Tennessee State University
Digital Scholarship @ Tennessee State University

Center for Prevention Research Publications | Center for Prevention Research

6-3-2019

Attitudes toward Precision Treatment of Smoking in the Southern Community Cohort Study

Nicole Senft
Vanderbilt University

Maureen Sanderson
Meharry Medical College

Rebecca Selove
Tennessee State University

William J. Blot
Vanderbilt University

Stephen King
Vanderbilt University

See next page for additional authors

Follow this and additional works at: https://digitalscholarship.tnstate.edu/preventionresearch-publications

 Part of the Behavioral Medicine Commons

Recommended Citation

N. Senft, M. Sanderson, R. Selove, W.J. Blot, S. King, K. Gilliam, S. Kundu, M. Steinwandel, S.J. Sternlieb, S.W. Andersen, D.L. Friedman, E. Connors, M.K. Fadden, M. Freiberg, Q.S. Wells, J. Canedo, R.F. Tyndale, R.P. Young, R.J. Hopkins, H.A. Tindle "Attitudes toward Precision Treatment of Smoking in the Southern Community Cohort Study" Cancer Epidemiol Biomarkers Prev August 1 2019 (28) (8) 1345-1352; DOI: 10.1158/1055-9965.EPI-19-0179

This Article is brought to you for free and open access by the Center for Prevention Research at Digital Scholarship @ Tennessee State University. It has been accepted for inclusion in Center for Prevention Research Publications by an authorized administrator of Digital Scholarship @ Tennessee State University. For more information, please contact XGE@Tnstate.edu.

Authors

Nicole Senft, Maureen Sanderson, Rebecca Selove, William J. Blot, Stephen King, Karen Gilliam, Suman Kundu, Mark Steinwandel, Sarah J. Sternlieb, Shaneda Warren Andersen, Debra L. Friedman, Erin Connors, Mary Kay Fadden, Matthew Freiberg, Quinn S. Wells, Juan Canedo, Rachel F. Tyndale, Robert P. Young, Raewyn J. Hopkins, and Hilary A. Tindle

This article is available at Digital Scholarship @ Tennessee State University: https://digitalscholarship.tnstate.edu/preventionresearch-publications/3

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

HHS Public Access

Author manuscript

Cancer Epidemiol Biomarkers Prev. Author manuscript; available in PMC 2020 February 01.

Published in final edited form as:

Cancer Epidemiol Biomarkers Prev. 2019 August ; 28(8): 1345–1352. doi: 10.1158/1055-9965.EPI-19-0179.

Attitudes towards precision treatment of smoking in the Southern Community Cohort Study

Nicole Senft[1], **Maureen Sanderson**[2], **Rebecca Selove**[3], **William J. Blot**[1], **Stephen King**[1], **Karen Gilliam**[1], **Suman Kundu**[1], **Mark Steinwandel**[1], **Sarah J. Sternlieb**[1], **Shaneda Warren Andersen**[1,4], **Debra L. Friedman**[1], **Erin Connors**[3], **Mary Kay Fadden**[2], **Matthew Freiberg**[1,5], **Quinn S. Wells**[1], **Juan Canedo**[2], **Rachel F. Tyndale**[6], **Robert P. Young**[7], **Raewyn J. Hopkins**[7], **Hilary A. Tindle**[1,5]

[1]Vanderbilt University Medical Center, Nashville, TN, USA

[2]Meharry Medical College, Nashville, TN, USA

[3]Tennessee State University, Nashville, TN, USA

[4]Universtiy of Wisconsin-Madison; University of Wisconsin Carbone Cancer Center, Madison, WI, USA

[5]Geriatric Research Education and Clinical Centers (GRECC), Veterans Affairs Tennessee Valley Healthcare System, Nashville, TN, USA

[6]Campbell Family Mental Health Research Institute, Centre for Addiction and Mental Health, and Departments of Pharmacology and Psychiatry, University of Toronto, ON, Canada

[7]University of Auckland, Auckland, NZ

Abstract

Background: Precision interventions using biological data may enhance smoking treatment, yet are understudied among smokers who are disproportionately-burdened by smoking-related disease.

Methods: We surveyed smokers in the NCI-sponsored Southern Community Cohort Study, consisting primarily of African American, low-income adults. Seven items assessed attitudes towards aspects of precision smoking treatment, from undergoing tests to acting on results. Items were dichotomized as favorable (5=strongly agree/4=agree) vs. less favorable (1=strongly disagree/2=disagree/3=neutral); a summary score reflecting generalized attitudes was also computed. Multivariable logistic regression tested independent associations of motivation (precontemplation, contemplation, preparation) and confidence in quitting (low, medium, high) with generalized attitudes, controlling for sociodemographic factors and nicotine dependence.

Results: Over 70% of respondents endorsed favorable generalized attitudes toward precision medicine, with individual item favorability ranging from 64-83%. Smokers holding favorable

Corresponding Author: Nicole Senft, 2525 West End Ave., Suite 450, Nashville, TN 37203, Nicole.senft@vumc.org.

Conflict of Interest: R.F.T. has consulted for Quinn Emmanual and Apotex on unrelated topics. Other authors declare no potential conflicts of interest.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

generalized attitudes reported higher income and education (p's < 0.05). Predicted probabilities of favorable generalized attitudes ranged from 63% to 75% across motivation levels (contemplation vs. precontemplation: Adjusted odds ratio [AOR]=2.10 [95%CI 1.36-3.25], p<.001; preparation vs precontemplation: AOR=1.83 [95%CI 1.20-2.78], p=.005; contemplation vs. preparation: AOR=1.15 [95%CI 0.75-1.77], p=.52) and from 59% to 78% across confidence (med vs low: AOR=1.91 [95%CI 1.19-3.07], p=.01; high vs low: AOR=2.62 [95%CI 1.68-4.10], p<.001; med vs high: AOR=0.73 [95%CI 0.48-1.11], p=.14).

Conclusions: Among disproportionately-burdened community smokers, most hold favorable attitudes towards precision smoking treatment. Individuals with lower motivation and confidence to quit may benefit from additional intervention to engage with precision smoking treatment.

Impact: Predominantly favorable attitudes towards precision smoking treatment suggest promise for future research testing their effectiveness and implementation.

Racial, economic, and regional disparities remain in tobacco use, with minority, low-income, and southern-dwelling smokers all bearing a disproportionate burden of smoking-related disease and mortality (1,2). Precision medicine that tailors smoking treatment to individuals' genetic characteristics is a promising approach for reducing smoking-related disparities. However, it remains unclear whether precision approaches will be taken up and used among populations of smokers who are disproportionately burdened by tobacco (i.e., based on their race/ethnicity, income, region of the United States, or the intersection of these (1,2)).

Past work supports the efficacy of precision approaches in promoting smoking cessation (3-9). Lerman et al (5) demonstrated that smokers with faster nicotine metabolism (assessed by the nicotine metabolite ratio (NMR), a genetically informed biomarker of hepatic nicotine metabolism) assigned to receive varenicline were twice as likely to quit smoking as those assigned to the nicotine patch. Among slower metabolizers, these treatments were equally effective, but side effects with varenicline were more pronounced. However, in that study smokers were not informed of their NMR results, leaving open the question of how they might react to this information if it were incorporated into smoking treatment. Other work has demonstrated that smokers who received results from a commercially available test for a gene-based lung cancer risk score (Respiragene) (7,8) were more likely to undergo lung cancer screening, use nicotine replacement therapy, and quit smoking. Further enthusiasm for these specific precision approaches is bolstered by evidence of their acceptability among smokers (10-13).

However, for precision approaches to promote health equity, they must be broadly implementable, especially among groups suffering from tobacco-related disparities. Evidence-based treatments for smoking cessation are underutilized among disproportionately burdened smokers (14-16) for many reasons, including unfavorable attitudes towards some of these treatments (17-20). Research in other healthcare contexts shows racial/ethnic minorities have more concerns about genetic testing and precision medicine than Whites, believing genetic testing or precision medicine may be misused, lead to racial discrimination, or do more harm than good (21,22). However, preliminary findings support the acceptability of precision approaches for smoking among minorities. Shields et al. (23) found that African American smokers were more likely than White smokers to be

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

willing to undergo genetic testing to be matched to optimal treatment. Another small study of primarily African-American smokers found that participants who had already expressed interest in receiving genetic risk results responded favorably to them and that quit attempts increased after receiving results (24). These preliminary findings support the hypothesis that precision approaches for smoking will be equitably taken up and utilized.

Another key step to successful clinical translation is understanding potential predictors of engagement in precision smoking treatment. Lack of motivation and confidence are known barriers to successful smoking cessation, and may be used by smokers or their providers as rationale to forego the use or offer of smoking treatments, respectively (25,26). However, recent research and updated guidelines suggest that services should be offered to smokers across the motivational spectrum (27-29). Understanding whether smokers lacking motivation or confidence would be willing to use precision treatments could help researchers and clinicians identify strategies to increase engagement in this population of smokers.

We build on existing knowledge by concurrently examining attitudes towards two promising precision approaches (NMR, which can be leveraged to select pharmacotherapy, and gene-based risk testing, Respiragene, which can be leveraged to enhance motivation to make healthy behavior change) and behavioral changes based on these test results. We examine these attitudes among participants of the Southern Community Cohort Study (SCCS), a population of disproportionately burdened smokers. We hypothesized that precision smoking treatment would generally be viewed favorably, and that favorable attitudes would be more likely among motivated, confident smokers.

Methods

Study Population

The Southern Community Cohort Study (SCCS) is a prospective cohort study sponsored by the National Cancer Institute and initiated in 2001 (30). The SCCS was established to identify causes of disparities in cancer and other health outcomes. The cohort includes approximately 85,000 adults throughout the southeastern United States that have been well-characterized by over 15 years of participation in the study. The cohort consists primarily of African American, low-income adults, members of demographic groups that are traditionally underrepresented in health research. A majority of the cohort was recruited at community health centers, and nearly 25% of respondents currently reside in rural areas. The study also features a large biorepository with genetic data for ~90% of participants.

Participants

Participants were eligible for inclusion in the current study's Precision Smoking Cessation Survey, collected in 2017, if they were active SCCS participants residing in Tennessee or Mississippi and identified as current smokers in the SCCS Followup 3 survey, collected between 2015 and 2018 (N=1407). A total of 988 responses to the Precision Smoking Cessation Survey were collected, yielding a response rate of 70%. Of these, 143 were excluded (72 had quit smoking since SCCS Followup 3; 31 lacked data on smoking status, and 40 did not respond to at least 2/3rd of the precision medicine items, a requirement for

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

inclusion in the analysis) yielding an analytic sample of 845 smokers. Compared to smokers with complete data on attitudes towards precision medicine, those missing < 1/3rd of data tended to have higher nicotine dependence, as defined by the Heaviness of Smoking Index (X^2=15.23, p<.001). Further exclusions based on missing data were made on an analysis-by-analysis basis (see Statistical Analyses). All participants provided written informed consent before enrollment in the SCCS. This study was conducted in accordance with recognized ethical guidelines (e.g., Declaration of Helsinki, CIOMS, Belmont Report, U.S. Common Rule) and was approved by institutional review boards at Vanderbilt University, Meharry Medical College, and Tennessee State University.

Measures

Attitudes towards Precision Medicine—Seven items assessed attitudes towards different aspects of precision treatment of smoking (Supplementary Table 1). Items were designed with iterative feedback from a Community Advisory Board consisting of current and former smokers to ensure the use of simple, understandable language. They were designed to capture attitudes towards both pharmacogenetics and gene-based lung cancer risk assessment, with a focus on clinically relevant behaviors (i.e., taking the tests, taking medication, getting lung cancer screening, and quitting smoking). At the time of survey construction, Respiragene was commercially available as a buccal swab while NMR was often conducted via blood test; item wording reflects these test modalities. Items were rated on a 5-point scale (1=strongly disagree, 5=strongly agree), responses were dichotomized to reflect favorable (4=agree, 5=strongly agree) vs. not favorable attitudes (1=strongly disagree, 2=disagree, 3=neutral).

While each individual item taps into a different aspect of precision smoking treatment, they theoretically also capture an underlying construct reflecting more generalized attitudes towards precision smoking treatment. To create a measure of generalized attitudes (see Statistical Analyses and Results), we first calculated the mean of all 7 items (mean=3.77, SD=0.95) and dichotomized mean total scores to correspond to the cutoffs used for the individual items reported above (<3.5=not favorable, ≥3.5=favorable), thus facilitating comparison between individual items and the summary statistic.

Motivation to Quit—Assessment of motivation to quit was guided by the two items from the transtheoretical model (31): “Are you thinking of quitting cigarettes in the next six months?” (Yes/No), and, “Are you planning to quit smoking in the next 30 days?” (Yes/No), producing three groups (precontemplation=not yet thinking of quitting; contemplation=thinking about quitting in the next six months but not planning to quit in the next 30 days; preparation=planning to quit in the next 30 days).

Confidence in Quitting—A single item assessed confidence in quitting, “I am confident that I can quit smoking,” rated on a 5-point scale (1=strongly disagree to 5=strongly agree) (32,33). Responses were categorized into low (disagree, strongly disagree), medium (neutral), and high (strongly agree, agree) confidence levels.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Individual Characteristics

Sociodemographics.: Sociodemographic items included age, sex, race and ethnicity, and highest education completed (assessed at SCCS baseline, 2002–2009), annual household income and insurance status (assessed at SCCS follow up, 2015–2018).

Nicotine Dependence.: Nicotine dependence was calculated via the Heaviness of Smoking Index (HSI, (34)), a metric based on self-reported time to first cigarette (within 5 minutes, 6–30 minutes, 31–60 minutes, after 60 minutes) and number of cigarettes smoked per day.

Lung Cancer Risk.: Predicted lung cancer risk for each respondent was calculated using the Tammemagi risk predictor, which incorporates age, education, race/ethnicity, body mass index (BMI), family history of lung cancer, personal history of cancer, diagnosis of chronic obstructive pulmonary disease (COPD), emphysema, or chronic bronchitis, current smoking status, current cigarettes per day, and years smoked (35). These data were collected through participation in the SCCS baseline and follow-up surveys. This calculated risk score was included for descriptive purposes to better characterize the sample, but the study was not designed to inform participants of this information. Because respondents were not informed of their predicted lung cancer risk scores, it was not expected that the scores would be associated with attitudes towards precision smoking treatment. Thus, this variable is not included in hypothesis testing.

Statistical Analyses—Statistical analyses were conducted using IBM SPSS Statistics 25 and Stata 15 SE. We conducted an exploratory factor analysis and examined inter-item correlations to calculate a summary score reflecting generalized attitudes towards precision smoking treatment. Next, we tested whether generalized attitudes towards precision smoking treatment differed across demographic and smoking-related factors, using t-tests for continuous variables and chi-square tests for both ordinal and nominal variables. These analyses used data from the full analytic sample (n=845).

Multivariable logistic regression tested associations between motivation (precontemplation, contemplation, preparation) and confidence in quitting (low, medium, high) with generalized attitudes towards precision treatment of smoking, adjusting for sociodemographic characteristics (age, race, sex, education, insurance) and nicotine dependence. The effects of these covariates were also explored. For each level of motivation and confidence, we calculated the average predicted probability of holding favorable generalized attitudes using the margins posttest in Stata. This test averages the estimates of each individual's probability of holding favorable generalized attitudes if all covariates are unchanged and the exposure variable is set to a given value (e.g., low confidence). Respondents with missing data on either confidence or motivation (n=50) or on one or more covariates (n=57) were excluded, resulting in a sample of 738 smokers for this analysis. Compared to those with complete data, smokers missing data tended to have lower levels of education ($\chi^2(2, 823)=10.91$, p=.004) but were similar across other factors. Income was not included in this analysis due to the amount of missing data in this variable. However, including income as an additional covariate did not change the pattern of results from that reported below.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Results

Attitudes towards Precision Treatment

Factor analysis of the seven survey questions relating to attitudes towards precision treatment of smoking revealed that a single factor explained 61% of total variance in responses. In the unrotated factor matrix, factor loadings for the seven individual items on the first factor ranged from 0.43 to 0.93. Furthermore, inter-item correlations revealed moderate to strong correlations across individual items (Table 1), and Cronbach's alpha of 0.89 supported scaling items to form a single construct.

Overall, 71% of smokers held favorable generalized attitudes towards precision smoking treatment (Figure 1). For individual items, favorability of each aspect of precision treatment ranged from 64% to 83%. The blood test for pharmacotherapy selection based on nicotine metabolism was less likely to be rated favorably (Item 2=64%, Item 1=69%) while the saliva test for lung cancer risk was most likely to be rated favorably (Item 5=79%, Item 6=81%, Item 7=83%). Within these categories, responses were well distributed. The modal "favorable" response was "4=agree" for each item, although approximately 1/3 to 1/2 of "favorable" responses indicated strong agreement. Within "not favorable" responses, strong disagreement was the most common response to items 1–4, while a neutral response was most common for items pertaining to the saliva testing for lung cancer risk (5-7).

Baseline Characteristics of the Sample and Relation to Attitudes

Smokers recruited through the SCCS were predominantly African American and low-income. Approximately one third of the sample was considered at high risk of developing lung cancer based on predicted lung cancer risk score (Table 2). Compared to respondents without favorable generalized attitudes towards precision smoking treatment, those with favorable attitudes tended to be younger, report higher income and education, have private insurance or Medicare, have lower nicotine dependence, and have higher motivation and confidence to quit smoking.

Multivariable Regression Results

Association between Motivation and Attitudes.—Controlling for sociodemographic characteristics and nicotine dependence, the odds of endorsing favorable generalized attitudes were directly related to motivation to quit (Table 3). Compared to smokers in precontemplation, smokers in contemplation (adjusted odds ratio [AOR]=2.10 [95% CI 1.36–3.25], p=.001) and preparation (AOR=1.83 [95% CI 1.20–2.78], p=.005) had more favorable generalized attitudes. Smokers in contemplation did not significantly differ from those in preparation (AOR=1.15 [95% CI 0.75–1.77], p=.52). Adjusted predicted probabilities of endorsing favorable attitudes were ≥63% across all levels of motivation (see Figure 2).

Association between Confidence and Attitudes.—Odds of endorsing favorable attitudes were also directly related to confidence in quitting (see Table 3). In adjusted models, compared to smokers with low confidence, those with medium (AOR=1.91 [95% CI 1.19–3.07], p=.007) and high (AOR= 2.62 [95% CI 1.68–4.10], p<.001) confidence had

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

more favorable generalized attitudes. Smokers with medium confidence did not significantly differ from those high in confidence (AOR= 0.73 [95% CI 0.48–1.11], p=.14). Adjusted predicted probabilities of endorsing favorable attitudes were ≥59% across all levels of motivation (see Figure 2).

Associations between Demographic Factors, Nicotine Dependence and Attitudes.—After adjustment, smokers who were younger (AOR=0.96 [95% CI 0.93–0.99], p=.02), had greater than a high school education (vs. less than high school; AOR=1.61 [95% CI 1.03–2.54], p=.04), or had private insurance (AOR=2.29 [95% CI 1.00–5.23], p=.05) remained more likely to hold favorable attitudes towards precision smoking treatment. In addition, African Americans were 53% less likely to hold favorable attitudes than Whites (AOR=0.47 [95% CI 0.27–0.83], p=.009). There was no significant effect of nicotine dependence after adjustment for other variables in the model.

Discussion

Among over 800 low-income, southern-dwelling, predominantly minority smokers in the Southern Community Cohort Study, 71% endorsed favorable attitudes towards precision approaches to smoking cessation. Smokers with greater motivation and confidence had over 2 times the odds of endorsing favorable attitudes than those at the lowest levels. Yet approximately 60% of those with the lowest levels of confidence and motivation still endorsed precision approaches, suggesting that intervention research and clinical implementation of precision approaches should be inclusive of smokers across the motivational and confidence spectrums. Similarly, despite less positive attitudes toward precision smoking treatment among older, African American, and less highly educated smokers, endorsement remained generally high. Together, these findings provide evidence that precision smoking treatment will be well-received and could promote behavior change among disproportionately burdened smokers.

This study is the first to concurrently document the acceptability of NMR, a genetically informed biomarker for nicotine metabolism, Respiragene, a gene-based lung cancer risk assessment, and participants' hypothetical estimates of their own behavior change based on these tests results. Results add further evidence to the promise of using precision approaches for smoking treatment among disproportionately burdened groups (23,24). The personalized nature of these approaches may increase their acceptability relative to other existing treatments such as counseling and medication, which tend to be viewed less favorably by members of disproportionately burdened groups (17-20). Data also support combining attitudes towards these varied aspects of precision treatment into a single measure of generalized attitudes towards precision smoking treatment, which will facilitate measurement and analysis of these and similar approaches in future work.

Results highlight the opportunity of integrating precision approaches into clinical care to improve health outcomes. For example, past work suggests that lung cancer screening is associated with 20% relative reduction in mortality (36), yet in 2016, only 1.9% of eligible smokers were screened, with screening rates in the Southern U.S. being among the lowest (37). Notifying patients of their lung cancer risk using Respiragene may motivate

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

engagement in smoking treatment; 83% of respondents in our sample reported that they would be more likely to get lung cancer screening if their genetic test result suggested they were at high risk of lung cancer. Given that nearly 1/3 of the sample is considered at high risk of developing lung cancer, this increased rate of lung cancer screening would likely result in lives saved. In addition, 64% of smokers in this sample said they would take medication based on results of a blood test, and matching patients to medication based on NMR status can double the efficacy of medication for faster metabolizers while minimizing side effects for slower metabolizers (5).

Integrating precision approaches with existing motivational and confidence-building tools may increase the impacts of each. For example, motivational interviewing, a style of counselling aimed at increasing motivation by addressing patients' ambivalence towards behavior change, has been widely applied in clinical settings with small to moderate effects (38,39). These data suggest a threshold effect of increased motivation and confidence, with more favorable attitudes among smokers with at least moderate (relative to low) levels of motivation and confidence, but no added benefit of being highly motivated or confident. It is possible that for smokers at the lowest levels of motivation and confidence, small increases in these factors may be enough to facilitate engagement in precision treatment. Incorporating precision approaches with motivational interviewing techniques may maximize impact on smoking cessation for all smokers, but especially those from disproportionately burdened groups who lack confidence or motivation. Yet another application of these tests lies in improving efficiency of care by reducing waste and cost. For example, a two-fold greater efficiency of lung cancer screening can be achieved by using this gene-based approach to assessing lung cancer risk to identify who benefits most from lung cancer screening (40).

Though these data suggest that most smokers view precision smoking treatment favorably, additional support may be necessary to engage smokers who are older, African American, and do not have a high school degree. Sources of resistance to precision treatment are likely to vary across these different aspects of identity, perhaps including perceived social norms, access, or privacy concerns. If precision approaches are to narrow health disparities, future work should examine means of further increasing their appeal to these groups of smokers. For example, to influence perceived social norms, these results may be disseminated to current smokers to demonstrate the social acceptability of precision smoking treatment among their peers. To ensure equity in access, future work should examine the acceptability and feasibility of implementing these approaches at the provider and system levels. Healthcare systems, particularly in community settings most likely to serve smokers from disproportionately burdened groups, may not have the infrastructure or resources in place to implement precision approaches. Providers may not be well informed about the efficacy of precision approaches or may believe some groups of patients will reject precision smoking treatment. Providers may also require additional education or training regarding culturally competent communication, which can address patients' concerns about privacy or the potential for harm.

Our study has several limitations. First, we did not assess actual behavior; thus, we cannot maintain that respondents will take the tests for nicotine metabolism or lung cancer risk, or that doing so will lead to improvements in lung cancer screening, cessation rates, or

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

medication adherence. However, intentions such as those measured here can be powerful predictors of behavior (41). Next, items related to Respiragene specified a buccal smear ("saliva test") and items related to NMR testing specified a blood test, confounding the type of test with the mode of testing. Higher observed favorability ratings for risk assessment vs. pharmacogenetics are likely due to preferences for less invasive buccal smear over blood tests. As the field moves forward, these tests will likely be widely available using blood or buccal swab samples, suggesting pharmacogenetics will be viewed even more favorably than reported here. Next, while the sample of disproportionately burdened smokers is a strength, these results may not generalize to other high-risk groups, such as low-income African Americans in large urban centers or immigrant groups lacking English proficiency, and future work should establish the likely acceptability of precision approaches among these groups.

Despite these limitations, results have broad implications for research and clinical settings. The study population is a significant strength. Participants were community smokers and members of social groups traditionally underrepresented in healthcare research and at high risk of suffering tobacco-related disparities. Understanding this group of smokers, their attitudes towards precision smoking treatment, and variation in attitudes associated with known barriers to cessation (e.g., motivation and confidence) lays the groundwork for intervention research to examine the efficacy of precision approaches for equitable treatment of smoking cessation. Further, data were collected through the Southern Community Cohort Study, which has characterized participants over more than 15 years. We leveraged previously collected data to accurately define smoking history and richly describe the sample (e.g., calculate predicted lung cancer risk) with minimal additional respondent burden. Further, the SCCS offers a large biorepository that can be leveraged for future precision treatment approaches with Respiragene and the NMR. This work also has clinical implications in that knowledge of the acceptability of genetic testing to assess lung cancer risk and to support pharmacotherapy choice supports wide implementation of these approaches. Future work would also benefit from the use of hybrid trial designs which integrate effectiveness and implementation outcomes (42). Implementation theories and frameworks like The Consolidated Framework for Implementation Research (CFIR) offer guidance regarding potential facilitators and barriers to the successful implementation of precision smoking treatment, such as an organization's readiness for change and available resources, patient and provider knowledge and attitudes, and the presence of individual champions or supportive opinion leaders (43). Intervention studies of precision smoking treatment would also be strengthened by the inclusion of implementation outcomes such as reach among eligible patients, adoption by healthcare systems and individual providers, and the sustainability of precision smoking treatment as a component of standard care (44). As this research continues to clarify patient, provider, and system level barriers and facilitators to precision smoking treatment, implementation science also offers strategies for addressing these barriers and increasing engagement (45).

Our collective findings suggest that precision smoking treatment is favorably viewed and likely to lead to behavior change among smokers who have historically been less successful at quitting and are at especially high risk of suffering and mortality from smoking-related disease. These data lay groundwork for future intervention research and support clinical

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

implementation of precision approaches by clarifying the promise of these approaches in promoting health equity. Future research should focus on testing the comparative effectiveness, as well as cost effectiveness and cost efficiency, of precision approaches in promoting health behavior change, including lung cancer screening, medication adherence, and smoking cessation. Research should also focus on implementation strategies that support efficacy in community health settings to ensure equitable implementation and dissemination of precision smoking treatments.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This work was supported by the National Cancer Institute (U54CA163072–09S1, PI: H. L. Moses, sub-project 6540, PI: H. A. Tindle; U54CA163069, PI: S. E. Adunyah, sub-project 6962, PI: M. Sanderson; U54CA163066, PI: B. A. Husaini, sub-project 6610, PI: R. Selove), This project was further supported by the Vanderbilt Center for Tobacco, Addiction, and Lifestyle (ViTAL; directed by H. A. Tindle). The Southern Community Cohort Study (SCCS) is funded by grant R01CA92447 (PI: W. J. Blot and W. Zheng) from the National Cancer Institute at the National Institutes of Health, including special allocations from the American Recovery and Reinvestment Act (3R01CA092447–08S1). N. Senft was supported by the Agency for Healthcare Research and Quality (AHRQ) under Award Number T32 HS026122. The content is solely the responsibility of the authors and does not necessarily represent the official views of AHRQ. S. Warren Andersen is supported by R00CA207848, P30CA014520 and the University of Wisconsin-Madison, Office of Vice Chancellor for Research and Graduate Education with funding from the Wisconsin Alumni Research Foundation.” The project was supported by CTSA award No. UL1 TR002243 from the National Center for Advancing Translational Sciences. We also acknowledge a Canada Research Chair in Pharmacogenomics (R. F. Tyndale).

References

1. Singh GK, Williams SD, Siahpush M, Mulhollen A. Socioeconomic, Rural-Urban, and Racial Inequalities in US Cancer Mortality: Part I—All Cancers and Lung Cancer and Part II—Colorectal, Prostate, Breast, and Cervical Cancers [Internet]. J. Cancer Epidemiol. 2011 [cited 2018 9 17]. Available from: https://www.hindawi.com/journals/jce/2011/107497/
2. U.S. Department of Health and Human Services. The Health Consequences of Smoking: 50 Years of Progress. A Report of the Surgeon General [Internet]. Atlanta (GA): Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2014 [cited 2019 5 20]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK179276/
3. Chen L-S, Baker TB, Grucza R, Wang JC, Johnson EO, Breslau N, et al. Dissection of the Phenotypic and Genotypic Associations With Nicotinic Dependence. Nicotine Tob Res. 2012;14:425–33. [PubMed: 22102629]
4. Chen L-S, Horton A, Bierut L. Pathways to precision medicine in smoking cessation treatments. Neurosci Lett. 2018;669:83–92. [PubMed: 27208830]
5. Lerman C, Schnoll RA, Hawk LW, Cinciripini P, George TP, Wileyto EP, et al. Use of the nicotine metabolite ratio as a genetically informed biomarker of response to nicotine patch or varenicline for smoking cessation: a randomised, double-blind placebo-controlled trial. Lancet Respir Med. 2015;3:131–8. [PubMed: 25588294]
6. Nichols JAA, Grob P, Kite W, Williams P, de Lusignan S. Using a genetic/clinical risk score to stop smoking (GeTSS): randomised controlled trial. BMC Res Notes. 2017;10:507. [PubMed: 29061161]
7. Viron S, Heyden JV, Ambrosino E, Arbyn M, Brand A, Oyen HV. Impact of Genetic Notification on Smoking Cessation: Systematic Review and Pooled-Analysis. PLOS ONE. 2012;7:e40230. [PubMed: 22808123]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

8. Young RP, Hopkins RJ, Gamble GD. Clinical applications of gene-based risk prediction for lung cancer and the central role of chronic obstructive pulmonary disease. Front Genet [Internet]. 2012 [cited 2019 1 23];3 Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3472507/
9. Bierut LJ, Tyndale RF. Preparing the Way: Exploiting Genomic Medicine to Stop Smoking. Trends Mol Med. 2018;24:187–96. [PubMed: 29307500]
10. Olfson E, Hartz S, Carere DA, Green RC, Roberts JS, Bierut LJ. Implications of Personal Genomic Testing for Health Behaviors: The Case of Smoking. Nicotine Tob Res. 2016;18:2273–7. [PubMed: 27613923]
11. Smerecnik C, Grispen JEJ, Quaak M. Effectiveness of testing for genetic susceptibility to smoking-related diseases on smoking cessation outcomes: a systematic review and meta-analysis. Tob Control. 2012;21:347–54. [PubMed: 21948804]
12. Wells QS, Freiberg MS, Greevy JR, Tyndale RF, Kundu S, Duncan MS, et al. Nicotine Metabolism-informed Care for Smoking Cessation: A Pilot Precision RCT. Nicotine Tob Res Off J Soc Res Nicotine Tob [Internet]. 2017 [cited 2018 10 8]; Available from: http://europepmc.org/abstract/med/29059367
13. Chiu A, Hartz S, Smock N, Chen J, Qazi A, Onyeador J, et al. Most Current Smokers Desire Genetic Susceptibility Testing and Genetically-Efficacious Medication. J Neuroimmune Pharmacol Off J Soc NeuroImmune Pharmacol. 2018;13:430–7.
14. Cokkinides VE, Halpern MT, Barbeau EM, Ward E, Thun MJ. Racial and Ethnic Disparities in Smoking-Cessation Interventions: Analysis of the 2005 National Health Interview Survey. Am J Prev Med. 2008;34:404–12. [PubMed: 18407007]
15. Pacek LR, McClernon FJ, Bosworth HB. Adherence to Pharmacological Smoking Cessation Interventions: A Literature Review and Synthesis of Correlates and Barriers. Nicotine Tob Res. 2018;20:1163–72. [PubMed: 29059394]
16. Trinidad DR, Pérez-Stable EJ, White MM, Emery SL, Messer K. A Nationwide Analysis of US Racial/Ethnic Disparities in Smoking Behaviors, Smoking Cessation, and Cessation-Related Factors. Am J Public Health. 2011;101:699–706. [PubMed: 21330593]
17. Christiansen B, Reeder K, Hill M, Baker TB, Fiore MC. Barriers to Effective Tobacco-Dependence Treatment for the Very Poor. J Stud Alcohol Drugs. 2012;73:874–84. [PubMed: 23036204]
18. Hendricks PS, Westmaas JL, Park VMT, Thorne CB, Wood SB, Baker MR, et al. Smoking Abstinence-related Expectancies among American Indians, African Americans, and Women: Potential Mechanisms of Tobacco-related Disparities. Psychol Addict Behav J Soc Psychol Addict Behav. 2014;28:193–205.
19. Ryan KK, Garrett-Mayer E, Alberg AJ, Cartmell KB, Carpenter MJ. Predictors of Cessation Pharmacotherapy Use Among Black and Non-Hispanic White Smokers. Nicotine Tob Res. 2011;13:646–52. [PubMed: 21464200]
20. Rutten LJF, Augustson E, Moser RP, Beckjord EB, Hesse BW. Smoking knowledge and behavior in the United States: sociodemographic, smoking status, and geographic patterns. Nicotine Tob Res Off J Soc Res Nicotine Tob. 2008;10:1559–70.
21. Canedo JR, Miller ST, Myers HF, Sanderson M. Racial and ethnic differences in knowledge and attitudes about genetic testing in the US: Systematic review. J Genet Couns. 2019;
22. Thompson HS, Valdimarsdottir HB, Jandorf L, Redd W. Perceived disadvantages and concerns about abuses of genetic testing for cancer risk: differences across African American, Latina and Caucasian women. Patient Educ Couns. 2003;51:217–27. [PubMed: 14630378]
23. Shields AE, Najafzadeh M, Schachter AB. Bumps along the translational pathway: anticipating uptake of tailored smoking cessation treatment., Bumps along the translational pathway: anticipating uptake of tailored smoking cessation treatment. Pers Med Pers Med. 2013;10, 10:813–25.
24. Hartz SM, Olfson E, Culverhouse R, Cavazos-Rehg P, Chen L-S, DuBois J, et al. Return of individual genetic results in a high-risk sample: enthusiasm and positive behavioral change. Genet Med Off J Am Coll Med Genet. 2015;17:374–9.
25. Blumenthal DS. Barriers to the Provision of Smoking Cessation Services Reported by Clinicians in Underserved Communities. J Am Board Fam Med. 2007;20:272–9. [PubMed: 17478660]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

26. Vogt F, Hall S, Marteau TM. General practitioners' and family physicians' negative beliefs and attitudes towards discussing smoking cessation with patients: a systematic review. Addiction. 2005;100:1423–31. [PubMed: 16185204]
27. Jardin BF, Cropsey KL, Wahlquist AE, Gray KM, Silvestri GA, Cummings KM, et al. Evaluating the Effect of Access to Free Medication to Quit Smoking: A Clinical Trial Testing the Role of Motivation. Nicotine Tob Res. 2014;16:992–9. [PubMed: 24610399]
28. Fucito LM, Czabafy S, Hendricks PS, Kotsen C, Richardson D, Toll BA, et al. Pairing smoking-cessation services with lung cancer screening: A clinical guideline from the Association for the Treatment of Tobacco Use and Dependence and the Society for Research on Nicotine and Tobacco: SRNT/ATTUD Screening Clinical Guideline. Cancer. 2016;122:1150–9. [PubMed: 26916412]
29. Burris JL, Heckman BW, Mathew AR, Carpenter MJ. A Mechanistic Test of Nicotine Replacement Therapy Sampling for Smoking Cessation Induction. Psychol Addict Behav J Soc Psychol Addict Behav. 2015;29:392–9.
30. Signorello LB, Hargreaves MK, Blot WJ. The Southern Community Cohort Study: investigating health disparities. J Health Care Poor Underserved. 2010;21:26–37.
31. DiClemente CC, Prochaska JO, Fairhurst SK, Velicer WF, Velasquez MM, Rossi JS. The process of smoking cessation: an analysis of precontemplation, contemplation, and preparation stages of change. J Consult Clin Psychol. 1991;59:295–304. [PubMed: 2030191]
32. Abrams DB, Niaura R, Brown RA, Emmons KM, Goldstein MG, Monti PM. The tobacco dependence treatment handbook: A guide to best practices. New York, NY, US: Guilford Press; 2003.
33. Bandura A Self-efficacy: Toward a unifying theory of behavioral change. Psychol Rev. 1977;84:191–215. [PubMed: 847061]
34. Heatherton TF, Kozlowski LT, Frecker RC, Fagerstrom K-O. The Fagerström Test for Nicotine Dependence: a revision of the Fagerstrom Tolerance Questionnaire. Br J Addict. 1991;86:1119–27. [PubMed: 1932883]
35. Tammemägi MC, Katki HA, Hocking WG, Church TR, Caporaso N, Kvale PA, et al. Selection Criteria for Lung-Cancer Screening. N Engl J Med. 2013;368:728–36. [PubMed: 23425165]
36. Reduced Lung-Cancer Mortality with Low-Dose Computed Tomographic Screening. N Engl J Med. 2011;365:395–409. [PubMed: 21714641]
37. Pham D, Bhandari S, Oechsli M, Pinkston CM, Kloecker GH. Lung cancer screening rates: Data from the lung cancer screening registry. J Clin Oncol. 2018;36:6504–6504.
38. Heckman CJ, Egleston BL, Hofmann MT. Efficacy of motivational interviewing for smoking cessation: a systematic review and meta-analysis. Tob Control. 2010;19:410–6. [PubMed: 20675688]
39. Hettema JE, Hendricks PS. Motivational interviewing for smoking cessation: A meta-analytic review. J Consult Clin Psychol. 2010;78:868–84. [PubMed: 21114344]
40. Young RP, Hopkins RJ, Duan F, Chiles C, Aberle D, Gamble GD. Genetic-Based Approach to Stratifying Risk of Lung Cancer Outperforms the Brock PLCO2012 Model - Optimization of CT Screening Outcomes in the NLST-ACRIN Sub-Study (N=10,054). Am J Respir Crit Care Med. 2018;197:A4422.
41. Ajzen I The theory of planned behavior. Organ Behav Hum Decis Process. 1991;50:179–211.
42. Curran GM, Bauer M, Mittman B, Pyne JM, Stetler C. Effectiveness-implementation Hybrid Designs. Med Care. 2012;50:217–26. [PubMed: 22310560]
43. Damschroder LJ, Aron DC, Keith RE, Kirsh SR, Alexander JA, Lowery JC. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. Implement Sci. 2009;4:50. [PubMed: 19664226]
44. Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: the RE-AIM framework. Am J Public Health. 1999;89:1322–7. [PubMed: 10474547]
45. Powell BJ, Waltz TJ, Chinman MJ, Damschroder LJ, Smith JL, Matthieu MM, et al. A refined compilation of implementation strategies: results from the Expert Recommendations for Implementing Change (ERIC) project. Implement Sci. 2015;10:21. [PubMed: 25889199]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

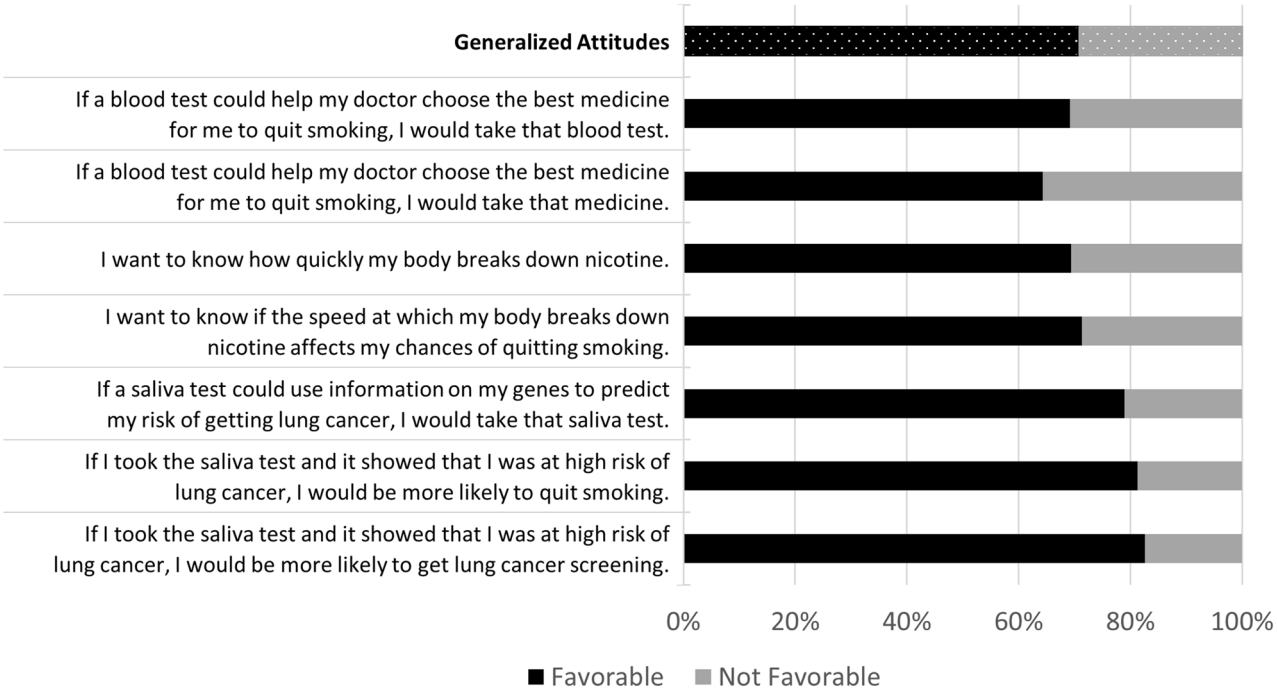

Figure 1.

Attitudes towards precision smoking treatment. Proportion of smokers endorsing favorable (vs. not favorable) generalized attitudes (top row) and attitudes towards aspects of precision smoking treatment.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

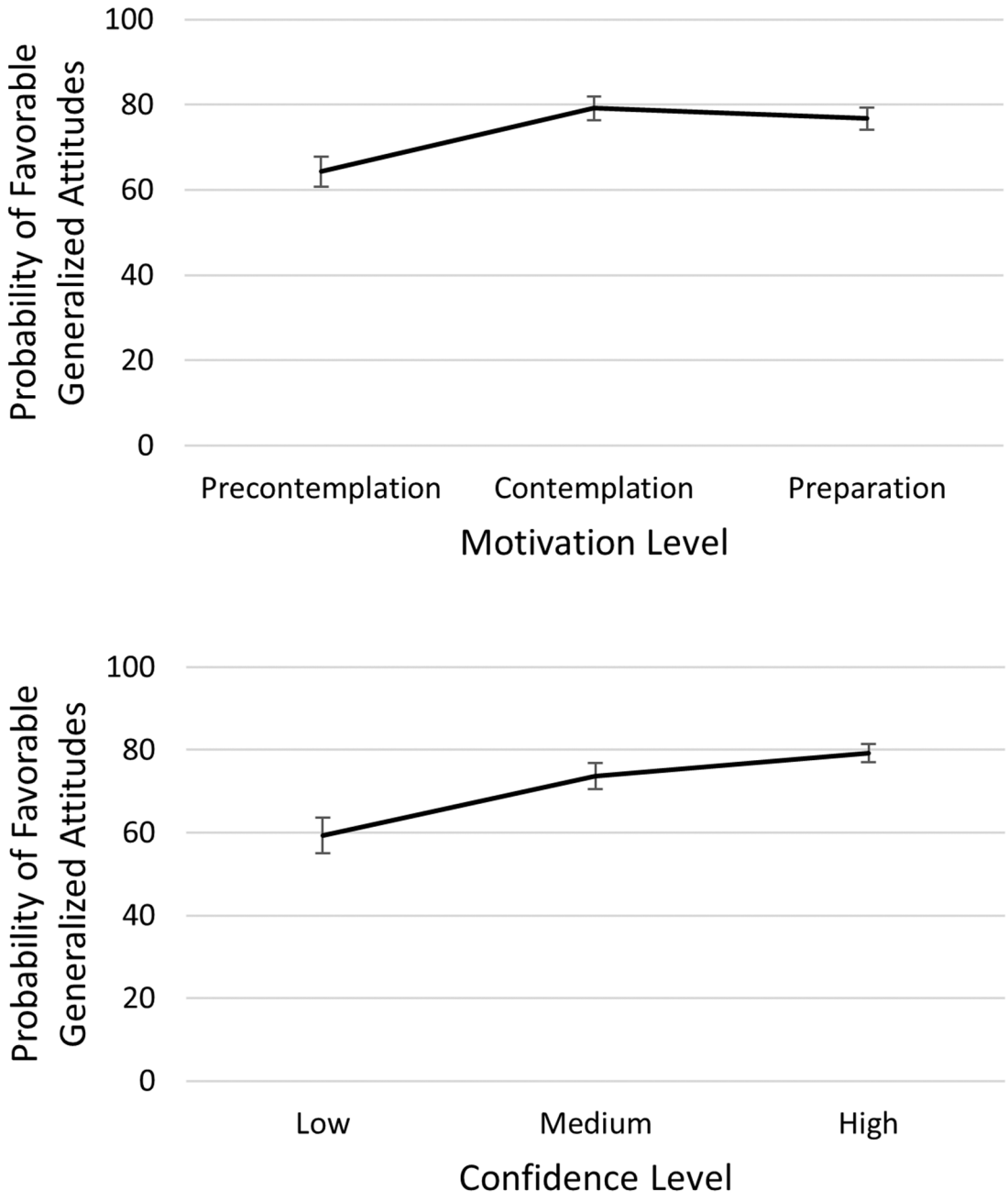

Figure 2.

Associations of motivation and confidence with generalized attitudes towards precision smoking treatment. Predicted probabilities of having favorable generalized attitudes towards precision smoking treatment across levels of motivation (upper panel) and confidence (lower panel) are based on results of multivariable logistic regression adjusting for age, sex, race/ethnicity, education, insurance, and nicotine dependence (n=738).

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 1.

Inter-item correlations for each aspect of attitudes towards precision smoking treatment*

	1	2	3	4	5	6	7
1. If a blood test could help my doctor choose the best medicine for me to quit smoking, I would take that blood test.	1						
2. If a blood test could help my doctor choose the best medicine for me to quit smoking, I would take that medicine.	0.88	1					
3. I want to know how quickly my body breaks down nicotine.	0.76	0.75	1				
4. I want to know if the speed at which my body breaks down nicotine affects my chances of quitting smoking.	0.79	0.77	0.88	1			
5. If a saliva test could use information on my genes to predict my risk of getting lung cancer, I would take that saliva test.	0.43	0.40	0.41	0.43	1		
6. If I took the saliva test and it showed that I was at high risk of lung cancer, I would be more likely to quit smoking.	0.37	0.34	0.37	0.38	0.58	1	
7. If I took the saliva test and it showed that I was at high risk of lung cancer, I would be more likely to get lung cancer screening.	0.34	0.34	0.35	0.36	0.55	0.66	1

* p<.001 for all inter-item correlations

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Table 2.

Sociodemographic characteristics, nicotine dependence (HSI), predicted lung cancer risk, motivation and confidence across generalized attitudes towards precision treatment

Characteristic: N, %	Total (N=845)	Favorable (n=599)	Not Favorable (n=246)	P-Value
Age[1] (median, IQR)	60 [56, 64]	59 [56, 64]	60 [57, 65]	.02
Male sex[1]	355 (42%)	248 (41%)	107 (44%)	.58
Race[1]				.09
White	124 (15%)	98 (16%)	26 (11%)	
African-American	705 (83%)	489 (82%)	216 (88%)	
Other	13 (2%)	9 (2%)	4 (2%)	
Missing	3	3	0	
Education[1]				.007
<High School	241 (29%)	156 (26%)	85 (35%)	
High School or GED	317 (38%)	223 (37%)	94 (38%)	
>High School	265 (31%)	205 (34%)	60 (24%)	
Missing	22	15	7	
Household Income[2]				.01
<$15,000	526 (62%)	365 (61%)	161 (65%)	
$15,000-$25,000	163 (19%)	118 (20%)	45 (18%)	
$25,000-$50,000	64 (8%)	57 (10%)	7 (3%)	
>50,000	25 (3%)	18 (3%)	7 (3%)	
Missing	67	41	26	
Insured[2]				.04
Medicaid & Medicare	124 (15%)	81 (14%)	43 (18%)	
Medicaid only	151 (18%)	103 (17%)	48 (20%)	
Medicare only	176 (21%)	134 (22%)	42 (17%)	
Private	74 (9%)	63 (11%)	11 (5%)	
Military	38 (5%)	24 (4%)	14 (6%)	
Other	66 (8%)	49 (8%)	17 (7%)	
Uninsured	179 (21%)	125 (21%)	54 (22%)	
Missing	37	20	17	
Heaviness of Smoking Index (HSI)[3]				.48
Low (0-1)	286 (34%)	196 (33%)	90 (37%)	
Medium (2-4)	508 (60%)	368 (61%)	140 (57%)	
High (5-6)	41 (5%)	30 (5%)	11 (5%)	
Missing	10	5	5	
Predicted Lung Cancer Risk[4]				.90
<1.3%	508 (60%)	359 (60%)	149 (61%)	
≥1.3%	263 (31%)	187 (31%)	76 (31%)	

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Characteristic: N, %	Total (N=845)	Favorable (n=599)	Not Favorable (n=246)	P-Value
Missing	74	53	21	
Motivation[3]				<.001
Pre-contemplation	236 (28%)	142 (24%)	94 (38%)	
Contemplation	262 (31%)	203 (34%)	59 (24%)	
Preparation	325 (39%)	243 (41%)	82 (33%)	
Missing	22	11	11	
Confidence[3]				<.001
Low	167 (20%)	92 (15%)	75 (30%)	
Medium	231 (27%)	160 (27%)	71 (29%)	
High	416 (49%)	325 (54%)	91 (37%)	
Missing	31	22	9	

[1] Assessed at baseline (2002-2009)

[2] Assessed at SCCS followup 3 (2015-2018)

[3] Assessed for the current study (2017)

[4] Based on Tammemagi lung cancer risk calculator, risk threshold ≥1.3% recommended for cancer screening (35).

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Table 3:

Results of regression analysis predicting generalized attitudes towards precision smoking treatment (n=738) [1, 2].

	Adjusted Odds Ratio (95% CI)	P-value
Motivation		
Precontemplation	1.00 (referent)	
Contemplation	2.10 (1.36-3.25)	0.001
Preparation	1.83 (1.20-2.78)	0.005
Confidence		
Low	1.00 (referent)	
Medium	1.91 (1.19-3.07)	0.007
High	2.62 (1.68-4.10)	<0.001
Age	0.96 (0.93-0.99)	0.02
Sex		
Female	1.00 (referent)	
Male	0.95 (0.67-1.36)	0.79
Race		
White	1.00 (referent)	
African Amer.	0.47 (0.27-0.83)	0.009
Other	0.55 (0.12-2.53)	0.44
Education		
<High school	1.00 (referent)	
High school	1.12 (0.74-1.71)	0.59
>High school	1.61 (1.03-2.54)	0.04
Insurance		
Dual (Medicare/aid)	1.00 (referent)	
Medicaid	1.14 (0.63-2.05)	0.67
Medicare	1.74 (0.98-3.09)	0.06
Private	2.29 (1.00-5.23)	0.05
Military	0.89 (0.38-2.04)	0.78
Other	1.21 (0.56-2.64)	0.63
None	1.00 (0.56-1.76)	0.99
Nicotine Dependence		
Low	1.00 (referent)	
Medium	1.35 (0.93-1.94)	0.11
High	1.54 (0.61-3.89)	0.36

[1] Multivariable logistic regression tested associations between motivation and confidence in quitting with generalized attitudes towards precision smoking treatment, adjusting for age, race, sex, education, insurance and nicotine dependence.

[2] Restricted to smokers with complete data (n=738).