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CLINICAL STUDY

# Can genetic risk information for age-related macular degeneration influence motivation to stop smoking? A pilot study

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**Abstract**

*Aims* **Smoking can increase the risk of macular degeneration and this is more than additive if a person also has a genetic risk. The purpose of this study was to examine whether knowledge of genetic risk for age-related macular degeneration (AMD) could influence motivation to quit smoking.**

*Methods* **A questionnaire-based study of hypothetical case scenarios given to 49 smokers without AMD. Participants were randomly allocated to a generic risk, high genetic risk, or low genetic risk of developing AMD scenario.**

*Results* **Forty-seven percent knew of the link between smoking and eye disease. In all, 76%, 67%, and 46% for the high risk, generic, and low risk groups, respectively, would rethink quitting ($P$ for trend = 0.082). In all, 67%, 40%, and 38.5%, respectively, would be likely, very likely, or would definitely quit in the following month ($P$ for trend = 0.023). Few participants (<16% of any group) were very likely to or would definitely attend a quit smoking session with no difference across groups. In all, 75.5% of participants would consider taking a genetic test for AMD.**

*Conclusion* **In this pilot study, a trend was seen for the group given high genetic risk information to be more likely to quit than the generic or low genetic risk groups. Participants were willing to take a genetic test but further work is needed to address the cost benefits of routine genetic testing for risk of AMD. More generic risk information should be given to the public, and health warnings on cigarette packets that 'smoking causes blindness' is a good way to achieve this.**

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*Keywords:* macular degeneration; smoking; risk factors; smoking cessation; risk

## Introduction

Age-related macular degeneration (AMD) is the commonest cause of irreversible visual loss in the Western world. In the United Kingdom, ~214 000 individuals have impaired vision secondary to AMD.[1]

AMD is a complex disease whose aetiology is associated with both genetic and environmental risk factors. This has led to interest in interventions that can reduce the incidence of AMD. Cigarette smoking is an obvious target with epidemiological studies showing that cigarette smoking increases the risk of AMD 2–4-fold.[2–6] It is estimated that AMD related to smoking causes visual impairment in 54 000 UK residents over 69 years of age, with blindness in 18 000 of them.[7] It is postulated that smoking affects the pathogenesis of AMD by a variety of methods including promoting oxidative damage, inducing angiogenesis, impairing the choroidal circulation, and by activating the immune system including complement pathway.[8–13] Stopping smoking reduces the risk of AMD and after 20 years of cessation the risk of developing AMD is the same as for non-smokers.[14]

In the last few years, the genetic factors significantly contributing to AMD risk have

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been identified. Two genes contribute over 70% of the population attributable risk for AMD.[2] These are complement factor H (CFH), chromosome location 1q32, and the genetic locus encompassing LOC397715 and HTRA1 on chromosome 10. Gene environment interactions have been assessed at these loci. The results and relative risks found vary between different populations and methods used, with not all studies showing an interaction with smoking.[2,14–17] However, some studies show the risk from smoking and genes to be multiplicative rather than additive.[15,18]

Schmidt *et al*[18] found that among people who are homozygous at the LOC397715/HTRA1 locus, without the CFH genotype, smokers have an odds ratio (OR) of 7.56 for developing AMD and non-smokers 2.4 compared with non-smokers with no genetic risk. For people who are homozygous for risk alleles at both loci the OR was 10.21 for non-smokers and 34.51 for smokers. Schaumberg *et al*[15] showed a similar multiplicative risk of smoking on risk of AMD, with non-smokers who are homozygous for the Y402H allele in CFH having a 4-fold increased risk and homozygous smokers having a nearly 9-fold risk compared with individuals with no genetic or smoking exposure. An even greater effect was seen for the LOC397715/HTRA1 locus with a 6-fold and 22-fold increased risk relative to those with no genetic risk or smoking exposure. Interestingly, while heterozygotes had an increased risk it was less than homozygotes at 3-fold and 4-fold increased risk for CFH and chromosome 10 genotypes, respectively.

Smoking is the major modifiable risk factor for AMD. A 2008/09 survey in the United Kingdom found 22% of residents were smokers with 29% smoking over 20 cigarettes/day.[19] This represents a significant number of people who could be targeted for behavioural change to lower their risk of developing AMD. The use of genetic testing for disease susceptibility is now well established but for diseases with more complex multifactorial causes little is known about how people will respond to the results. While a positive test may aid behavioural change a negative test may give false reassurance and reduce the motivation for behavioural change.[20] As accessibility to genetic information becomes more widespread, it will be crucial to understand the psychological impact of this information and to determine whether it can lead to behavioural change that would justify the costs of large-scale genetic testing. Indeed, genetic testing for AMD is already commercially available.

The purpose of this study was to examine whether genetic testing for AMD could influence motivation to quit smoking. We utilized a common vignette paradigm that asks individuals to consider different hypothetical scenarios for genetic testing.[21–23]

## Materials and methods

### *Participants and procedures*

A questionnaire-based study was performed in 49 smokers who were given a hypothetical scenario about their risk of developing AMD to consider. Participants were recruited from patients and visitors to the ophthalmic outpatient department who were over 18 years of age and smoked at least 1 cigarette/day. Exclusion criteria included having a visual acuity worse than 6/24, diagnosis of AMD, or history of any smoking-related ocular disorder, for example, thyroid eye disease and tobacco alcohol amblyopia. The study had ethics approval and all participants gave informed consent. Randomization was done by shuffling packs of questionnaires with different scenarios.

### *Background questionnaire*

Participants completed an initial questionnaire about personal demographics, smoking history, and ocular and medical history. It also included knowledge of conditions related to smoking (including a confounder, deafness, that has no link to smoking), the source of this knowledge, and the perception of the seriousness of sight loss.

The smoking history established the nicotine-dependent score (number of cigarettes a day and time to first cigarette of the day[24,25]), barriers to quitting,[26] and current state of change. Ten possible barriers to quitting were asked (adapted from the BQS-SAT, barriers to quitting smoking during substance abuse treatment questionnaire[26]).

The current state of change categorizes participants according to how likely they are to attempt to quit: preparation (planning to stop smoking within the next month); contemplation (planning to stop smoking within the next 6 months but not within the next month); pre-contemplation (planning to stop smoking within the next 5 years; and not planning to stop smoking within the next 5 years).[27]

### *Scenarios*

Participants were then given one of three scenarios—high genetic risk, low genetic risk, and generic risk of developing AMD. They had to imagine themselves in the situation described and then answer a series of questions based on this.

The 'high genetic risk' group told that results of the genetic test were positive, 'indicating that the participant had two copies of a faulty macular degeneration gene on chromosome 10. As a smoker with two copies of this faulty gene the chances of getting macular degeneration

are three times those of a non-smoker with this gene combination, and >20 times someone who has no faulty gene and does not smoke'.

The 'low genetic risk' group told that results of the genetic test were negative 'indicating the participant did not have the faulty gene and therefore had no increased genetic risk but were still at increased risk as a smoker.'

The third group given a 'generic risk' with a leaflet, which provided information about AMD and the general risk to smokers of developing AMD. 'A smokers chances of getting AMD are double those of a non-smoker'. These participants were not told about the genetic risk.

The scenarios contained letters and leaflets based on those used in clinical practice to make them as realistic as possible. Each scenario included information about the benefits of stopping smoking—'Stopping smoking will lower your risk of developing AMD. This decreases every year you remain a non-smoker'. All participants were given a quitters leaflet about stopping smoking.

### *Scenario assessment*

The post-scenario questionnaire first tested the participants' understanding of the scenario. The primary outcome was assessed with three questions: has it made the participant rethink their plan to quit smoking; how likely is the person to quit smoking in the following month; and how likely they are to attend a quit smoking session. Answers to the latter two questions were not going to; unlikely to; likely to; very likely to; and definitely will.

Further questions established perception of stopping smoking and risk of sight loss to look for evidence of genetic fatalism (belief that change in lifestyle would not influence risk of acquiring a disease once there already exists an increased genetic risk) and information derogation.

### *Post-study assessment*

Following completion of the study all patients were asked whether they would consider genetic testing, if they would act on the results, and whether blindness is more of an incentive to quitting than other smoking-related disease.

### *Statistical analysis*

Statistical analysis was performed using the SPSS−17 (SPSS, Chicago, IL, USA). The three groups were compared for demographics, and smoking behaviour including current plans to quit smoking pre-manipulation. Post-manipulation, understanding of the scenario was verified and groups compared for rethink in plan to quit, likelihood of quitting in the next month and of attending a quit smoking session. Statistical tests used included $\chi^2$, *t*-test, ANOVA and difference between means.

The primary outcomes were analysed according to variables of age, length of smoking, current state of change, previous quit attempts, nicotine-dependent score, and barriers to quitting.

## Results

### *Descriptive data*

*Demographics.* Forty-nine participants entered and completed the study. There was no significant difference in demographic and background variables between the three scenario groups apart from the age at first cigarette (Table 1). In all, 53% (26/49) of participants were male and the mean age was 36.6 years (range 19–76 years).

*Knowledge of smoking-related diseases.* Significantly fewer (46.9%) of respondents knew about the link between eye disease and smoking (see Table 2) than those who knew about the increased risk of lung disease (94%), lung cancer (88%), and heart disease (88%) associated with smoking. (Minimum difference = 40.9%; 99% CI of difference: 19–62%).

Newspapers, magazines, and warnings on cigarette packets were the commonest sources of information about the effect of smoking on health (Table 2). The Internet was significantly lower than the other sources ($\chi^2 = 6.54$, $P = 0.01$—for comparison with friends).

Thirty-seven respondents (75.5%) agreed or strongly agreed that losing significant part of their sight would be a serious disability and would have major consequences for their lives with no significant difference across age groups.

*Smoking history.* Table 1 gives baseline smoking history. There was no significant difference in age at starting smoking between males and females (15.6 and 15.1 years, respectively), but the positive gene test group was younger. The majority (69%, 34/49 participants) had a history of at least 1 attempt to quit smoking, with 25 having between 1 and 5 quit attempts. Few participants (8.2%) were in a high state of change, intending to quit smoking in the next month. The average barrier to quitting score was 4.43 (range 0–9) with 77.6% believing it would be difficult to quit because they would feel tense and irritable (see Table 2). Significantly, more males than females felt the need to smoke to give them a lift when tiredness was a barrier to quitting (Figure 1a).

**Table 1** Baseline characteristics of participants in each study group

| | *Positive gene test (N = 21)* | | *No gene test (N = 15)* | | *Negative gene test (N = 13)* | | *Total (N = 49)* | |
|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % |
| *Age* | | | | | | | | |
| <25 years | 7 | 33.3 | 5 | 33.3 | 5 | 38.5 | 17 | 34.7 |
| 22–44 years | 7 | 33.3 | 3 | 20.0 | 5 | 38.5 | 15 | 30.6 |
| >44 years | 7 | 33.3 | 7 | 46.7 | 3 | 23.0 | 17 | 34.7 |
| Mean age (in years) | 35.7 SE = 3.0 | | 39.1 SE = 4.1 | | 35.2 SE = 4.4 | | 36.6 SE = 2.1 | |
| *Gender* | | | | | | | | |
| Male | 12 | 57.1 | 6 | 40.0 | 8 | 61.5 | 26 | 53.1 |
| Female | 9 | 42.9 | 9 | 60.0 | 5 | 38.5 | 23 | 46.9 |
| *Mean age of first cigarette (in years)* | 13.7 SE = 0.6[a] | | 15.0 SE = 0.7 | | 18.4 SE = 1.7 | | 15.4 SE = 0.6 | |
| Male | 13.6 SE = 0.9 | | 14.2 SE = 1.8 | | 19.4 SE = 2.7 | | 15.6 SE = 1.1 | |
| Female | 13.9 SE = 0.9 | | 15.4 SE = 0.6 | | 16.8 SE = 1.5 | | 15.1 SE = 0.6 | |
| *Mean length of smoking (in years)* | 22.0 SE = 3.1 | | 24.2 SE = 4.3 | | 16.8 SE = 3.7 | | 21.2 SE = 2.1 Range 4–62 years | |
| *Time before lighting first cigarette of day* | | | | | | | | |
| Within 30 min | 9 | 42.9 | 10 | 66.7 | 7 | 53.8 | 26 | 53.1 |
| >30 min | 12 | 57.1 | 5 | 33.3 | 6 | 46.2 | 23 | 46.9 |
| Mean nicotine-dependent score | 3.7 SE = 0.39 | | 4.2 SE = 0.33 | | 4.2 SE = 0.44 | | 4.0 SE = 0.23 | |
| *Barriers to quitting score range* | | | | | | | | |
| 0–4 | 11 | 52.4 | 8 | 53.3 | 6 | 46.2 | 25 | 51.0 |
| 5–9 | 10 | 47.6 | 7 | 46.7 | 7 | 53.8 | 24 | 49.0 |
| Mean barriers to quitting score | 4.4 SE = 0.54 | | 4.5 SE = 0.53 | | 4.3 SE = 0.47 | | 4.4 SE = 0.31 | |
| *Number of participants who had previous quit attempts* | 15 | 71.4 | 10 | 66.7 | 9 | 69.2 | 34 | 69.4 |
| *Pre-intervention state of change (quitting plan)* | | | | | | | | |
| Planning to stop within next month | 1 | 4.8 | 1 | 6.7 | 2 | 15.4 | 4 | 8.2 |
| Planning to stop within 2–6 months | 11 | 52.4 | 4 | 26.7 | 3 | 23.1 | 18 | 36.7 |
| Planning to stop within 5 years | 3 | 14.3 | 4 | 26.7 | 3 | 23.1 | 10 | 20.4 |
| Not planning to stop | 6 | 28.6 | 6 | 40 | 5 | 38.5 | 17 | 34.7 |

[a]Mean age of first cigarette significantly younger for positive gene test group compared with negative gene test group. (Difference between means = 4.67; SE difference = 1.58; 95% CI of difference = 1.46–7.88.)

### *Outcomes of experimental groups*

In all, 21, 15, and 13 of the respondents were randomized to the positive test group, no test group, and negative test group, respectively. All participants understood the information given in the scenarios.

*Primary outcomes.* In all, 76%, 67%, and 46% for the high risk, generic, and low risk groups, respectively, would rethink quitting ($P$ for trend = 0.082; Figure 1b). In all, 67%, 40%, and 38.5%, respectively, would be likely, very likely, or would definitely quit in the following month ($P$ for trend = 0.023; Figure 1c). Few participants (<16% of any group) were very likely to or would definitely attend a quit smoking session with no difference across groups (Figure 1d).

*Outcome variables (age, length of smoking, nicotine dependence, previous quit attempts, and current state of change).* Tables 3 and 4 show the effects of these variables on whether participants will rethink their quit plans and likelihood of quitting in the following month. Due to the small numbers in this pilot study there are no sufficient data to assess these variable within or between study groups. While nicotine dependence had a significant influence on rethinking quit plans with 82.1% of the lower dependence group (score 1–4) rethinking quitting compared with 42.9% of the higher dependence group (score 5–8), $\chi^2 = 0.0042$ it did not affect likelihood of quitting. The current state of change significantly correlated with the likelihood of rethinking the quit plan and intention to quit in the next month. Those in the higher states of change were more willing to rethink quitting and consider acting on this information.

**Table 2** Knowledge of smoking and perceived barriers to quitting by gene test group

| | *Positive gene test (N = 21)* | | *No gene test (N = 15)* | | *Negative gene test (N = 13)* | | *Total (N = 49)* | |
|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % |
| *Diseases linked with smoking* | | | | | | | | |
| Heart disease | 18 | 85.7 | 13 | 86.7 | 12 | 92.3 | 43 | 87.8 |
| Breathing problems | 19 | 90.5 | 15 | 100.0 | 12 | 92.3 | 46 | 93.9 |
| Eye disease | 8 | 38.1 | 11 | 73.3 | 4 | 30.8 | 23 | 46.9[a] |
| Lung cancer | 18 | 85.7 | 13 | 86.7 | 12 | 92.3 | 43 | 87.8 |
| Hearing loss | 1 | 4.8 | 3 | 20.0 | 0 | 0.0 | 4 | 8.2 |
| *Source of information* | | | | | | | | |
| Doctor | 15 | 71.4 | 11 | 73.3 | 11 | 84.6 | 37 | 75.5 |
| Printed press | 15 | 71.4 | 13 | 86.7 | 13 | 100.0 | 41 | 83.7 |
| Friends | 15 | 71.4 | 9 | 60.0 | 10 | 76.9 | 34 | 69.4 |
| Radio/TV | 13 | 61.9 | 12 | 80.0 | 10 | 76.9 | 35 | 71.4 |
| Internet | 10 | 47.6 | 8 | 53.3 | 6 | 46.2 | 24 | 49.0[b] |
| Cigarette packets | 17 | 81.0 | 12 | 80.0 | 12 | 92.3 | 41 | 83.7 |
| *Perceived barriers in quitting smoking* | | | | | | | | |
| Fear of insomnia | 2 | 9.5 | 1 | 6.7 | 1 | 7.7 | 4 | 8.2 |
| Need smoking to give lift when tired | 9 | 42.9 | 9 | 60.0 | 5 | 38.5 | 23 | 46.9 |
| Fear of gaining weight | 11 | 52.4 | 4 | 26.7 | 8 | 61.5 | 23 | 46.9 |
| Need smoking to lift mood when feeling down | 13 | 61.9 | 10 | 66.7 | 5 | 38.5 | 28 | 57.1 |
| Lack of willpower to quit smoking | 10 | 47.6 | 8 | 53.3 | 5 | 38.5 | 23 | 46.9 |
| Urge to smoke is so strong it is irresistible | 9 | 42.9 | 7 | 46.7 | 5 | 38.5 | 21 | 42.9 |
| Not smoking leads to restlessness and inability to concentrate | 11 | 52.4 | 7 | 46.7 | 11 | 84.6 | 29 | 59.2 |
| Would feel anxious | 13 | 61.9 | 9 | 60.0 | 5 | 38.5 | 27 | 55.1 |
| Would feel tense and irritable | 15 | 71.4 | 12 | 80.0 | 11 | 84.6 | 38 | 77.6 |

[a]Significantly, fewer knew about the risk of eye disease than lung disease, lung cancer, and heart disease. Minimum difference = 40.9%; 99% CI of difference: 19–62%).
[b]The Internet was significantly lower than the other sources, $\chi^2 = 6.54$, $P = 0.01$ for comparison with friends.

Older participants (>44 years) were significantly less likely to quit in the next month. Length of smoking did not affect whether participants rethought quit plans, but those who were very likely to quit in the following month had a significantly shorter smoking history and higher state of change. A history of previous quit attempts and the barrier to quitting score did not affect the likelihood of rethinking quit plans or quitting in the following month.

Older participants were significantly less likely to attend a smokers' quit session: 35.3% of the youngest respondents (<25 years) and 6.7% of those of 25–44 years of age would very likely attend a session but none of the respondents over 44 years ($P = 0.01$).

*Genetic fatalism.* There was no difference between the groups in the proportion who thought stopping smoking would reduce their risk of sight loss. In all, 76% (high risk), 56% (no test), and 69% (low risk) groups thought it would reduce their risk ($P = 0.314$). Few participants showed genetic fatalism, believing stopping would have no effect (three participants) but nine did not fully understand the message, stating they thought stopping smoking would increase their risk of sight loss (three people, four and four in each group, respectively).

*Perception of information and deterrent to smoking.* Although blindness and lung disease (65.3% each) scored highest among diseases that would definitely or very likely influence people to stop smoking this was not statistically significantly different from heart disease (53.06%) and premature death (59.2%).

*Genetic testing.* After completing the study, 75.5% of respondents said they would consider taking a genetic test for AMD, with no difference across age groups, current state of change and number of quit attempts.

*Effect of participating in study.* When asked how likely respondents would be to try quitting smoking in the next month following participation in the study,

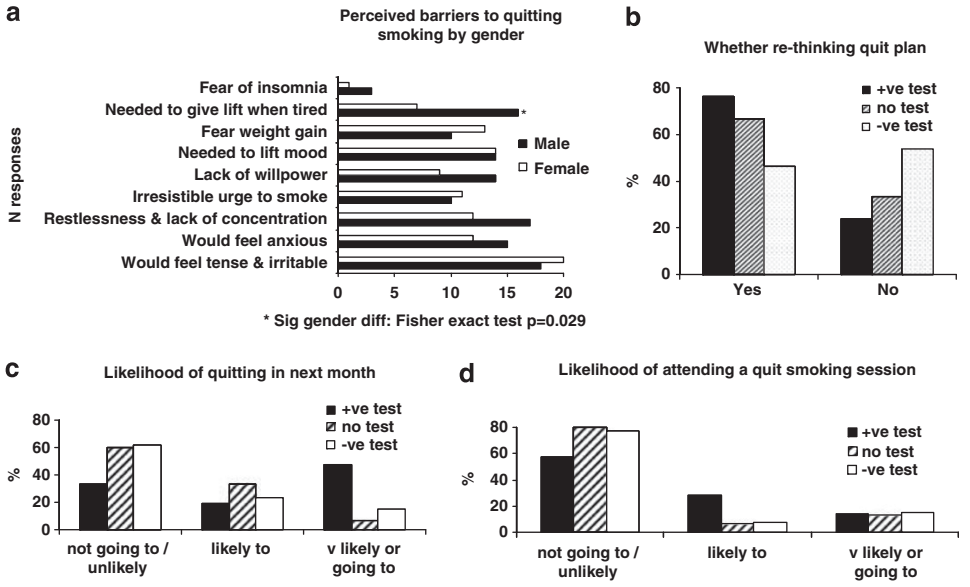


**Figure 1** (a) Perceived barriers to quitting smoking by gender, (b) proportion rethinking quit plans for each study group, (c) likelihood of quitting in the next month for each study group, and (d) likelihood of attending a quit smoking session.

**Table 3** Effect of variables on whether patient rethinks quit plan after scenario

| *Variable* | *Participants who would rethink* | | *Participants who did not rethink* | | *Total* | |
|---|---|---|---|---|---|---|
| *Age* | | | | | | |
| <25 years | 12 | 70.6% | 5 | 29.4% | 17 | $\chi^2$, $P=0.41$ |
| 26–44 years | 11 | 73.3% | 4 | 26.7% | 15 | |
| >45 years | 9 | 52.9% | 8 | 47.1% | 17 | |
| *Length of smoking* | 19.6 years | | 24.2 years | | | *t*-test, $P=0.3$ |
| *Nicotine-dependent score* | | | | | | |
| Score 1–4 | 23 | 82.1% | 5 | 17.9% | 28 | $\chi^2=8.17$, $P<0.0042$[a] |
| Score 5–8 | 9 | 42.9% | 12 | 57.1% | 21 | |
| Average nicotine-dependent score | 3.7 | | 4.6 | | | *t*-test, $P=0.3$ |
| *History of quit attempts* | | | | | | |
| Any previous quit attempt | 25 | 73.5% | 9 | 26.5% | 34 | $\chi^2$, $P=0.104$ |
| No previous quit attempts | 7 | 46.7% | 8 | 53.3% | 15 | |
| *Barriers to quitting score* | | | | | | |
| 1–4 | 18 | 72.0% | 7 | 28% | 25 | $\chi^2$, $P=0.3$ |
| 5–9 | 14 | 58.3% | 10 | 41.7% | 24 | |
| *Current state of change* | | | | | | |
| Next month | 4 | 100% | 0 | 0% | 4 | $\chi^2=20.6$, $P=0.0001$[a] |
| Within 6/12 | 16 | 88.9% | 2 | 11.1% | 18 | |
| Within 5 years | 8 | 80% | 2 | 20% | 10 | |
| Not going to stop | 4 | 23.5% | 13 | 76.5% | 17 | |

[a]Statistically significant difference in nicotine dependence score and current state of change between those participants who would and would not rethink quitting.

significantly more of the positive test group (47.6%) compared with the negative test group (25.4%) or the no test group (6.7%) reported being very likely to quit. (Difference between means of positive and negative = 32.2%; 95% CI of difference = 3.23–61.2.)

## Discussion

To our knowledge, this is the first study to investigate the use of genetic testing as an aid for smoking cessation to reduce the risk of developing AMD. This pilot study showed a trend

**Table 4** Effect of variables on whether participants will definitely or be very likely to quit in the following month or attend quit sessions

| | *Definitely or very likely to quit in following month* | | | | | |
|---|---|---|---|---|---|---|
| | *Yes* | | *No* | | *Total* (N = *49*) | P |
| | N | % | N | % | N | |
| *Age (in years)* | | | | | | |
| <25 | 7 | 41.1 | 10 | 58.8 | 17 | Fisher's exact test |
| 25–44 | 5 | 33.3 | 10 | 66.7 | 15 | $P = 0.016$ |
| 45 and over | 1[a] | 5.9[a] | 16 | 94.1 | 17 | (<45 cp 45 and over)[a] |
| | *Whether very likely or definitely would attend quit sessions* | | | | | |
| | *Yes* | | *No* | | *Total* (N = *49*) | P |
| | N | % | N | % | N | |
| <25 | 6 | 35.3 | 11 | 64.7 | 17 | Fisher's exact test |
| 25–44 | 1 | 6.7 | 14 | 93.3 | 15 | $P = 0.04$ |
| 45 and over | 0[a] | 0[a] | 17 | 100 | 17 | (<45 cp 45 and over)[a] |
| | *Length of smoking and likelihood of quitting* | | | | | |
| | *Average years of smoking* | | *SD* | *Number* | | |
| Definitely would | 14 | | 9.4 | 6 | *ANOVA P* for | |
| Very likely to | 16 | | 8.0 | 17 | linearity = 0.032[a] | |
| Likely to | 23.7 | | 15.5 | 12 | | |
| Unlikely to | 19.6 | | 13.1 | 7 | | |
| Not going to | 34.5 | | 19.7 | 6 | | |
| | *Definitely or very likely to quit in following month* | | | | | |
| | *Yes* | | *No* | | *Total* | |
| | N | % | N | % | N | |
| *Nicotine-dependent score* | | | | | | |
| Score 1–4 | 8 | 29 | 20 | 71 | 28 | $\chi^2$, $P = 0.7$ |
| Score 5–8 | 5 | 24 | 16 | 76 | 21 | |
| *Any previous quit attempts* | | | | | | |
| Definitely would | 5 | 83 | 1 | 17 | 6 | |
| Very likely to | 4 | 57 | 3 | 43 | 7 | $\chi^2$, $P = 0.108$ |
| Likely to | 11 | 92 | 1 | 8 | 12 | |
| Unlikely to | 12 | 67 | 6 | 33 | 18 | |
| Not going to | 2 | 33 | 4 | 77 | 6 | |
| *Barriers to quitting score* | | | | | | |
| 0–4 | 7 | 28 | 18 | 72 | 25 | $\chi^2$, $P = 0.9$ |
| 5–9 | 6 | 33 | 18 | 67 | 24 | |

| | *Likelihood of quitting in following month* | | | | | | |
|---|---|---|---|---|---|---|---|
| | *Not going to* | *Unlikely to* | *Likely to* | *Very likely to* | *Definitely would* | *Total* | |
| *Current state of change* | | | | | | | |
| Next month | 0 | 0 | 2 | 1 | 1 | 4 | $\chi^2$, $P = 0.08$, |
| Within 6/12 | 0 | 6 | 5 | 4 | 3 | 18 | $P$ for trend = 0.002[a] |
| Within 5 years | 0 | 6 | 2 | 1 | 1 | 10 | |
| Not going to stop | 6 | 6 | 3 | 1 | 1 | 17 | |

[a]Statistically significant results.

for participants who were given high genetic risk information to be more likely to quit in the next month compared with those given generic or low genetic risk information. Younger age, higher state of change, and lower nicotine dependence were associated with greater motivation to quit smoking. Few participants were interested in attending a quit smoking session with no difference between the groups. Older participants were less likely to try quitting and less likely to attend a smokers' quit session.

Knowledge of the link between smoking and eye disease (46.9%) is much higher than previous studies which found 9% of the UK adult[28] and 5% of the teenage population[29] were aware of the link. A survey from Singapore found only 7.3% of their population knew of the link.[30] The participants in this study were recruited from the relatives and friends of visitors to an eye department who may be better informed about the effect of smoking.

The use of scenarios allows the numbers of participants in each group to be controlled to ensure adequate numbers. There is evidence that scenario-based questionnaires can predict behaviour;[20] however, this was a pilot study so does not have sufficient numbers to consider the influence of all the smoking factors that were questioned. Giving a relative rather than absolute risk to participants may reduce the effect of the message as it can be more difficult for people to understand.

Previous studies have used hypothetical scenarios to examine the impact of genetic information for other smoking-related conditions on motivation to quit.[22,23,31] Sanderson and Michie[21] found knowledge of high genetic risk of developing heart disease had a positive influence on intention to quit smoking. A study of genetic risk information for coronary heart disease by Wright *et al*[23] found the gene positive group had greater intentions to quit compared with the no test group. Patients in all groups who had higher self-efficacy showed increased intentions to quit. The relatively small sample size of our study may be the reason we found a trend rather than a significant difference in intention to quit between the groups.

A number of studies have undertaken genetic or biomarker testing to aid smoking cessation and found that genetic knowledge of increased risk may motivate smokers towards cessation. However, while these studies show an initial increase in cessation this was not sustained.[32–34] Carpenter *et al*[32] found that although smokers who tested severely deficient for alpha 1 antitrypsin deficiency (associated with emphysema) were significantly more likely to have a 24-h quit attempt, there were no group differences in smoking cessation at 3 months. McBride *et al*[33] found that at 6 months smoking cessation was greater in the gene tested group compared with standard intervention but that this difference was lost at 12 months. This may be because the majority of participants were already experiencing health effects of smoking.

One concern with genetic testing is that people with a low genetic risk may be falsely reassured or that those with a high risk may exhibit genetic fatalism and less likely to quit. Frosch *et al*[22] found evidence of false reassurance in testing negative for obesity risk. However, Lerman *et al*[34] found that genetic feedback for lung cancer risk may heighten vulnerability and promote distress, while not enhancing quitting. In our study, the lack of difference in likelihood of quitting between the generic and low genetic risk groups (who are given the same relative risk for developing AMD) suggests that participants were not getting false reassurance. However, a few individuals may experience genetic fatalism.

After the study, 75% of participants were willing to take a genetic test to assess their risk of blindness from AMD, highlighting that people are interested in the future of their health. Before the widespread introduction of genetic testing, we need evidence that it results in a significant behavioural change that would justify the costs of large-scale genetic testing. This pilot study indicates that knowledge of genetic status may lead to positive health changes, but increased awareness of a generic risk may be as cost effective and cause less distress. After the study those participants in the positive group reported being more likely to try quitting, suggesting a 'teachable moment' in the risk counselling.

The desire to quit is an important predictor of being motivated to quit after genetic testing, regardless of test result. As might be expected the higher state of change, or more psychologically ready the smoker, the more likely they would be to quit. This was seen in a large study in the United States where younger people interested in quitting, and with lower levels of dependence, were more likely to quit and stay so for a prolonged period.[35] Concern about feeling tense and irritable was the biggest deterrent to stopping smoking, a common symptom of tobacco withdrawal.[26]

### *Implications of study*

Routine testing of genetic risk of AMD is not currently indicated. Low risk patients might be falsely reassured and the use of generic risk information can influence people to stop smoking. A larger study is required to investigate if the trend for the high risk group to quit reaches significance, and whether widespread testing would be cost effective.

Blindness scored as highly or higher than lung disease, heart disease, and premature deaths as an incentive to quit smoking. Papers, magazines, and warnings on cigarette packages were the most important source of information on effects of smoking on health. This

knowledge should be used to educate and inform the public as to the risks of smoking. When Australia and New Zealand introduced graphic warnings on cigarette packages in 2006 these included 'smoking causes blindness'. In the year following this the numbers of people contacting the Australian quitline service doubled, and the warning about the risk of blindness is thought to have had the greatest impact.[36]

The lack of interest in attending a quitter's session has significant implications for the Government backed anti-smoking campaigns. The UK National Statistics' Survey for the year 2008/2009 revealed that 22% of UK residents were smokers.[19] The total expenditure on NHS Stop Smoking Services for the period April 2009 to December 2009 was estimated at £60.6 million, an increase of 17% on the final figure for the same period in 2008/09 (£51.6 million).[37] However, in 2008–2009 only 8% of UK smokers were referred or self-referred to a stop smoking group.[19] The majority of smokers quit without assistance and smokers need to be reassured that this is possible and common.[38]

## Conclusion

To the best of our knowledge, this pilot study is the first to try and assess whether knowledge of increased genetic risk of developing AMD among smokers would influence behavioural change and increase the likelihood of quitting. A trend was seen for the high genetic risk group to be more likely to quit following receipt of this information than the generic or low genetic risk groups. Participants were willing to take a genetic test but a larger study is required to assess the impact and cost benefits of routine genetic testing for risk of AMD. More generic risk information should be given to the public, and health warnings on cigarette packets that 'smoking causes blindness' is a good way to achieve this.

### Summary

**What was known before**

- Smoking and genetic factors can increase the risk of visual loss from AMD.
- The combination of smoking and genetic risk factors gives a multiplicative risk for visual loss.
- Stopping smoking can reduce the risk of visual loss from AMD.

**What this study adds**

- Our study demonstrated that people are willing to take a genetic test for AMD but the cost effectiveness of this is not known.
- Participants responded to generic risk information about smoking and AMD so more of this should be provided to encourage people to quit.

## Conflict of interest

The authors declare no conflict of interest.

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