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Motivations for Genetic Testing for Lung Cancer Risk among Young Smokers

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Abstract

Objective—To examine why young people might want to undergo genetic susceptibility testing for lung cancer despite knowing tested gene variants are associated with small increases in disease risk.

Methods—We used a mixed-methods approach to evaluate motives for and against genetic testing and the association between these motivations and testing intentions in 128 college students who smoke.

Results—Exploratory factor analysis yielded four reliable factors: *Test Skepticism*, *Test Optimism*, *Knowledge Enhancement*, and *Smoking Optimism*. *Test Optimism* and *Knowledge Enhancement* correlated positively with intentions to test in bivariate and multivariate analyses ($p < .001$). *Test Skepticism* correlated negatively with testing intentions in multivariate analyses ($p < .05$). Open-ended questions assessing testing motivations generally replicated themes of the quantitative survey.

Conclusions—In addition to learning about health risks, young people may be motivated to seek genetic testing for reasons such as gaining knowledge about new genetic technologies more broadly.

Keywords

motivations; primary prevention; genetic testing; *GSTM1*

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Competing Interests Statement

The authors have no competing interests to declare.

Contributions

Study concept: SCO, IML, SCS, JS, SD, CMM

Study design: SCO, IML, SCS, JS, SD, CMM

Acquisition of data: IML, JS

Statistical analysis: SCO

Draft of manuscript: SCO, CMM

Comments on manuscript: IML, SCS, JS, SD

Obtained funding: IML, JS, CMM

Final Approval: SCO, IML, SCS, JS, SD, CMM

Cigarette smoking continues to be the single most prominent behavioral cause of premature death worldwide.¹⁻³ One way to reduce tobacco-related morbidity and mortality is to dissuade young adults from smoking or to encourage them to quit⁴ before smoking habits become entrenched.⁵ Teen and young adult smoking cessation programs consistently show low cessation rates (~12%), with little to no benefit of intervention.⁶ Moreover, research to date sheds little light on how to engage young and healthy smokers to use available cessation materials and to try recommended strategies.⁷

Providing genetic susceptibility feedback may deter smoking and motivate cessation by stimulating engagement in smoking cessation programs. However, these proposed benefits are the subject of intense debate.^{8,9} Some argue that genetic susceptibility testing could lead to iatrogenic reactions to test results, such as demotivation, fatalism and worry.^{10,11} Recent reviews suggest that while communication of genetic susceptibility feedback does not harm, it also has limited effect on cessation intentions and outcomes.¹² This is despite immediate motivational effects that could be leveraged for cessation.¹³ Having a better understanding of what motivates smokers to seek genetic testing may be useful given these motives likely will influence responses to test results.

Capitalizing on motivations to obtain genetic tests (motivators) and redressing potential demotivating effects can support intervention development in future trials.^{11,14,15} The few studies that explored genetic testing motivations examined older smokers who were already experiencing smoking side effects or had smoking-related chronic health conditions.¹³ These studies assessed health-related motives thought to be salient to older smokers. No study has examined genetic testing motivations in young smokers or explored the fuller complement of motivations young smokers might have.

Using genetic susceptibility feedback to motivate young smokers to quit smoking presents both challenges and opportunities. Smokers hold optimistic biases about the risks associated with their behavior,¹⁶⁻¹⁸ which may be partially responsible for null effects in previous studies to date. Young smokers are known to downplay the health consequences of their behaviors, including smoking-related consequences.^{19,20} They may seek genetic testing for reasons other than to gain insights into their health risks, potentially using personal genetic risk information that indicates decreased disease risk to downplay smoking-related health threats. It is also possible that the motives of young smokers for seeking testing could influence their interpretation of high susceptibility genetic test feedback and increase the likelihood that they will question the accuracy and credibility of the test. These self-protective and self-serving reactions could exacerbate tendencies to deny smoking-related health risks¹⁷

Young smokers could be receptive to genetic risk information for a number of reasons. By virtue of their age, they may lack information about their family history of lung cancer and thus find genetic risk information particularly informative. Also, most young smokers have yet to fully entrench their smoking habit, perhaps making them less defensive about their smoking and more willing to consider cessation. As such, young smokers with briefer smoking histories and greater interest in quitting may be more likely to express motivations related to potential health benefits and, as a result, could be most interested in testing. They also may be especially drawn to new technologies.²¹

This report uses a mixed method approach to assess the reasons young smokers provide for and against genetic testing for lung cancer susceptibility using both open- and closed-ended items. We examined the extent to which these motivations were related to intentions to undergo genetic susceptibility testing and whether motivations and intentions differed

according to variables related to lung cancer risk, including family history of the disease and smoking-related variables.

Our primary hypotheses were that young smokers would: (a) hold strong intentions for testing, (b) express positive health effects and curiosity about this new technology as motivations for testing, and (c) express concerns about the utility of testing and that results could undermine cessation efforts as reasons not to be tested. We also hypothesized that participants' risk factors, based on their family history and their smoking behavior, as well as quit motivation, would be associated with more positive motives for and in turn, stronger intentions to undergo genetic testing. Specifically, those with a family history of lung cancer would report greater motivation to take a genetic test and would report stronger intentions to test, as would participants with more quit attempts, stronger quit motivation and shorter smoking histories. In contrast, participants with fewer quit attempts, weaker quit motivation and longer smoking histories would more strongly endorse items capturing motives that might undermine cessation efforts and would hold weaker intentions for testing.

METHODS

Recruitment and Procedure

Participants were smokers ages 18–21 who attended the University of Florida. Inclusion criteria included being a student at the University of Florida, aged 17–22, having smoked at least one cigarette in the prior week and at least 50 cigarettes in their lifetime. We used active and passive recruitment methods. Potential participants were approached on campus, as well as via advertisements that indicated they would receive \$40 for participation. Interested individuals received a weblink where they completed a brief screener at home (N=409). Eligible smokers who consented completed a baseline online survey (N=182). Following completion, they were contacted and invited to attend another session in the psychology laboratory (N=128). At the laboratory, participants read an online brochure adapted from previous research,^{22,23} which described a *GSTM1* genetic test for lung cancer susceptibility. The *GSTM1* gene is involved in the detoxification of carcinogens. Lung cancer rates are higher among smokers with the *GSTM1*-null-null genotype than smokers with at least one copy of *GSTM1* (OR 1.13–1.20).²⁴ Afterwards, participants completed another questionnaire online in the laboratory. Most participants completed the laboratory session within three weeks of the baseline online survey. The study was approved by the Institutional Review Boards at the University of Florida and Duke University Medical Center.

Measures

Sociodemographics and Family Lung Cancer History—Participants provided age, race/ethnicity, and education at the beginning of the online survey. To assess family history, we asked participants, *As far as you know, have any of your relatives ever had lung cancer?* Participants indicated each affected relative. We assessed this at the end of the laboratory session to avoid prompting the participants to think about their family history as they responded to potential motivations. Family history was treated as dichotomous (Present/Absent).

Smoking characteristics—After completing the demographics, we assessed smoking duration (months), number of serious quit attempts (*In the past year, how many times have you quit smoking for at least 24 hours?*) and quit motivation on a 1–7 scale. We assessed quit attempts in this way, rather than the standard method of assessing whether they had made a quit attempt, due to the high prevalence of quit attempts in this young adult population.²⁵

Motivations for Testing—After reading the brochure during the laboratory session, we assessed motivations for genetic testing in two ways. First, participants responded to two open-ended items asking why they would or would not want to be tested for *GSTM1*. Second, participants responded to 20 items that assessed motives for (8 items)/against (12 items) genetic testing. Health-related motives were adapted from measures of motivations for and against hereditary cancer testing,²⁶ whereas other items were drawn from measures of altruism related to research participation and interest in science.²⁷ Additionally, we operationalized measures related to curiosity and demotivation based on commentaries that raised concerns about genetic testing applications in the context of smoking.^{9,11} Item themes included: health behavior motivation/demotivation, altruism, uncertainty reduction, impact on perceived risk and worry, and curiosity about oneself. Participants rated statements using a 7-point scale.

Intentions for Testing—Participants rated their interest in getting the *GSTM1* enzyme test using a single item on a 1–7 scale.

Data Analysis

To analyze open-ended responses, two coders independently reviewed responses and grouped them thematically. All meaningful responses were included in the analysis. Responses that were inconsistent with the stem for each question were not included. The categories were reduced based on thematic review and consensus within the research team. We calculated the proportion and frequency of participants who reported each theme as their reason for getting or not getting tested.²⁸

We conducted an exploratory factor analysis of the quantitative data to identify whether the items aligned with the literature and could be distilled to a few overarching domains (i.e., factors). We conducted a principal components factor analysis using direct oblimin rotation on the 20 items. We used Kaiser criterion of eigenvalues ≥ 1.0 and Cattell's scree test to select the number of factors, combined with assessment of the factor content. Examining the factor loadings in the rotated solution, we retained items with factor loadings greater than 0.4. Items that did not load on any factor were dropped. We reran the analysis to confirm the final factor structure. Items that correlated negatively with other items within a factor were reverse coded. We then calculated total factor scores and a total scale score by summing these items. We used Cronbach's alpha to determine factor internal reliability.

We computed bivariate correlations to assess associations between factor scores and intentions. We also assessed whether motivations and intentions correlated with family history of lung cancer, duration of smoking, number of quit attempts, and quit motivation. We used multivariate regression to assess the associations of all factors simultaneously with intentions for testing. Quantitative data were analyzed using SPSS 19.0.

RESULTS

Students reported an average of 31 months as a current smoker, with moderate quit motivation ($M = 3.79$ on a 7-point scale), yet an average of 24 serious quit attempts in the prior year (see Table 1). Because months smoking and quit attempts were highly skewed, we dichotomized them at the median in our subsequent analyses (≥ 24 months and ≥ 6 quit attempts). Participants held moderately strong intentions for testing ($M = 5.21$ on a 7 point scale).

Open-Ended Responses

All participants provided answers to the open-ended question regarding why they would want to get tested; two indicated that the question regarding why they would not want to be tested was “not applicable” or provided nonsensical responses that were not coded. 15 responded that there was no reason not to be tested. Four themes emerged as reasons to be tested that were similar to those included in the motivation scale (see Table 2), including gaining more knowledge of smoking/lung cancer risk (52%), seeing testing as a potential source of quit motivation (32%) and satisfying curiosity (14%). A small minority (2%) expressed that they would want to be tested in the hopes that a result of lower risk would justify continued smoking.

Six themes emerged as reasons for not being tested: 1) Fear/worry about the result (36%), 2) distrust/unimpressed by the science supporting the test or not seeing the result as useful (25%), 3) potential financial cost (12%), 4) wanting to avoid information that would indicate the need for behavior change (10%), 5) concern that a low risk test result would undermine motivation to quit smoking (9%), and 6) fear of insurance or employer discrimination (8%). The two coders showed excellent agreement on the coding of themes for and against testing ($\kappa = .92$ and $.81$, respectively).

Factor Analyses

Using eigenvalues > 1.00 , we obtained five initial factors. However, using the combination of our scree plot and factor loadings, a four-factor solution appeared most statistically valid and provided the best fit for the data (Table 3). Two items were dropped from the final solution (*I would be paid to participate in the study*; *If I were at higher risk, I would worry about my family members who smoke*) because they did not load highly on any factor.

Two factors broadly reflected positive motivations. The first factor, subsequently labeled *Test Optimism*, comprised four items indicating perceptions that genetic testing could provide information about their risk. A second factor, *Knowledge Enhancement*, comprised three items that reflected interest in learning more about oneself and the technology and the opportunity to contribute to science. Two factors captured aspects of demotivation. One factor, *Test Skepticism*, comprised eight items that captured skepticism about the science underlying the test or the utility of the test for the participant's health. The final factor, *Smoking Optimism*, consisted of three items specific to smoking behavior suggesting that undergoing genetic testing for susceptibility to the harms of smoking was unnecessary because personal health risks associated with smoking were low. The internal consistency of all scales was acceptable ($\alpha = .73-.80$) and overall, item means for positive motivation factors were higher than demotivation factors.

Factor Intercorrelations and Relationship with Intentions for Testing

Our first hypothesis stated that motives to improve health and curiosity about this novel technology would correlate positively with intentions to test, whereas motives that might undermine cessation efforts and concerns over the utility of testing would correlate negatively with intentions to test. Table 4 presents the bivariate correlations, as well as the multivariate regression results to assess the association between motivations and intentions. In support of our hypothesis, Test Optimism and Knowledge Enhancement correlated positively with intentions and with each other in bivariate and multivariate regression analyses ($p < .001$). Test Optimism also correlated positively with Test Skepticism ($p < .001$) and Smoking Optimism ($p < .01$). Test Skepticism was unrelated to intentions for testing in bivariate analyses, but was significantly associated with lower intention to test in multivariate regression analyses ($p < .05$).

Relationships between Motivation Factors, Family History and Smoking Variables

We hypothesized that participants with a family history of lung cancer would report greater motivation to be tested and stronger intention to test, as would participants reporting more quit attempts, stronger quit motivation and shorter smoking histories. We also predicted that participants reporting fewer quit attempts, weaker quit motivation and longer smoking histories would be more likely to endorse factors that might undermine motivation to test and report weaker intentions for testing.

This hypothesis was not supported. Family history of lung cancer was unrelated to motivations and intentions. Likewise, smoking-related variables were unrelated to intentions, but they were associated with Test Skepticism. Specifically, skepticism was higher among participants who were more motivated to quit smoking ($r = .18, p < .05$), and those who reported fewer quit attempts ($t = 2.40, p < .05$).

DISCUSSION

This study provides preliminary evidence that young adult smokers may be inclined to undergo genetic susceptibility testing for lung cancer. We identified four domains of motivation, suggesting that learning about health risks may not be the sole motivator. Moreover, the association of motives with intentions differed across domains. Participants scoring highest on Test Optimism and Knowledge Enhancement reported the strongest intentions. Conversely, participants who were most skeptical reported the weakest intentions. Smokers' beliefs about sufficiency of exposure to tobacco smoke (i.e., Smoking Optimism) were unrelated to intentions to test. These results suggest that young smokers can be critical of testing in ways that indicate a relatively sophisticated understanding of the limits of current genetic tests.

It is noteworthy that Test Optimism was positively associated with Test Skepticism and Smoking Optimism, suggesting that young smokers may experience ambivalence about the eventual test result and their potential reactions.⁴ For example, young smokers could be interested in seeking testing as a means to prompt cessation, while acknowledging that results might not motivate them to take steps to quit. The potential influence of these findings on motivational responses to genetic susceptibility feedback is unclear and begs further study.

These results also suggest potential mechanisms for promoting cessation that should be examined among target groups who seek genetic susceptibility testing. For example, the loading of the item, "The result might upset me," which was designed to capture a reason against testing, loaded on the Test Optimism factor. Thus, given that no items were reverse coded, participants who endorsed being tested as a means to stop smoking were the same participants who acknowledge that feeling upset is a reason to avoid being tested. This result is not entirely unexpected, as emotions are an important predictor of behavior change.²⁹ Perhaps negative emotions are a mechanism through which genetic test results can prompt cessation.

Our hypotheses regarding how participants' risk factors and smoking behavior would relate to motivations and intentions were mostly unsupported. However, the lack of associations may have been in part the result of skewed distributions in this sample of young smokers. Rates of quit attempts and family history were higher than expected, perhaps suggesting that our study attracted individuals with higher motivation. With that said, young adults typically report higher rates of quit attempts in compared to other adults.²⁵ Indeed, it was this motivation that we wanted to capitalize on for this line of research. Also, some young smokers might have deemed lapses (>24 hours) as "quit attempts" even though they were

not a trying to quit. Even with these caveats, the lack of associations among motives, intentions and risk factors suggests that inclinations to seek genetic testing are not influenced by these risk factors.

In general, participants' responses to our open-ended questions were synchronous with our quantitative items. However, our open-ended responses yielded novel information regarding reasons young smokers may not want to be tested, most notably, to avoid prompts for unwanted health behavior change. This finding is consistent with prior studies showing that people are more likely to avoid health information that potentially creates an undesired emotion, challenges a desired self-view, or eventuates an unwanted action.³⁰ It is noteworthy that this theme of avoidance emerged from a second, purely qualitative study our research team conducted using semi-structured interviews with a separate sample of undergraduates in a different part of the country.³¹ These findings suggest that avoidance as a motivation is particularly important in a young, healthy population with numerous priorities other than health.

Our results have several implications. First, our results further challenge assertions that genetic susceptibility testing on its own will be a powerful motivational tool for behavior change, in this case, smoking cessation among young smokers.¹² Our sample was not particularly inclined to quit smoking and participants with the greatest quit motivation were the most skeptical of the benefits of testing. This might reflect greater contemplation of the pros and cons of testing among those with heightened quit motivation. Moreover, general positive inclination towards genetic testing observed in this group, and the lack of association among smoking-related characteristics, motivations for genetic testing, and test intentions suggest that this group will be heterogeneous with respect to their pattern of smoking behaviors and their motives for testing. This heterogeneity raises risk communication challenges. Serialized communication strategies, tailored to the dominant motivation for a given smoker, could accommodate such heterogeneity.¹⁵ Alternatively, genetic testing could be included as part of a cessation intervention for a subset of participants most likely to be responsive. Such tailoring would require testing the motivation items we have identified in other populations and settings which offer testing.

Our study has several limitations. First, our sample was drawn from undergraduates who responded to our advertisements at one institution in the US and participants were primarily White or Hispanic. This approach could have led to sampling or recruitment bias when compared to more generalizable methods. Our participants may have been better educated or more curious about technologies than the general US population. Their smoking characteristics, such as their high number of quit attempts, are not generalizable to the broader population of smokers. We also did not include a measure of nicotine dependence that could have further described our sample and informed our findings. With that said, we were specifically interested in the thoughts of young adult smokers. Our findings need replication in new and different samples and using confirmatory factor analysis. This is particularly true given racial differences in both lung cancer risk^{32–34} and differential awareness of this risk.³⁵ Second, given that research shows that intentions for testing correlate modestly with uptake²³ and given that our participants knew that they would not be offered testing our results should be replicated in a sample receiving testing. Given the preliminary nature of our work, we suggest that all four factors be retained and perhaps additional items be constructed to capture the novel constructs shown in our participants' open-ended responses. For instance, we included intrapersonal factors that would be associated with interest in testing, and not interpersonal influences from friends and family that likely influence young smokers. Despite these limitations, our study is among the first to assess reasons for genetic testing for susceptibility to a chronic, behavior-linked disease

among young smokers, demonstrating the diverse nature of these motivations and how these might relate to genetic test uptake.

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Table 1

Sociodemographic characteristics of study participants

(N = 128)		
Characteristic	%	M (SD)
Demographics		
Female	50	
Age		20.10 (1.03)
Race/ethnicity		
Caucasian	71	
African American	3	
Hispanic	18	
Asian or Pacific Islander	3	
Biracial	5	
Years in undergraduate education		
1	15	
2	18	
3	36	
4	31	
Family history of lung cancer		
Yes	41	
No	59	
Smoking-related variables		
Number of quit attempts (12 mos.)		24.10 (49.27)
Length of smoking (months)		31.11 (19.43)
Desire to quit		3.79 (1.71)
Intentions for Testing		5.21 (1.67)

Table 2

Responses to open-ended questions

Motivation Theme		Example	%
1	Knowledge of risk	"It would be beneficial to get tested so I know if I am more at risk."	52
2	Quit Motivation	"If I found out I was more at risk, I would seriously consider quitting."	32
3	Curiosity	"After reading this pamphlet, my basic motivation for getting tested would be curiosity."	14
4	Reason to continue smoking	"Knowing that I had the gene would make me a little more comfortable with my cigarette smoking."	2
Demotivation/Avoidance Theme			
1	Fear/Worry of Results	"If I found out negative results, in that I am missing the enzyme, it would make me nervous and think about it a lot and I don't want to know if there is nothing that I can do to produce it that would help."	36
2	Not trusting/not being impressed by the science supporting the test	"I feel that two out of 100 people is not very increased chance so it doesn't really matter."	25
3	Potential financial cost	"If the test costs money to get tested. I cannot afford it right now."	12
4	May prompt unwanted behavior change	"If I knew I lacked the enzyme, I might be more concerned about the places I go such as bars and clubs where people smoke because I would be fearful of developing cancer due to second hand smoke, thus, not enjoying myself"; "Ignorance is bliss. Pretty much what I don't know can't hurt me and it's one less thing for me to worry about."	10
5	Fear of demotivation in response to lower risk	"If it came back negative, I probably wouldn't quit smoking."	9
6	Fear of insurance or employer discrimination	"I wouldn't want to get tested only because of the risk of employers and insurance companies discriminating against my participation in the test."	8

Item Means and Factor Loadings

Table 3

	Factors				
	M (SD)	Test Skepticism	Test Optimism	Knowledge Enhancement	Smoking Optimism
When you think about why you WOULD want to be tested from GSTM1, how important are the following reasons?					
1. The result might motivate me to stop smoking if I find out I am at greater risk.	5.59 (1.48)	.04	.84	.17	.12
2. I want to know what my chances are of getting lung cancer, if I continue to smoke.	5.52 (1.50)	.04	.81	.26	.11
3. I could learn more about myself.	4.92 (1.72)	.21	.37	.72	-.07
4. I could help advance science.	4.90 (1.63)	-.03	.19	.82	-.13
5. The technology is interesting to me.	4.66 (1.79)	-.06	.16	.79	.21
6. Testing would considerably reduce my uncertainty about the future.	4.07 (1.66)	.23	.76	.22	.09
7. If I knew I was at lower risk, it would protect me and allow me to keep smoking.	3.00 (1.52)	.53	.36	.07	.45
When you think about why you WOULD NOT want to be tested from GSTM1, how important are the following reasons?					
8. There is no proof that MISSING the GSTM1 enzyme causes lung cancer.	3.40 (1.67)	.71	.19	.02	.36
9. The result won't tell me about my risk for other diseases.	3.27 (1.84)	.71	.27	-.05	.33
10. The result might upset me.	3.43 (1.99)	.53	.56	-.23	.35
11. I'm planning to quit smoking soon, so my risk as a smoker is not important.	3.32 (1.76)	.32	.23	-.11	.68
12. I don't smoke enough to be at risk.	3.37 (1.86)	.14	.02	-.03	.88
13. Even if the test result shows that I am at higher risk, I do other things that are good for me (exercise, eating well) that counteract the risks of smoking.	3.48 (1.84)	.38	.17	.04	.80
14. My health risks are not a concern for me compared to other issues in my life (school, work, friends, etc.).	2.87 (1.63)	.59	-.17	-.24	.25
15. I wouldn't know what to do with the result.	3.05 (1.73)	.57	.13	-.45	.21
16. The result might suggest that I should quit smoking and I don't want to quit right now.	2.72 (1.70)	.57	.13	-.06	.19
17. The result cannot give me a definite answer if and when I am going to get lung cancer.	3.62 (1.94)	.79	.03	.08	.22
18. Early knowledge is not useful to prevent disease.	2.52 (1.93)	.61	.13	-.03	.09
Scale Means (SD)		3.03 (1.09)	4.63 (1.23)	4.83 (1.41)	3.31 (1.47)
Cronbach's alpha for factor		.80	.73	.77	.73

Note. Items used a 7-point scale ("not at all important" to "extremely important").

Table 4
Factor Intercorrelations and Bivariate and Multivariate Associations between Factors and Intentions for Testing

Factors	Intentions for Testing					
	Test Skepticism	Test Optimism	Knowledge Enhancement	Smoking Optimism	Bivariate (r)	Multivariate ()
Test Skepticism	--	.30 ***	-.03	.41 ***	-.10	-.18 *
Test Optimism			.20 *	.23 **	.39 ***	.38 ***
Knowledge Enhancement				.07	.49 ***	.41 ***
Smoking Optimism					-.01	-.05

* p < .05;

** p < .01;

*** p < .001.