

Consumer preferences for the predictive genetic tests for Alzheimer's disease: a review article

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ABSTRACT

With the advent of predictive genetic tests, individuals will have the option to investigate their future risk of developing diseases like Alzheimer's disease (AD). This knowledge can benefit people as they start to prepare themselves as well as their families for the disease process.

This review discusses issues associated with people's preferences when making a decision to test for AD or not. Several issues have been identified, which include prediction value (i.e., false-positive/false-negative results), availability of treatments that would prevent or delay onset of AD, and anonymity/confidentiality. Literature indicates the most relevant issues regarding consumer preference for AD genetic testing is predictive value (accuracy). While fewer studies have discussed the effects of treatment availability or anonymity on consumer preference, these issues may become more important as technology continues to advance and public awareness of these issues increases. Future research in the area of consumer behavior with regard to predictive genetic testing is suggested.

Most previous studies regarding consumer intent and preference for AD genetic tests have used small samples, convenience samples, or samples which were predominantly Caucasian, female and high socioeconomic status. Additionally, effects of most socio-demographics on the preference for AD genetic test are unclear in the literature. Conflicting results have been found regarding gender, education, income, and culture. An extension of the previous work using a larger and randomized sample may help to provide clearer relationship between these socio-demographics and consumer preference for AD genetic test.

Keywords

Alzheimer's disease; Predictive genetic test; Preference; Willingness-to-pay

INTRODUCTION

As the sixth leading cause of death in US, Alzheimer's disease (AD) currently affects more than 5 million Americans [1,2]. Worldwide, approximately 36 million people are living with dementia [3]. While Alzheimer's disease has an unknown etiology, high prevalence and no cure, it is still known to have a genetic link. People might be able to prepare themselves and their family for the disease's debilitating effects if one could obtain knowledge of future risk for the disease.

With the advent and increased prevalence of predictive genetic tests, individuals now have the option to investigate their future risk of developing diseases like AD. Even though genetic testing for AD is only recommended in certain cases [4], the use of predictive genetic tests is almost sure to increase as technology and genetic marker identification

continue to advance. Thus, aligning the clinical practice of predictive genetic testing for Alzheimer's disease with patient values and preferences has the potential to improve healthcare delivery. In this literature review, we discuss issues associated with people's preferences when making a decision to test for AD or not.

Several issues have been identified in this literature review regarding people's preferences when making a decision to test for AD, which include:

- prediction value (i.e., false-positive/false-negative results);
- availability of treatments that would prevent or delay onset of AD;
- anonymity/confidentiality.

The **prediction value** of the AD genetic test can help people know how confident they can be with the result.

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Treatment availability for AD impacts people's health outcomes, quality of life, and future plans.

Another important issue is **anonymity/confidentiality**, which brings concerns about discrimination in health insurance and employment.

This literature review explores consumer preferences, which can have implications for individual decision making such as arranging for personal affairs, purchase of insurance for long-term care, or even family's preparation for possible future illness. Previous studies related to people's intention to seek AD genetic testing have used various samples including convenience samples (e.g., students, samples that enrolled relatives of AD patients), samples which were predominantly Caucasian, female and high socioeconomic status, or general population samples. By understanding consumer preferences, healthcare professionals can provide services that more closely fulfill patient/customer needs. Finally, this understanding will also assist policy makers as they contemplate optimal testing/screening strategies and related policy relative to Alzheimer's disease.

PREDICTIVE VALUE OF THE GENETIC TESTING FOR ALZHEIMER'S DISEASE

How well the test can predict the risk of developing AD plays an important role in the decision making process. Owing to low sensitivity/specificity and uncertain causality of the disease, genetic risk information in AD testing can have predictive value as low as 42%, which means the result will be true in only 42% of cases [5]. One study asked physicians about the minimal predictive value of AD genetic tests suitable to be used in clinical practice: the responses ranged from 20% to 100% with a median of 80% [6]. As for the opinion from relatives of people with AD, Green et al. used a convenience sample of people aged 22-77 and found that even if the tests were only 60% accurate, 35% of people surveyed would still choose to take the test [7]. Bassett et al. found that among offspring of people with AD, only 20% would not obtain any predictive testing and more than 40% of respondents would accept tests with imperfect sensitivity /specificity as low as 30% [8]. Neumann et al. used a general population sample and found 45% of respondents stated that they would take a predictive genetic test for AD when the test result has a 90% chance to be correct [9]. One recent study incorporated conjoint analysis in an online survey of the general population. This study

revealed that accuracy was the most important factor regarding the preference for the AD genetic tests, however, the accuracy of the tests may not need to be 100% to appeal to many consumers [10]. So, the literature supports, to some extent, the premise that consumers might accept genetic tests which are not 100% accurate: 80% accuracy may be a good enough target for AD genetic test development [6,10].

TREATMENT AVAILABILITY FOR ALZHEIMER'S DISEASE

Availability of treatment options for Alzheimer's disease is also essential to people's decision regarding genetic testing for AD. To date, there is still no cure for Alzheimer's disease, but several drugs currently being prescribed may temporarily help with the symptoms and improve quality of life for AD patients. Complementary options such as mental training, physical exercise, sensory stimulation and regular leisure activity can also help to decrease behavioral problems [11]. With the understanding of limited treatment options, 77.8% of participants still desired to take the test [12]. One qualitative study showed that a genetic test for AD could still be beneficial to at-risk individuals and their family by helping them cope with emotional responses and plan the future [13]. These results indicate consumers are still interested in AD genetic test even with the understanding that treatment options are limited. As technology continues to advance, treatment options with better potential outcomes may appear and have more impact on consumer preferences regarding AD genetic tests.

ANONYMITY/CONFIDENTIALITY ISSUE REGARDING THE GENETIC TESTING FOR ALZHEIMER'S DISEASE

Concerns about discrimination in health insurance and employment may also influence one's decision to obtain a genetic test for AD (refer to Table I for the comparison of previous works on people's intention to seek AD genetic testing). In a study regarding reasons for seeking genetic susceptibility testing, Roberts et al. found 34.3% of people thought it was risky to take a genetic test for AD because their insurance company or employer might find out the test results and use them to discriminate against the patients [12]. Neumann et al. also found 31.8% of respondents worried about others gaining access to their test results [9]. The previous findings pointed

Study	Participant recruitment	N.	Hypothetical scenario	Res (%)	FGT
Green et al., 1997 [7]	Convenience sample from: (a) family members and caregivers of patients with AD attending a regional symposium; (b) subjects participating in a study of past exposures to chemicals in the workplace; (c) volunteers from a civic organization	176	Test accuracy: 60% 100%	35 69	No
Roberts et al., 2000 [12]	Children and siblings of patients with AD. Referral from geriatric medical care facilities and advertising in hospital and community in Michigan	203	Test accuracy: 99% 85% Treatment availability: Prevention Delay AD onset Test result information: Less certain risk (50%) More certain risk (95%)	58.1 54.7 96.1 77.8 49.5 63.1	No
Neumann et al., 2001 [9]	Random sample of US adults using random-digit-dialing techniques	314	Perfect test: zero chance to be incorrect Imperfect test: one in ten chance to be incorrect	N/A	No
Frost et al., 2001 [15]	Convenience sample of undergraduate students in UK	449	Test result information: More certain (90%) Less certain (50%)	N/A	No
Roberts et al., 2003 [16]	Randomized controlled trial (Risk Evaluation and Education for Alzheimer Disease – REVEAL study) Adult children of patients with AD	206	No hypothetical scenarios Intervention arm: genetic counseling and risk assessment (lifetime risk estimates based on family history and sex ranging from 13% to 57%) Control arm: risk estimates based on family history and sex ranging from 18% to 29%	77.7% went on to seek testing (overall)	Yes
Hipps et al., 2003 [17]	Convenience sample of: (a) health workers/family members attending a conference in Alabama; (b) healthcare workers attending a meeting in Florida; (c) persons in Georgia who were participating in other public health surveys; (d) members of church congregations/civic organizations and participants in support groups/health fairs in Atlanta	452	100% accurate with treatment available to delay the onset of AD 60% accurate and cost \$ 200 100% accuracy 80% accuracy 60% accuracy	80.3 19.6 64 51 30	No
Bassett et al., 2004 [8]	Convenience sample of the adult offspring of AD patients currently enrolled in a genetic linkage study	518	Test accuracy: Sensitivity (False-positive): • 92% • 69% • 31% Positive predict value: • 87% • 65% • 33%	76.3 68.8 59.9 65.1 55.0 47.9	No
Roberts et al., 2004 [18]	Randomized controlled trial (REVEAL study) Adult children of a person with clinically diagnosed and/or autopsy-confirmed AD	Self-referred: 179 Systematically contacted: 110	No hypothetical scenarios Intervention arm: genetic counseling and risk assessment (lifetime risk estimates based on family history and sex ranging from 13% to 57%) Control arm: risk estimates based on family history and sex ranging from 18% to 29%	64% went on to have genotyping and received AD risk disclosure 24% went on to have genotyping and received AD risk disclosure	Yes Yes
Binetti et al., 2006 [19]	Clinical trial (REVEAL study) Italian sample: first and second degree relatives of patients from families were at least affected individuals, subjects were not paid	134	99% test accuracy and 95% lifetime risk Less test accuracy (85%) Immediate risk Less certain risk information (50% lifetime risk) Available treatment to delay AD onset Available treatment to prevent AD	73.8 70.8 71.5 70.0 77.7 87.7	No
Huang et al. 2011 [10]	Online panel	295	Predictive value (accuracy): • 40% • 80% • 100% Treatment availability: • Cure available • No cure but treatment available for symptom relief Result anonymity: • Anonymous • Not anonymous	N/A	No

Table 1. Previous work on people's intention to seek AD genetic testing

Res = respondents expressing probable or definite intentions to seek testing or went on to seek testing

FGT = free genetic test provided

out that anonymity might also play an important role for decision making when obtaining a predictive genetic test for AD. Although the Genetic Information Nondiscrimination Act (GINA) signed by President Bush in 2008 forbids discrimination based on genetic information in health insurance and employment, it is not clear whether people's concerns about genetic discrimination have changed since the law passed. GINA prohibits health insurers from requesting genetic testing from customers for decisions about coverage eligibility or premiums. It also prohibits employers from using genetic information for hiring or discharge decisions [14].

RELATIONSHIP BETWEEN SOCIO-DEMOGRAPHICS AND PEOPLE'S ATTITUDES TOWARD PREDICTIVE GENETIC TESTING FOR ALZHEIMER'S DISEASE

The literature indicates that age, gender, education, income, and race/cultural background may impact the decision for genetic testing for AD. Frost et al. used a college student sample and suggested that demand for genetic AD testing was likely to be low among young people [15]. Others have found that people below the age of 60 were more likely to seek tests compared to people age 60 and above; indicating the "baby boomer" generation might want to seek more genetic information than older generations [18].

Different results have been found regarding the role of gender for genetic testing for AD. Roberts et al. found that men expressed more interest in being tested than women [12]. Bassett et al. showed that men tend to accept tests with higher error rates [8]. In contrast, women were the majority in a study asking consumers to take part in a clinical trial that provided free genetic testing [18]. Other studies have suggested that gender was not associated with the desire to be tested for AD [9,15].

The effect of education on the desire to obtain genetic testing for AD is unclear. In one study, Green et al. found that subjects who expressed the desire to obtain genetic testing for AD had lower educational levels [7]. However, Roberts et al. found that respondents with a college level education were more likely to seek testing [18]. Educational level may also impact test acceptance based on sensitivity/specificity. One study showed that respondents with lower education levels were more likely to accept tests for AD which had higher error rates [8].

Roberts et al. found income was not associated with the desire to seek genetic testing for

AD [18]. Neumann et al., however, found that income was associated with the likelihood of seeking a genetic test. Respondents with lower incomes (household income less than \$ 30,000) were more likely to be interested in taking the genetic tests [9].

There were also conflicting results about cultural effects on the desires to obtain genetic testing for AD. Binetti et al. showed that Italians were more likely to obtain an AD genetic test than Americans and indicated the culture background may influence the desire to obtain the AD genetic testing [19]. Another study suggested African Americans showed less interest in genetic testing for AD when compared to whites [20]. While these two studies found that culture may have an effect, Neumann et al., however, showed that desire to take a genetic test for AD was constant across different races including whites, African American and Hispanic in the US . Neumann et al. also showed that people with AD family history or AD care-giving experience were more likely to take AD genetic test, although the differences were not statistically significant [9].

Conflicting, unclear, or non-significant results have been found in the literature regarding the relationship between various social-demographics and consumers preferences for genetic tests. Studies using larger, more generalizable, randomized samples are needed to provide a better understanding of consumer preferences with respect to predictive genetic tests.

VALUATION OF PREDICTIVE GENETIC TESTING FOR ALZHEIMER'S DISEASE

There has been limited research evaluating people's willingness-to-pay for genetic testing for AD. This is likely due to the fact that the test is still not recommended for clinical use. However, research on the community's willingness-to-pay (WTP) for genetic testing for AD can have implications for research development, health policy, and clinical practice. Neumann et al. determined people's WTP for genetic testing for AD by using a double-bounded, dichotomous choice contingent valuation method. Respondents were randomized to one of four bidding amounts: \$ 100, \$ 500, \$ 1000, \$ 1500 and answered whether they would or would not take a predictive test with 100% accuracy. If respondents answered yes to the initial bidding, they were asked whether they would pay double that amount. If they answered no to the initial bidding, they were asked whether they would pay half of the amount. Their study showed that

Study	Participant recruitment	N.	Response rate	Mean age and range	Gender (% female)	Race (% white)	Annual household income	AD care-giving history*	FGT
Green et al., 1997 [7]	Convenience sample from: (a) family members and caregivers of patients with AD attending a regional symposium; (b) subjects participating in a study of past exposures to chemicals in the workplace; (c) volunteers from a civic	176	54	45 (22-77)	75	70	N/A	N/A	No
Roberts et al., 2000 [12]	Children and siblings of patients with AD. Referral from Geriatric medical care facilities and advertising in hospital and community in Michigan	203	N/A	53.5 (30-92)	75.4	95.6	74.7% had an income over \$ 40,000	93.1	No
Neumann et al., 2001 [9]	Random sample of US adults using random-digit-dialing techniques	314	47	43.3	62.4	73.0	48.1% had an income of \$ 30,000-75,000	24	No
Frost et al., 2001 [15]	Convenience sample of undergraduate students in UK	449	87.5	All college student	55.68	N/A	N/A	N/A	No
Roberts et al., 2003 [16]	Randomized controlled trial (Risk Evaluation and Education for Alzheimer Disease – REVEAL study) Adult children of patients with AD	206	N/A	52.8 (30-78)	72.3	94.7	Median household income: \$ 70,000-99,999	75	Yes
Hipps et al., 2003 [17]	Convenience sample of: (a) health workers/family members attending a conference in Alabama; (b) healthcare workers attending a meeting in Florida; (c) persons in Georgia who were participating in other public health surveys; (d) members of church congregations/civic organizations and participants in support groups/health fairs in Atlanta	452	N/A	47	78	61	Median household income: \$ 40,000-59,999	20	No
Bassett et al., 2004 [8]	Convenience sample of the adult offspring of AD patients currently enrolled in a genetic linkage study	518	78	40.4% in the range of 50-59 (18-78)	59.7	96.3	75% had a income over \$ 35,000	25	No
Roberts et al., 2004 [18]	Randomized controlled trial (REVEAL study) Adult children of a person with clinically diagnosed and/or autopsy-confirmed AD	Self-referred: 179	N/A	52.5 (31-82)	78.8	91.1	Median: \$ 70,000-99,999	N/A	Yes
		Systematically contacted: 110	N/A	57.9 (30-82)	58.2	97.3	Median: \$ 50,000-69,999	N/A	Yes
Gooding et al., 2006 [13]	Adult children of people with AD enrolled in REVEAL study (REVEAL-QRI study)	60	N/A	54 (37-76)	87	95	Median: 70,000-99,999	N/A	Yes
Binetti et al., 2006 [19]	Clinical trial (REVEAL study) Italian sample: first and second-degree relatives of patients from families were at least affected individuals, subject were not paid Compare to American sample [12]: one family member with AD, subjects were paid	134	54.5	47.5	57	100% Italian	N/A	58%	No
Moscarillo et al., 2007 [21]	Convenience sample of unaffected relatives being followed as part of an ongoing genetic linkage study	Pilot survey: 57	87.7	73.1 (38-93)	53	100	N/A	N/A	No
		Focus group: 16	N/A	40-70	68.8	62.5	N/A	N/A	No
Huang et al., 2011 [10]	Online panel	295	N/A	44.7 (18-64)	49	86	47% had an annual income over \$ 50,000	16	No

Table II. Comparison of the sample description

* % had served as caregiver

FGT = Free genetic test provided

respondents were willing to pay \$ 170 for a predictive test which had a one-in-ten chance of being incorrect and \$ 324 for a perfectly predictive test [9]. Another study which also surveyed the general population, showed that the median willingness-to-pay for a perfect scenario (Accuracy 100%, a cure is available, test result is anonymous) was \$ 100 (mean WTP was \$ 276). It also showed that even though there was no cure available for AD, respondents were still willing to pay for the test if the accuracy were at least 80% [10].

CONCLUSION

The literature identifies the most relevant issues regarding consumer preference for AD genetic testing including: predictive value (accuracy), treatment availability and anonymity. Most previous studies have examined the relationship between predictive value and consumer preferences for taking an AD genetic test. It has been shown that consumers may be more concerned with the predictive value of AD genetic test than either anonymity or the availability of treatment options. Since consumer preference for AD genetic testing seems to be driven by the tests

ability to correctly predict the disease, genetic test developers should focus on strategies that improve predictive accuracy to at least 80%. While fewer studies discussed the effects of treatment availability or anonymity on consumer preference, these issues may become more important as technology continues to advance or public awareness of these issues increases.

Most previous studies regarding consumer intent and preference for AD genetic test have used small samples, convenience samples (e.g. students, samples that enrolled relatives of AD patients), or samples which were predominantly Caucasian, female and high socioeconomic status (refer to Table II for sample comparison). Additionally, the effects of most socio-demographics on the preference for AD genetic test are unclear in the literature. Conflicting results have been found regarding gender, education, income, and culture. More research is needed which will add to the previous work using more representative, randomized samples. This should help to provide a clearer understanding of the relationship between socio-demographics variables and consumer preferences for AD genetic test.

REFERENCES

1. Thies W, Bleiler L. 2011 Alzheimer's disease facts and figures. *Alzheimers Dement* Mar 2011; 7: 208-44
2. Miniño AM, Murphy SL, Xu J, et al. Deaths: final data for 2008. *Natl Vital Stat Rep* 2011; 59: 1-155
3. *World Alzheimer Report 2011*. Available at: www.alz.co.uk/worldreport2011 [last accessed May 2012]
4. Goldman JS, Hahn SE, Catania JW, et al. Genetic counseling and testing for Alzheimer's disease: joint practice guidelines of the American College of Medical Genetics and the National Society of Genetic Counselors. *Genet Med* 2011; 13: 597-605
5. Saunders AM, Hulette O, Welsh-Bohmer KA, et al. Specificity, sensitivity, and predictive value of apolipoprotein-E genotyping for sporadic Alzheimer's disease. *Lancet* 1996; 348: 90-3
6. Chase GA, Geller G, Havstad SL, et al. Physicians' propensity to offer genetic testing for Alzheimer's disease: results from a survey. *Genet Med* 2002; 4: 297-303
7. Green RC, Clarke VC, Thompson NJ, et al. Early detection of Alzheimer disease: methods, markers, and misgivings. *Alzheimer Dis Assoc Disord* 1997; 11(Suppl 5): S1-5; discussion S37-9
8. Bassett SS, Havstad SL, Chase GA. The role of test accuracy in predicting acceptance of genetic susceptibility testing for Alzheimer's disease. *Genet Test* 2004; 8: 120-6
9. Neumann PJ, Hammitt JK, Mueller C, et al. Public attitudes about genetic testing for Alzheimer's disease. *Health Aff (Millwood)* 2001; 20: 252-64
10. Huang M, Perri M. Public preferences for the predictive genetic test for Alzheimer's disease in the United States. International Society for Pharmacoeconomics and Outcomes Research 14th Annual European Conference. Madrid, 2011
11. Richter RW, Richter BZ. *Alzheimer's Disease: The Physician's Guide to Practical Management*. 1st ed. Totawa: Humana press, 2004
12. Roberts JS. Anticipating response to predictive genetic testing for Alzheimer's disease: a survey of first-degree relatives. *Gerontologist* 2000; 40: 43-52

13. Gooding HC, Linnenbringer EL, Burack J, et al. Genetic susceptibility testing for Alzheimer disease: motivation to obtain information and control as precursors to coping with increased risk. *Patient Educ Couns* 2006; 64: 259-67
14. Genetic Information Nondiscrimination Act of 2008. Available at: <http://www.eeoc.gov/laws/statutes/gina.cfm> [last accessed May 2012]
15. Frost S, Myers LB, Newman SP. Genetic screening for Alzheimer's disease: what factors predict intentions to take a test? *Behav Med* 2001; 27: 101-9
16. Roberts JS, LaRusse SA, Katzen H, et al. Reasons for seeking genetic susceptibility testing among first-degree relatives of people with Alzheimer disease. *Alzheimer Dis Assoc Disord* 2003; 17: 86-93
17. Hipps YG, Roberts JS, Farrer LA, et al. Differences between African Americans and Whites in their attitudes toward genetic testing for Alzheimer's disease. *Genet Test* 2003; 7: 39-44
18. Roberts JS, Barber M, Brown TM, et al. Who seeks genetic susceptibility testing for Alzheimer's disease? Findings from a multisite, randomized clinical trial. *Genet Med* 2004; 6: 197-203
19. Binetti G, Benussi L, Roberts S, et al. Areas of intervention for genetic counselling of dementia: cross-cultural comparison between Italians and Americans. *Patient Educ Couns* 2006; 64: 285-93
20. Hipps YG, Roberts JS, Farrer LA, et al. Differences between African Americans and whites in their attitudes toward genetic testing for Alzheimer's disease. *Genetic Testing* 2003; 7: 39-44
21. Moscarillo TJ, Holt H, Perman M, et al. Knowledge of and attitudes about Alzheimer disease genetics: report of a pilot survey and two focus groups. *Community Genet* 2007; 10: 97-102