participants received AD risk information based on age, sex, race, family history, and *APOE* genotype. Follow-up sessions occurred at 6 weeks, 6 months, and 1 year postdisclosure.

Questions about patients' willingness to pay for *APOE* genetic testing and the economic value placed on the *APOE* genetic test were assessed at the 6-week follow-up with a mail survey. The WTP questions were as follows: (1) "If you could receive the same type of AD risk assessment from your own doctor's office...how likely is it that you would you have asked for this service if health insurance covered the cost of testing?" (willing to have insurance pay), (2) "...how likely is it that you would you have asked for this service if you had to pay for the testing yourself?" (willing to self-pay), and (3) "How much would you be willing to pay for this AD risk assessment?" (payment scale) (see Appendix A). Answers for the first two questions were dichotomized as "willing" and "not willing" in the tables below. The payment scale question was dichotomized based on midpoint cutoffs to compare those willing to pay more than \$100 for testing to those who were not willing to pay more than \$100 for testing.

Age, race, gender, income, education, and baseline perceived risk (percentage) were assessed by self-report. *APOE* status was determined by laboratory testing and participants who had at least one $\epsilon 4$ allele were considered to be positive. Two constructs were measured by asking participants to respond on a 5-point Likert scale, with response choices ranging from 1=Strongly disagree to 5=Strongly agree. "Desire to know future AD status" was measured by agreement or disagreement to the statement, "I would like to know if I am going to develop AD at some point later in my life." "Concern about developing AD" was measured by agreement or disagreement to the statement, "I am concerned that I will develop AD someday." Scale values 1, 2, or 3 were considered "disagree/neutral" and scale values 4 or 5 were considered "agree."

We conducted univariate analyses and multivariate logistic regression to determine factors associated with willingness to have insurance pay, willingness to self-pay, and willingness to pay more than \$100. Age, gender, race, *APOE* status, education, income, self-perceived risk, and questions about desire to know risk and concern about developing AD were evaluated as predictor variables. Statistical analyses used SAS 9.1.

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Results

Demographic characteristics of the 276 subjects were as follows: mean age was 58.1 (SD 10.6), 70.6% were female, 19.2% were African American, and 96.4% had health insurance. Mean number of years of education was 16.1 (SD 2.5) and 73% of participants had incomes \geq \$50,000 per year. After receiving disclosure of their *APOE* genotype, 40.6% of subjects learned that they were positive for at least one $\epsilon 4$ allele. Mean baseline perception of risk was 51.1% (SD 22.5%).

Seventy-one percent of participants reported that they would request genetic testing for AD if it were covered by insurance, whereas 60% would ask for it if it were self-pay. Of note, 29% of participants indicated that they would probably or definitely not have such testing done in their doctor's office if covered by health insurance. A multivariate model examining predictors of willingness to be tested if insurance

TABLE 1. WILLING TO HAVE ALZHEIMER'S DISEASE RISK ASSESSMENT IF INSURANCE PAYS

Variable	Willing to be tested if insurance pays (n=191)	Not willing to be tested if insurance pays (n=78)	Adjusted (multivariable) ^a	
			Odds ratio (95% CI)	p-value
Mean age	58.7±10.9	56.8±9.7	1.023 (0.991, 1.055)	0.1598
Sex (% female)	133 (69.6%)	56 (71.8%)	0.865 (0.429, 1.744)	0.6853
Race (% African American)	40 (20.9%)	10 (12.8%)	2.175 (0.919, 5.150)	0.0772
Mean education, in years	15.8±2.7	16.7±2.1	0.836 (0.728, 0.961)	0.0118
Income (% \geq \$50K)	129 (72.5%)	55 (74.3%)	1.400 (0.678, 2.874)	0.3633
<i>APOE</i> status (% $\epsilon 4$ positive)	67 (35.1%)	43 (55.1%)	0.439 (0.237, 0.812)	0.0087
Baseline self-perceived risk	50.5±22.4	53.0±23.2	0.998 (0.984, 1.012)	0.7494
Desire to know future AD status	144 (75.8%)	51 (65.4%)	2.364 (1.211, 4.613)	0.0117
Concern about developing AD someday	123 (64.7%)	52 (66.7%)	1.336 (0.665, 2.685)	0.4157

^aAdjusted for all the variables in Table 1. AD, Alzheimer's disease.

TABLE 2. WILLING TO HAVE ALZHEIMER'S DISEASE RISK ASSESSMENT IF SELF-PAY

Variable	Willing to be tested if self-pay (n=159)	Not willing to be tested if self-pay (n=106)	Adjusted (multivariable) ^a	
			Odds ratio (95% CI)	p-value
Mean age	57.7 ± 10.0	58.7 ± 11.4	1.010 (0.981, 1.040)	0.5065
Sex (% female)	110 (69.2%)	77 (72.6%)	0.864 (0.445, 1.677)	0.6660
Race (% African American)	30 (18.9%)	20 (18.9%)	1.892 (0.869, 4.116)	0.1080
Mean education, in years	16.2 ± 2.5	16.0 ± 2.6	0.988 (0.877, 1.112)	0.8399
Income (% ≥\$50K)	116 (78.4%)	66 (66%)	1.850 (0.940, 3.639)	0.0748
APOE status (% ε4 positive)	61 (38.4%)	46 (43.4%)	0.566 (0.311, 1.029)	0.0621
Baseline Self-Perceived Risk	50.6 ± 21.2	52.2 ± 24.2	0.993 (0.980, 1.007)	0.3178
Increased desire to know future AD status	128 (81.0%)	66 (62.3%)	3.089 (1.595, 5.980)	0.0008
Increased concern about developing AD someday	113 (71.5%)	57 (53.8%)	3.102 (1.620, 5.940)	0.0006

^aAdjusted for all the variables in Table 2.

were paying revealed significant associations with lower education, greater desire to know future AD status, and negative APOE ε4 status (Table 1). A similar model examining predictors of willingness to be tested if participants were required to self-pay revealed significant associations only with desire to know future AD status and concern about future risk of AD (Table 2).

In terms of self-pay, 106 participants (41.4%) reported willingness to pay more than \$100 for AD risk assessment with APOE disclosure. Of these, 55 (52%) reported willingness to pay \$200, 51 (48%) reported willingness to pay \$500 or more, and 15 (5.8%) reported willingness to pay \$1000 or more. In the multivariate model, higher income and greater desire to know future AD status were significantly associated with willingness to self-pay over \$100 (Table 3).

Twenty participants (7%) out of the total 276 were missing values for at least one of the predictor measures, particularly for income because this variable included "refuse to answer" as a choice. Twenty participants (7%) did not answer the pay scale question. Seven (2%) did not answer the "willing to have AD risk assessment if insurance pays" question, and 11 (4%) did not answer the "willing to have AD risk assessment if self-pay" question. A comparison of the analyzed and unanalyzed participants revealed no significant differences between the groups, except that a slightly larger percentage of participants included in the analysis indicated that they would like to know if they would develop AD at some point in their lives (75% vs. 60%, $p=0.03$).

Discussion

This is the first report to examine willingness to pay for susceptibility gene testing in participants who had actually undergone such testing. Even though this population was restricted to first-degree relatives of AD patients who had volunteered for a study in which they received AD risk assessment and were therefore highly motivated, 71% reported that they would ask for such testing from their doctor if it were covered by health insurance, and 60% would ask for it if it required self-pay. However, 29% of participants probably or definitely would not want testing in a doctor's office if health insurance covered the cost of the test. Participants with higher education and those who had learned that they were APOE ε4 positive were less willing to endorse a scenario wherein insurance covered their testing. These patients may be more aware of the potential negative implications of sharing genetic information with a health insurance company. Anecdotal comments from participants suggested that insurance and employment discrimination were on their minds, and this interpretation is consistent with other studies of genetic testing. For example, in a study of eligible participants who declined BRCA testing for breast cancer risk, more than half cited cost concerns and insurance discrimination as the major reasons for doing so (Peterson *et al.*, 2002).

Predictors for whether or not participants would self-pay for genetic testing were greater desire to know about such risk and greater concern about developing AD, suggesting that

TABLE 3. AMOUNT WILLING TO PAY FOR ALZHEIMER'S DISEASE RISK ASSESSMENT

Variable	Willing to pay >\$100 for testing (n=106)	Willing to pay ≤\$100 for testing (n=150)	Adjusted (multivariable) ^a	
			Odds ratio (95% CI)	p-value
Mean age	56.9 ± 10.4	58.5 ± 10.5	1.011 (0.980, 1.043)	0.4864
Sex (% female)	68 (64.2%)	112 (74.7%)	0.702 (0.361, 1.363)	0.2956
Race (% African American)	13 (12.3%)	35 (23.3%)	0.959 (0.424, 2.170)	0.9203
Mean education, in years	16.6 ± 2.4	15.8 ± 2.5	1.076 (0.949, 1.219)	0.2533
Income (% ≥\$50K)	89 (88.1%)	90 (64.8%)	2.969 (1.367, 6.450)	0.0060
APOE status (% ε4 positive)	47 (44.3%)	56 (37.3%)	1.119 (0.619, 2.024)	0.7091
Baseline Self-Perceived Risk	53.0 ± 22.3	49.1 ± 22.6	1.004 (0.990, 1.018)	0.5567
Increased desire to know future AD status	91 (86.7%)	98 (65.3%)	3.224 (1.516, 6.856)	0.0024
Increased concern about developing AD someday	75 (71.4%)	89 (59.3%)	1.324 (0.681, 2.575)	0.4079

^aAdjusted for all the variables in Table 3.

willingness to self-pay was associated with information seeking and fear of developing the disease. Over 40% of participants were willing to pay more than \$100 for the *APOE* susceptibility test, with a significant proportion willing to pay \$500 or more and 5.8% willing to pay \$1000 or more. This is particularly significant given that personal genome services currently provide panels of multiple tests within this price range. Of note, those with negative *APOE* status were also willing to pay a greater amount, perhaps because even probabilistic reassurance is valuable. Those with a strong desire to find out their chances of developing AD and those with higher incomes were more likely to pay a higher amount, and to pay out-of-pocket, for this test.

In this study, all participants had volunteered to receive *APOE* genotyping as part of the research study and had actually received their genotype and risk assessment before they were queried about willingness to pay. Thus, this represents an unusually motivated group of individuals. Yet, the study is distinctive in that all participants underwent a standardized education protocol about the limits of the susceptibility testing with *APOE* and the lack of available treatments for AD. The study therefore examines a situation in which the value of risk information is addressed, without concern that the participants may have misunderstood the predictive accuracy of the test, or have been misinformed about medical treatments that could alter their risk of AD. Those participants who endorsed a willingness to pay larger amounts truly valued the information itself, rather than its potential to improve their health.

Limitations of our study include small sample size and homogeneity of subjects in terms of family history, education, gender, insurance status, and higher income. Subjects' WTP was not assessed at baseline, but only after receiving their *APOE* results. Subject reports of WTP for services in our survey may not correlate with actual behavior in the marketplace. Willingness to pay as a research tool is also not without controversy, particularly in terms of different methods of data collection. Some argue that in-person interview is more accurate than a mailed survey (Olsen, 2001). Another area of debate is whether open-ended questions or a pay scale format is more effective (Frew *et al.*, 2004). Range bias can also exist with use of the payment scale (Whynes *et al.*, 2004). Our study focuses on only one specific disease. It is not clear whether these results could be generalized to other diseases.

Why do participants apparently value genetic testing results that are neither definitive nor actionable? In hypothetical scenarios reported by Neumann *et al.*, subjects reported that their motives included financial planning and creation of advance directives (Neumann *et al.*, 2001), and that if faced with positive but untreatable results, they would both consult with their medical practitioners and make changes in their personal lives. In prior analyses of data from the REVEAL Study, we found that participants cited numerous motivations for seeking *APOE* testing, many of which were not related to informing treatment or prevention. For example, participants stressed planning for the future and preparing family members for the possibility of AD (Roberts *et al.*, 2003). In a related study, we found that $\epsilon 4+$ participants were significantly more likely than their $\epsilon 4-$ counterparts to report making changes in long-term care insurance (Zick *et al.*, 2005).

The findings in our study underscore in specific monetary terms that some participants may find valuable personal utility in genetic risk information even when such information does not have proven clinical utility.

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Disclosure Statement

No authors have any conflicts of interest.

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APPENDIX A

1. If you could receive the same type of AD risk assessment from your own doctor's office, how likely would you have asked for this service if:

a...your health insurance covered the cost of testing

Definitely not have testing	1	<i>Same scale used for a and b</i>
Probably not have testing	2	
Probably would have testing	3	
Definitely would have testing	4	

b...you had to pay for the testing yourself

2. How much would you be willing to pay for this AD risk assessment?

\$25	1
\$50	2
\$100	3
\$200	4
\$500	5
\$1000	6
More than \$1000	7
