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Validation of a Respiratory Symptom Questionnaire in Adolescent Smokers

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Abstract

Objectives—Adolescent smokers experience respiratory symptoms as a consequence of smoking, which may be impacted by harm-reduction products. We sought to validate the American Thoracic Society Questionnaire (ATSQ), a measure of respiratory symptoms, in adolescent smokers.

Methods—Data were drawn from 2 studies of adolescents (ages 14 to 19). Study 1 (N = 118) comprised daily smokers. Study 2 (N = 216) comprised 118 smokers and 98 nonsmokers; a subset of the total sample comprised 70 matched pairs of smokers and non-smokers.

Results—The ATSQ showed high internal consistency. In Study 1, ATSQ scores were positively correlated with dependence. In Study 2, scores were positively correlated with CO, cotinine, and cigarettes per day; and scores were significantly greater for smokers than non-smokers.

Conclusions—The ATSQ offers a psychometrically valid method for measuring respiratory symptoms in adolescent smokers.

Keywords

adolescents; smoking; methodology; respiratory symptoms

Cigarette smoking remains one of the world's leading causes of premature death. More than 5 million smokers die every year from smoking-related disease.¹ Most smokers began smoking in adolescence, with 88% of current smokers reporting that they began smoking before age 18.¹ Thus, adolescence is a crucial time in the development of smoking behavior. Adolescent smokers exhibit significant withdrawal symptoms and other evidence of nicotine dependence despite a tendency for adolescents to be lighter and more intermittent

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Human Subjects Approval Statement

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Conflict of Interest Disclosure Statement

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smokers.²⁻⁷ In addition to dependence and withdrawal, smoking also creates physical symptoms, particularly respiratory issues such as cough and production of phlegm.⁸

Evidence indicates that adolescent smokers show decreased lung function as well as decreased gain in expected lung function over time, and adolescent smokers are at risk for developing chronic cough and production and expulsion of phlegm.⁹⁻¹³ Daily adolescent smokers are also more likely to perceive their own general health - including respiratory health - to be poorer when compared to peers who have never tried cigarettes, and to endorse more health complaints in general.^{14,15} Therefore, even at this early stage, the health of adolescent smokers begins to diverge from their non-smoking peers. Thus, tracking and understanding adolescents' respiratory symptoms, and in particular their smoking-related respiratory symptoms, is an important part of characterizing the sequelae of smoking in this population.

For adolescents and adult smokers, the landscape of available products is also changing rapidly. Emerging tobacco products are changing our understanding of nicotine and tobacco use. E-cigarettes, dissolvable tobacco products, and very low nicotine cigarettes all deliver nicotine in very different ways, and current smokers may shift their behavior to these products in part due to concerns over health. Adult e-cigarette users, in particular, report that they switch from traditional to electronic cigarettes in part due to respiratory issues, and that e-cigarettes result in decreased cough and breathing issues compared to traditional cigarettes.¹⁶ However, the extent to which these products may affect respiratory symptoms in adolescents is unclear. A validated measure of respiratory symptoms in adolescent smokers would allow for harmonization of data across studies tracking the health effects of these new products, and allow for comparison of symptom alleviation in both adolescents and adults. In turn, this type of research could inform policies regarding the regulation of tobacco products.

One self-report instrument that has been used widely for measuring general respiratory symptoms in adults is the American Thoracic Society Questionnaire (ATSQ).¹⁷ The ATSQ is an 8-item querying coughing, wheezing, phlegm production, shortness of breath, and other symptoms. The ATSQ has been used less frequently to assess respiratory symptoms specifically as they relate to smoking; however, several relevant studies have been conducted. In young adults, smokers have been found to endorse 5 of 8 distinct symptoms on average, and ATSQ scores have been shown to decrease significantly following 2 weeks of smoking abstinence, indicating criterion validity.^{18,19} In adolescents, a small study of 28 smokers and 18 nonsmokers showed that ATSQ scores were higher among smokers, and that smokers endorsed specific items (morning cough, shortness of breath when walking and during exercise, and getting tired easily) at significantly higher rates than nonsmokers.¹⁰ The ATSQ also has been reported to correlate with a single-item self-report of cigarettes per day in adolescent smokers.⁷

To date the ATSQ has not been thoroughly validated in a sample of adolescent smokers, and its psychometric properties and relationship to biomarkers of smoking have not been reported. Furthermore, the relationship between the ATSQ and validated measures of smoking behavior and dependence in adolescents has not been explored. The aim of the

current study was to extend the limited literature on ATSQ scores in this population by validating the ATSQ in 2 studies of adolescents. We hypothesized that respiratory symptoms, as indexed by the ATSQ, would be reported at higher rates and with greater severity among smokers compared to matched nonsmokers, and that higher ATSQ scores would be associated with higher rates of smoking (indexed by self-report and biomarkers) and dependence. The ATSQ is a comparatively short, easily self-administered questionnaire. If validated, it would provide a practical instrument for assessing baseline levels of respiratory symptoms related to smoking in adolescents, and for evaluating changes in symptoms as a result of changes in product use patterns or cessation.

METHODS

Study 1

In Study 1, 118 adolescent daily smokers between the ages of 14 and 19 were recruited from local high schools in Rhode Island (RI) and southeastern Massachusetts (MA) using flyers and information sessions. (ATSQ symptoms were significantly higher among adolescents with asthma in both studies ($t = -4.0$, $p < .001$ in the first sample; $t = -3.8$, $p < .001$ in the second sample). Because asthma is an independent contributor to respiratory symptoms, we excluded asthmatic adolescents from all presented analyses. Each presented N refers to the analyzed samples of non-asthmatic adolescents only.) Interested participants completed a brief, confidential screening interview by phone to establish initial eligibility for a laboratory-based study of smoking behavior, described elsewhere.²⁰ To be eligible, participants had to be English speakers, and report daily smoking of 5 or more cigarettes for at least the prior 6 months. Individuals were ineligible if they reported using other forms of tobacco or nicotine more than 4 days in the past month, or if they reported daily drug or alcohol use in the past month. Female participants could not be pregnant or breastfeeding. Informed consent was obtained prior to research participation. Participants younger than 18 provided assent and were required to have parental consent. The relevant measures were administered contemporaneously at an initial session.

Study 2

In Study 2, adolescent smokers ($N = 118$) and non-smokers ($N = 98$) were recruited from local high schools in RI and MA using newspapers, flyers, and information sessions. Youths interested in participating completed a brief screening survey to determine eligibility and provided information for the matching procedure (described below). To be eligible, individuals had to be English speakers, aged 14–19, and currently attending high school. Nonsmokers were defined as those who reported never smoking a whole cigarette, not smoking at all (even a puff) in the past year, and not using other forms of tobacco or nicotine in the past 30 days. Smokers were defined as those who reported smoking one or more cigarettes in the past 14 days, and not using other forms of tobacco or nicotine on more than 4 days in the past 30 days. Exclusion and informed consent procedures were the same as described in Study 1.

Matching procedure—Nonsmoking participants were recruited to match enrolled smoker participants on sex, grade (within one year), a proxy of socioeconomic status (eligible for

free or reduced price lunch versus full-pay lunch), racial/ethnic minority status (non-Hispanic white versus other), and school type (private parochial, private non-parochial, RI public school, MA public school). Public school students in RI were matched further on school performance (based on statewide testing scores of *high performing*, *moderately performing*, or *needs improvement*); public school students in MA were matched within specific schools. This created a subsample of smokers who were matched (N = 70 pairs).

Measures

ATSQ—The ATSQ is an 8-item questionnaire measuring morning cough, daily cough, wheezing, shortness of breath when walking, shortness of breath during exercise, phlegm production, chest pain, and fatigue onset.¹⁷ The response scales are coded from 1–5, which correspond to frequency categories: (1) never; (2) less than once per week; (3) 1–2 times per week; (4) several times per week; and (5) every day. Responses are summed across all 8 items; scores can range from 8 to 40.

Carbon monoxide (CO)—Expired alveolar breath CO level has a half-life of 4 to 6 hours and is a reliable and valid assessment of recent smoking. CO was measured using a Smokerlyzer ED50 CO meter (Bedfont Instruments).

Cotinine (Study 2 only)—Cotinine, a nicotine metabolite measured from saliva samples, is a sensitive and specific measure of recent nicotine exposure with a half-life of 15 to 17 hours.^{21,22} Samples were analyzed by an external laboratory (Salimetrics, Inc.) using gas chromatography.

Demographic and smoking history variables—Participants were asked their age and the number of years that they had been smoking daily.

Modified Fagerström Tolerance Questionnaire (mFTQ)—The mFTQ is a 7-item measure of nicotine dependence that has been adapted from the original FTQ and validated for use with adolescent smokers.^{23,24} Possible scores range from 0 to 9.

Timeline Follow-back (TLFB)—The Timeline Follow-back is a calendar-assisted interview method which is used to help participants estimate their daily cigarettes, other tobacco use, and alcohol and other drug use over the last month. The TLFB has been validated for use in adolescents.⁷ Daily smoking over the prior 30 days (Study 1) and prior 2 weeks (Study 2) was assessed and used to calculate the average cigarettes smoked per day. As e-cigarettes were not widely available at the time these studies were conducted, we did not ask about e-cigarette use.

Second-hand smoke exposure—In Study 1, the extent to which adolescents might be exposed to second-hand smoke was derived from items on the Interpersonal Influences Questionnaire.²⁵ Participants were asked to rate the frequency with which people smoke around them on a scale from 1 (never) to 5 (always) and to state the number of smokers who live in the same home with them.

In Study 2, exposure was estimated from the smoking version of the Important People (IP) measure, which is a structured interview assessing characteristics of a network of up to 10 important people in the respondent's life.²⁶ Among other questions, the adolescents reported whether each network member was a current smoker. From this measure, a dichotomous variable was created that indicated parental smoking status (0 = 0 smoking parents/step-parents in network; 1 = 1 or more smoking parents/step-parents in network).

Data Analysis Plan

Descriptive statistics were calculated for the ATSQ total score and each item for the adolescent smokers in Study 1 and by smoking status for Study 2. Scale reliability was evaluated by calculating Cronbach's alpha (internal consistency coefficient) for the ATSQ in both samples. Convergent validity of the ATSQ was evaluated by examining bivariate correlations between the ATSQ total score and measures of smoking intensity (average cigarettes per day), recent smoke and nicotine exposure (CO and cotinine levels), potential sources of second-hand smoke exposure and nicotine dependence (mFTQ) in Study 1 and in the full sample of smokers, both matched and non-matched, in Study 2. As a test of criterion validity, we also conducted matched-pairs t-tests with Study 2 to examine whether mean ATSQ total and item scores were greater among the matched subsample of smokers, compared to the non-smoking matched participants.

RESULTS

Sample characteristics are listed in Table 1. Demographics are highly comparable across the samples from Studies 1 and 2. Study 1 smokers reported approximately double the cigarettes per day compared with Study 2 smokers, consistent with the higher smoking rate required for inclusion in Study 1. The ATSQ showed high internal consistency in both studies (Cronbach's alpha = 0.80 in Study 1, N = 118; 0.86 in Study 2, matched pairs, N = 140). Adolescent smokers (N = 118) scored an average of 18.7 on the ATSQ (SD = 6.3) in Study 1 and 16.7 (SD = 6.4) in Study 2's matched smokers (N = 70). In contrast, matched non-smokers in Study 2 scored an average of 10.3 (SD = 2.5; N = 70). Descriptive statistics associated with each of the ATSQ items are listed in Table 2. For both studies, the item with the highest mean score, corresponding to a frequency of 1–2 times per week on average was the item addressing the symptom of feeling shortness of breath during exercise or when walking up stairs. Among smokers, most items had a mean of about 2, which indicates a symptom frequency of less than once per week. In contrast, among the nonsmoking adolescents, no item received a mean score higher than 1.6. The mean number of symptoms endorsed was 5.17 (SD = 2.1) by smokers in Study 1 and 4.54 (SD = 2.47) by smokers and 1.64 (SD = 1.56) by nonsmokers in Study 2.

Construct validity measures are listed in Table 3. Among adolescent smokers in Study 1, ATSQ scores were positively correlated with nicotine dependence as measured by the mFTQ but not with CO levels or average cigarettes smoked per day as calculated from the past 30 days on the TLFB. Results from the matched sample (N = 70 pairs) in Study 2 showed that ATSQ scores were significantly greater among adolescent smokers compared to their non-smoking peers ($t(69) = 8.51, p < .001$). Likewise, each of the 8 ATSQ scale items

was greater among smokers than non-smokers (all t s > 3.3 , all p s $< .001$). Furthermore, among all smokers in Study 2 ($N = 118$), the ATSQ correlated significantly with the mFTQ, CO level and cotinine level. ATSQ scores also correlated with the number of cigarettes smoked per day, measured from the past 14 days on the TLFB. The ATSQ was not correlated with age, nor with number of years of daily smoking, in either study. The ATSQ was not significantly correlated with either the frequency with which others smoked around them, nor with the number of smokers in the home, in Study 1. On the IPI in Study 2, every participant nominated at least one parent; parent smoking status in Study 2 was not significantly correlated with ATSQ scores in smokers ($r = .16$, $p = .08$); however, parental smoking status was correlated with ATSQ scores in non-smoking participants ($r = .28$, $p = .004$). All significant correlations remained significant at the $\alpha = .05$ level when controlling for second-hand smoke exposure measures, with the exception of the relationship between cotinine and parental smoking status in Study 2; however, this relationship remained statistically significant at the 0.1 level ($r = .16$, $p = .079$).

DISCUSSION

The present study presents a psychometric validation of the ATSQ, a measure of respiratory symptoms, in 2 samples of adolescents. The ATSQ showed strong internal consistency, and reliably discriminated between smokers and non-smokers. Importantly, the ATSQ also correlated with other measures of smoking behavior and biomarkers of exposure (CO and cotinine). In addition, item-level analyses showed that adolescents endorsed several respiratory symptoms, and the average adolescent smoker reported experiencing shortness of breath 1–2 times a week. Smokers experienced about 5 symptoms out of the 8 queried, consistent with data on young adult smokers.¹⁸

It is unclear why the ATSQ total score was significantly related to smoking rate (cigarettes per day) in Study 2 but not Study 1. One plausible reason may be due to differences in the duration of the TLFB used in the 2 studies. In Study 1, participants were asked about their past 30-day cigarette use and CPD was calculated from the full 30 days, while in Study 2, the TLFB covered only the past 2 weeks. Because the ATSQ asks about past-week symptoms, TLFB data in Study 2 were more closely temporally aligned to ATSQ data than in Study 1. It is also possible that the relationships between CO and respiratory symptoms that were found in Study 2 and not in Study 1 were due to assessing a larger range of adolescent smoking patterns in Study 2 (ie, including those very early in their smoking trajectory), allowing for more variability at the lower end of the distribution of CO levels. Additionally, CO levels were higher overall in Study 1 due to the inclusion criteria, which called for smokers of 5 or more cigarettes per day. It may be that the ATSQ is particularly sensitive to changes in smoking status – ie, for people early in their smoking careers and for comparisons between smokers who have quit recently and current smokers, though this conclusion is tentative and should be investigated further.

It is also interesting to note that ATSQ scores were highly significantly correlated with parental smoking status in nonsmoking adolescents, whereas this was not evident in smokers. Thus, the ATSQ may be sensitive enough to pick up changes in respiratory symptoms that occur due to second-hand smoke. Therefore, it is reasonable to conclude that

some proportion of the relationship between ATSQ and smoking may be due to second-hand smoke exposure. However, with the exception of the cotinine measure in Study 2, correlations with smoking variables remained statistically significant even after controlling for second-hand smoke exposure. Overall, these results indicate that among smokers, the ATSQ is most strongly related to personal smoking status, though for nonsmokers, exposure to second-hand smoke also may serve to increase scores.

Overall, the item with the highest mean score, corresponding to a frequency of 1–2 times per week on average for both studies, was the item that queried feeling shortness of breath during exercise or when walking up stairs. Among smokers, most items had a mean of about 2, which indicates a symptom frequency of less than once per week. In contrast, among the nonsmoking adolescents, no item received a mean score higher than 1.6. As a score of 1 indicates “never,” it is apparent that most nonsmoking adolescents are unlikely to experience frequent respiratory symptoms of any kind. The average summed score for smokers was 18.7 in Study 1 and 16.7 in Study 2, and these scores (particularly for Study 1) are similar to those reported with slightly older college student smokers ($M = 18.4$)²⁷ The frequency of respiratory symptoms are likely lower in Study 2 because the inclusion criteria allowed for lighter smokers to enter the study.

A limitation of the current study is that it is cross-sectional. Thus, we were unable to track changes in respiratory symptoms as a function of changes in smoking over time. In college student smokers, however, Calabro and Prokhorov¹⁹ demonstrated that the ATSQ scores declined significantly following 2 weeks of abstinence. Future studies should look closely at changes in ATSQ items and total scores as a function of different durations of smoking abstinence. A strength of the current study is that it extends use of the ATSQ to adolescents, an important age group for evaluating symptoms earlier in the course of smoking uptake. However, other research has found that the ATSQ correlates with dependence and smoking history in adult smokers, and has demonstrated that scores improve following abstinence; therefore, the ATSQ also can be used to measure symptoms in adult populations and potentially compare them to symptoms in adolescents.²⁸

Overall, the current data support the use of this measure for evaluating smoking-related respiratory symptoms in this population. It may be useful for researchers to examine individual items when evaluating respiratory symptoms in this population, as items were not equally endorsed (eg, shortness of breath when exercising was much more frequently reported than wheezing) and quitting or changing products may differentially impact symptoms. A systematic comparison of ATSQ scores in adolescent and adult smokers, as well as further validation of psychometric properties in both populations (eg, test-retest reliability and more fine-grained analyses of relationships with smoke exposure), will enhance the utility of this measure.

IMPLICATIONS FOR TOBACCO REGULATION

The current study has implications for the study of potential reduced-harm products in adolescent smokers. The introduction of products such as e-cigarettes and very low nicotine content (VLNC) cigarettes has the potential to change smoking patterns and exposure to CO

and nicotine for adolescents. We hope that these products promote cessation of traditional combustible cigarettes and decrease nicotine dependence; however, use of these products may differentially impact respiratory health. For example, e-cigarettes – devices that heat a nicotine-containing liquid to a vapor which is then inhaled – could leave nicotine dependence unchanged while decreasing perceived respiratory symptoms.^{29,30} Alternatively, flavored e-cigarettes may affect lung functioning through different means, as the aerosol components may have independent effects on respiratory symptoms.^{31,32} In contrast, VLNC cigarettes may result in decreased dependence while failing to reduce respiratory symptoms, or even transiently increasing some symptoms as a function of compensatory smoking.³³ In short, respiratory symptoms are an important facet of the constellation of factors that make adolescent smoking an important public health challenge, and tracking these symptoms will allow researchers to better evaluate the impact of reduced harm products and smoking cessation treatments.

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References

1. US Department of Health and Human Services (USDHHS). The Health Consequences of Smoking-50 Years of Progress: A Report of the Surgeon General. Atlanta, GA: USDHHS, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2014.
2. Bidwell LC, Leventhal AM, Tidey JW, et al. Effects of abstinence in adolescent tobacco smokers: withdrawal symptoms, reactive irritability and cue reactivity. *Nicotine Tob Res.* 2013; 15(2):457–464. [PubMed: 22949582]
3. Branstetter SA, Muscat JE. Time to first cigarette and serum cotinine levels in adolescent smokers: National Health and Nutrition Examination Survey, 2007–2010. *Nicotine Tob Res.* 2013; 15(3): 701–707. [PubMed: 22990214]
4. Colby SM, Leventhal AM, Brazil L, et al. Smoking abstinence and reinstatement effects in adolescent cigarette smokers. *Nicotine Tob Res.* 2010; 12(1):19–28. [PubMed: 19933776]
5. Bailey SR, Jeffery CJ, Hammer SA, et al. Assessing teen smoking patterns: the weekend phenomenon. *Drug Alcohol Depend.* 2012; 120(1–3):242–245. [PubMed: 21885211]
6. Costello DM, Dierker LC, Jones BL, Rose JS. Trajectories of smoking from adolescence to early adulthood and their psychosocial risk factors. *Health Psychol.* 2008; 27(6):811–818. [PubMed: 19025277]
7. Lewis-Esquerre JM, Colby SM, O’Leary-Tevyaw T, et al. Validation of the timeline follow-back in the assessment of adolescent smoking. *Drug Alcohol Depend.* 2005; 79(1):33–43. [PubMed: 15943942]
8. Stavem K, Aaser E, Sandvik L, et al. Lung function, smoking and mortality in a 26-year follow-up of healthy middle-aged males. *Eur Respir J.* 2005; 25(4):618–625. [PubMed: 15802334]
9. Gold DR, Wang X, Wypij D, et al. Effects of cigarette smoking on lung function in adolescent boys and girls. *N Engl J Med.* 1996; 335(13):931–937. [PubMed: 8782500]
10. Prokhorov AV, Emmons KM, Pallonen UE, Tsoh JY. Respiratory response to cigarette smoking among adolescent smokers: a pilot study. *Prev Med.* 1996; 25(5):633–640. [PubMed: 8888333]
11. Tager IB. The effects of second-hand and direct exposure to tobacco smoke on asthma and lung function in adolescents. *Paediatr Respir Rev.* 2008; 9(1):29–37. [PubMed: 18280977]

12. Chen JM, Hwang BF, Chen YC, Lee YL. Active smoking, environmental tobacco smoke and bronchitic symptoms among adolescents in Taiwan: a prospective cohort study. *Prev Med*. 2014; 65:116–121. [PubMed: 24823904]
13. Oechli FW, Seltzer CC, van den Berg BJ. Adolescent smoking and early respiratory disease: a longitudinal study. *Ann Allergy*. 1987; 59(2):135–140. [PubMed: 3619133]
14. Botello-Harbaum M, Haynie DL, Murray KW, Iannotti RJ. Cigarette smoking status and recurrent subjective health complaints among US school-aged adolescents. *Child Care Health Dev*. 2011; 37(4):551–558. [PubMed: 20825423]
15. Holmen TL, Barrett-Connor E, Holmen J, Bjerner L. Health problems in teenage daily smokers versus nonsmokers, Norway, 1995–1997: the Nord-Trøndelag Health Study. *Am J Epidemiol*. 2000; 151(2):148–155. [PubMed: 10645817]
16. Dawkins L, Turner J, Roberts A, Soar K. ‘Vaping’ profiles and preferences: an online survey of electronic cigarette users. *Addiction*. 2013; 108:1115–1125. [PubMed: 23551515]
17. Comstock GW, Tockman MS, Helsing KJ, Hennesy KM. Standardized respiratory questionnaires: comparison of the old with the new. *Am Rev Respir Dis*. 1979; 119(1):45–53. [PubMed: 420437]
18. Lipkus IM, Prokhorov AV. The effects of providing lung age and respiratory symptoms feedback on community college smokers’ perceived smoking-related risks, worries and desire to quit. *Addict Behav*. 2007; 32(3):516–532. [PubMed: 16824688]
19. Calabro KS, Prokhorov AV. Respiratory symptoms after smoking cessation in college students. *Pediatr Allergy Immunol Pulmonol*. 2011; 24:215–219.
20. Cassidy RN, Tidey JW, Kahler CW. Increasing the value of an alternative monetary reinforcer reduces cigarette choice in adolescents. *Nicotine Tob Res*. In press.
21. Hukkanen J, Jacob P, Benowitz NL. Metabolism and disposition kinetics of nicotine. *Pharmacol Rev*. 2005; 57(1):79–115. [PubMed: 15734728]
22. Scherer G, Engl J, Urban M, et al. Relationship between machine-derived smoke yields and biomarkers in cigarette smokers in Germany. *Regul Toxicol Pharmacol*. 2007; 47(2):171–183. [PubMed: 17034917]
23. Fagerström KO. Measuring the degree of physical dependence to tobacco smoking with reference to individualization of treatment. *Addict Behav*. 1978; 3:235–241. [PubMed: 735910]
24. Prokhorov AV, Pallonen U, Fava JL, et al. Measuring nicotine dependence among high-risk adolescent smokers. *Addict Behav*. 1996; 21(1):117–127. [PubMed: 8729713]
25. Colby SM, Monti PM, O’Leary-Tevyaw TA, et al. Brief motivational intervention for adolescent smokers in a hospital setting. *Addict Behav*. 2005; 30:865–874. [PubMed: 15893085]
26. Zwiak WH, Longabaugh R, Wurtz PW. Decomposing the relationship between pretreatment social network characteristics and alcohol treatment outcome. *J Stud Alcohol Drugs*. 2002; 63(1): 114.
27. Prokhorov AV, Yost T, Mullin-Jones M, et al. “Look at your health”: outcomes associated with a computer-assisted smoking cessation counseling intervention for community college students. *Addict Behav*. 2008; 33(6):757–771. [PubMed: 18280668]
28. Clarke JG, Martin SA, Martin RA, et al. Changes in smoking-related symptoms during enforced abstinence of incarceration. *J Health Care Poor Underserved*. 2015; 26(1):106–118. [PubMed: 25702731]
29. Farsalinos KE, Romagna G, Tsiapras D, et al. Characteristics, perceived side effects and benefits of electronic cigarette use: a worldwide survey of more than 19,000 consumers. *Int J Environ Res Public Health*. 2014; 11(4):4356–4373. [PubMed: 24758891]
30. Foulds J, Veldheer S, Yingst J, et al. Development of a questionnaire to assess dependence on electronic cigarettes in a large sample of ex-smoking e-cig users. *Nicotine Tob Res*. 2015; 17(2): 186–192. [PubMed: 25332459]
31. Farsalinos KE, Kistler KA, Gillman G, Voudris V. Evaluation of electronic cigarette liquids and aerosol for the presence of selected inhalation toxins. *Nicotine Tob Res*. 2015; 17(2):168–174. [PubMed: 25180080]
32. Lerner CA, Sundar IK, Watson RM, et al. Environmental health hazards of e-cigarettes and their components: oxidants and copper in e-cigarette aerosols. *Environ Pollut*. 2015; 198C:100–107. [PubMed: 25577651]

33. Hatsukami DK, Kotlyar M, Hertsgaard LA, et al. Reduced nicotine content cigarettes: effects on toxicant exposure, dependence and cessation. *Addiction*. 2010; 105(2):343–355. [PubMed: 20078491]

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Table 1

Sample Characteristics across Study 1 (Full Sample) and Study 2 (Full Sample)

	Study 1 (N = 118)	Study 2 (N = 216)	
	Smokers	Smokers (N = 118)	Non-smokers (N = 98)
Average age	16.5 (1.4)	16.6 (1.2)	16.1 (1.2)
Percent female	56%	45%	52%
Percent non-Hispanic white	86%	84%	86%
Average CPD	11.1 (5.6)	5.7 (6.0)	-
Average mFTQ	4.4 (1.5)	3.8 (1.9)	-
Years daily smoker	2.6 (1.8)	1.7 (1.5)	-
CO (ppm)	11.4 (6.9)	5.1 (5.2)	0.9 (1.0)
Cotinine (ng/ml)	n/a	86.3 (102.7)	1.1 (7.8)

Note.

CPD = Cigarettes per day; mFTQ = modified Fagerstrom Tolerance Questionnaire; CO = expired alveolar carbon monoxide level.

Standard deviations are presented in parentheses.

Table 2

Descriptive Characteristic of the ATSQ Items across Study 1 (Full Sample) and Study 2 (Matched Pairs)

ATSQ item	Study 1 N = 118	Study 2 Smokers N = 70	Study 2 Non-Smokers N = 70
Cough first thing in the morning	2.1 (1.3)	2.0 (1.2)	1.2 (0.5)
Cough frequently throughout the day	2.3 (1.2)	2.2 (1.2)	1.4 (0.6)
Wheezing	1.7 (0.9)	1.4 (0.8)	1.1 (0.3)
Shortness of breath when walking	2.6 (1.2)	2.2 (1.3)	1.2 (0.6)
Shortness of breath during exercise or walking upstairs	3.1 (1.2)	2.8 (1.3)	1.6 (0.8)
Phlegm or mucous when you cough	2.4 (1.4)	1.9 (1.2)	1.2 (0.5)
Pain or tightness in the chest	1.9 (1.1)	1.9 (1.0)	1.2 (0.4)
Getting very tired in a short time	2.3 (1.2)	2.3 (1.2)	1.4 (0.9)
ATSQ sum	18.7 (6.3)	16.7 (6.4)	10.3 (2.5)
Cronbach's alpha	.80		.86

Table 3

Correlations of ATSQ Sum with Measures of Smoking and Nicotine Dependence across Study 1 (Full Sample) and Study 2 (All Smokers)

	Study 1 (N = 118)	Study 2 (N = 118)
CO	.12	.24**
mFTQ	.31**	.33***
Average cigarettes per day	.17	.30**
Cotinine (ng/ml)	n/a	.18*

*
p < .05,

**
p < .01,

p < .001