Brief report

Examining Risk Perceptions Among Daily Smokers Naïve to Reduced Nicotine Content Cigarettes

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Abstract

Introduction: The U.S. Food and Drug Administration (FDA) has stated its interest in reducing the addictiveness of combustible cigarettes by lowering their nicotine content. Delineating risk perceptions of reduced nicotine content (RNC) cigarettes prior to federal regulation may inform the content of future educational campaigns accompanying this policy.

Methods: Five hundred non-treatment-seeking, daily smokers naïve to RNC cigarettes (63.0% male, 51.6% nonWhite, mean [*SD*] cigarettes per day = 15.69 [7.58], age = 43.44 [11.46]) completed a 10-item RNC cigarette risk perception questionnaire at baseline in two, unrelated experimental studies. We used multinomial logistic regression models to identify demographic (eg, gender) and smoking-related (eg, nicotine dependence) correlates of RNC cigarette risk perceptions.

Results: Although the majority of participants did not misperceive RNC cigarettes as less harmful than regular or high nicotine cigarettes, a large portion of the sample held misperceptions about RNC cigarettes' addictiveness (56.4%) and cessation aid potential (63.4%). More than 20% of the sample reported being unsure about RNC-related risks, especially tar content (51.8%). NonWhite smokers were 2.5 to 3 times more likely to be incorrect about multiple RNC cigarette risks ($p = .002-.006$).

Conclusions: If the FDA mandates a reduced nicotine content standard for cigarettes, educational campaigns will be needed to correct misperceptions about RNC cigarettes' addictiveness and potential to aid cessation as well as inform consumers about their safety risks. Campaigns tailored toward nonWhite smokers may also be needed to correct misperceptions of RNC cigarette risks held by this subgroup.

Implications: The FDA has stated its interest in reducing cigarettes' addictiveness by lowering their nicotine content, enabling smokers to quit. Our findings suggest that most smokers who have not used RNC cigarettes do not perceive these products as less addictive or as cessation tools, stressing a need for future educational campaigns to correct these misperceptions. Campaigns are also

needed to educate uninformed smokers about RNC cigarettes and should consider targeting messages toward subgroups likely to hold misperceptions about the risks and benefits of using these products (eg, nonWhite smokers).

Introduction

On July 28, 2017, the US Food and Drug Administration (FDA) announced¹ its intent to reduce the addictiveness of combustible cigarettes by reducing their nicotine content, using its authority to mandate tobacco product standards that protect public health.² A nicotine reduction approach is supported empirically, as reduced nicotine content (RNC) cigarettes decrease dependence and several tobacco exposure biomarkers relative to higher nicotine content cigarettes without increasing puffing behavior,^{3–9} and may encourage cessation.^{3,4}

Although this approach may benefit population health by enabling smokers to quit and preventing nondependent smokers from becoming addicted,^{10,11} RNC cigarettes still pose risks to individual smokers. RNC cigarettes do not reduce all constituent exposure nor do they exert favorable effects at all reduced nicotine levels.^{5,8,9} Thus, they are not safer cigarettes; they are intended as tools to move smokers away from combustible cigarettes. There is concern that the tobacco industry may exploit this paradox and falsely market these products to consumers as less harmful (eg, “light” cigarettes^{12,13}). Indeed, the investigational RNC cigarette manufacturer used by recent trials has applied to the FDA to market its cigarettes as modified risk tobacco products.¹⁴ Misperceptions about RNC cigarette risks may discourage cessation or promote increased product use,¹⁵ negating potential benefits of mandated nicotine reduction.

Establishing a better understanding of RNC cigarette risk perceptions now, while most smokers are naïve to these products, provides a unique opportunity to inform campaigns to educate the public before policy implementation and industry marketing efforts. Such information may determine whether educational campaigns are needed to merely inform consumers about RNC cigarettes, or actively correct misperceptions. Further, this data may provide ideas for what types of content could be embedded into campaigns (eg, statements addressing nicotine vs. other cigarette constituents vs. broad health effects). Finally, campaigns could use this information to target subgroups of smokers most in need of education.

We assessed RNC cigarette risk perceptions and their correlates using secondary data from two unrelated experimental trials to examine how smokers naïve to these products perceive their risks. Extant research suggests that smokers hold misperceptions about the risks of using RNC cigarettes.^{6,16,17} These studies, however, have assessed perceptions following exposure to these products,^{6,16} which may not represent perceptions before policy implementation, or have been limited to assess only one or two beliefs (eg, cancer risk¹⁷; addictiveness, harmfulness¹⁸). Thus, our data extend this literature by examining multiple risk perceptions among an RNC-naïve sample. We hypothesized that, consistent with studies of previously commercially-available¹⁵ and investigational^{6,16} RNC cigarettes, smokers would misperceive RNC cigarettes as less harmful. Consistent with industry research,¹⁹ we also hypothesized that age and gender would predict RNC cigarette risk perceptions, such that older and female smokers would be more likely to hold these misperceptions.

Methods

Study Sample and Design

Participants were 500 non-treatment-seeking daily smokers recruited from the Philadelphia area from June 2014 to June 2017 (ie, before the FDA announcement¹) for two, laboratory-based studies of cigarette packaging ($n = 177$) and warning labels ($n = 323$) unrelated to RNC cigarettes. Eligible participants were aged 21–65, reported smoking ≥ 5 filtered cigarettes/day (CPD), and reported smoking regularly for at least the past 5 years. We further excluded participants who reported: drinking >25 alcohol-containing drinks/week; using other nicotine-containing products; current/planned cessation program enrollment; a serious/unstable medical condition or substance abuse disorder in the past 12 months; pregnancy and/or lactation; or who provided a breath alcohol concentration reading >0 or an initial carbon monoxide sample <5 ppm. The packaging study also excluded colorblind, menthol, and non-Marlboro smokers. To control for previous RNC cigarette use, we excluded those who had enrolled in prior RNC cigarette studies at our laboratory. To ensure that we did not duplicate data from participants who completed baseline for both studies, we retained data from only the first study completed by these individuals.

Prospective participants responded to digital and print media advertisements and completed a telephone interview to determine initial eligibility; those eligible attended a laboratory visit to provide written informed consent and confirm final eligibility. Participants completed demographic, smoking history, and RNC cigarette risk perception questionnaires before randomization to study-specific interventions and divergent protocols. Prior to completing the risk perception questionnaire, participants received no preamble or background information related to a federal nicotine reduction policy to avoid influencing their subsequent responses. The University of Pennsylvania Institutional Review Board approved all procedures.

Measures

RNC cigarette risk perceptions were assessed using a 10-item scale (Table 1 contains item wording). Items provided statements about the risks of “low nicotine cigarettes” relative to “regular” or “high nicotine” cigarettes, rated on a 5-point response scale: 1=“definitely not true,” 2=“not true,” 3=“unsure,” 4=“true,” 5=“definitely true.” Because few smokers endorsed the “definitely true” option, responses were subsequently collapsed into three categories: 1=“not true,” 2=“unsure,” 3=“true.” Based on extant research,^{3–9} we scored the “not true” and “true” responses, respectively, as “correct” and “incorrect” for all but the “less addictive” and “easier to quit” items. Because research supports these statements as accurate, “not true” and “true” responses were scored, respectively, as “incorrect” and “correct.”

Demographic information included participants’ age, gender, race, ethnicity, and highest completed education level.

Smoking history information included self-reported CPD and nicotine dependence, assessed, respectively, using the question “In the past 7 days, how many cigarettes did you smoke per day?” and the Fagerström Test for Nicotine Dependence.²⁰

Table 1. Distribution of Responses to RNC Risk Perceptions Scale (*n* = 500)

Belief item	Response		
	Definitely not true/ Not true	Unsure	True/Definitely true
1. Cigarettes that are lower in nicotine are less likely to cause cancer than regular cigarettes	337 (67.4%)	126 (25.2%)	37 (7.4%)
2. Cigarettes that are lower in nicotine are safer than regular cigarettes	317 (63.4%)	127 (25.4%)	55 (11.0%)
3. Cigarettes that are lower in nicotine are healthier than regular cigarettes	339 (67.8%)	111 (22.2%)	50 (10.0%)
4. Cigarettes that are lower in nicotine have fewer chemicals than regular cigarettes	282 (56.4%)	170 (34.0%)	48 (9.6%)
5. Cigarettes that are lower in nicotine are less addictive than regular cigarettes	317 (63.4%)	136 (27.2%)	47 (9.4%)
6. Smoking cigs that are lower in nicotine make it easier to quit smoking completely compared to regular cigarettes	255 (51.0%)	188 (37.6%)	57 (11.4%)
7. Cigarettes that are lower in nicotine also have less tar than regular cigarettes	196 (39.2%)	259 (51.8%)	45 (9.0%)
8. High nicotine content cigarettes are worse for your health than low nicotine cigarettes, even if you smoke the same number of each	212 (42.4%)	163 (32.6%)	125 (25.0%)
9. A low nicotine cigarette is safer to smoke than a high nicotine cigarette, even if you don't quit	282 (56.4%)	152 (30.4%)	66 (13.2%)
10. Low nicotine cigarettes are healthier for you than high nicotine cigarettes even before you quit	289 (57.8%)	139 (27.8%)	72 (14.4%)

"Definitely not true" and "not true" responses to items 1–4 and 7–10 were categorized as "correct"; "True" and "definitely true" responses for these items were scored as "incorrect." Items 5 and 6 (bolded typeface) categorized "definitely not true/not true" responses as "incorrect" and "true/definitely true" responses as correct.

Analytic Plan

Analyses were conducted using IBM SPSS Statistics v24. Descriptive statistics characterized variable distributions using all response options. Unpaired *t*-tests and chi-square independence tests determined study differences, respectively, in continuous and categorical variables. Ten multinomial logistic regression models regressed each RNC risk perception item (using "correct" as the reference category) onto demographic and smoking history predictors previously associated with RNC cigarettes and perceptions^{16,18}: age, gender, race, education level, CPD, and dependence (excluding the CPD item). We additionally included a term for study to account for sample differences. Models omitted menthol status due to (1) exclusion of menthol smokers from the packaging study, and (2) multicollinearity from associations of menthol, race, and education. To assess linearity in the logit for continuous predictors, we first ran models including Box-Tidwell transformation terms. None were significant and were omitted from final models.

Results

Sample Characteristics

Participants, on average, were 43.44 years old (*SD* = 11.46), reported smoking 15.69 CPD (*SD* = 7.58), and were moderately to heavily nicotine dependent (*M* = 5.42, *SD* = 2.11). The majority were male (63.0%) and nonHispanic (96.4%); 48.4% identified as White and 51.8% had completed some college or technical training as their highest level of education. Warning label (vs. packaging) study participants were more likely to be nonWhite [$\chi^2(1) = 54.17, p < .001$], less educated [$\chi^2(1) = 5.31, p = .021$], and marginally more likely to be female [$\chi^2(1) = 3.38, p = .066$]. RNC risk perceptions did not differ between studies [$\chi^2(2) = 0.10$ – $4.02, p = .13$ – 0.95].

Prevalence of RNC Cigarette Risk Perceptions

Table 1 presents raw RNC risk perception item responses. Overall, the majority of participants endorsed correct responses for all risk perception items with three notable exceptions: 63.4% and 51.0% respectively endorsed the perception items that RNC cigarettes are less addictive and make it easier to quit as incorrect, and 51.8% were unsure about the less tar item. Excepting these items, few participants endorsed incorrect responses for any other items. More than 20% of the sample endorsed each risk perception item as unsure.

Correlates of RNC Cigarette Risk Perceptions

Separate multinomial logistic models regressed each RNC risk perception item onto demographic and smoking history variables, using the "correct" response as the reference category. Models were not significant overall for perceptions that RNC cigarettes are less likely to cause cancer than regular cigarettes and have fewer chemicals than regular cigarettes, that high nicotine content cigarettes are worse for health than RNC cigarettes even when smoking the same number of each, and that RNC cigarettes are healthier than high nicotine cigarettes even before quitting [$\chi^2(14) = 17.14$ – $23.49; p = .053$ – $.249$]. These risk perception items are not discussed further. We present results for significant models below and in Table 2.

Race was associated with incorrect perceptions of multiple RNC cigarette risks, whereas gender was correlated only with perceptions related to tar content and quitting potential. NonWhite smokers were more likely than White smokers to incorrectly (vs. correctly) perceive RNC cigarettes as safer (RRR = 2.92, 95% CI = 1.50 to 5.69, *p* = .002), healthier (RRR = 3.01, 95% CI = 1.49 to 6.06, *p* = .002) and having less tar (RRR = 3.12, 95% CI = 1.38 to 7.04, *p* = .006) than regular cigarettes, and safer than high nicotine cigarettes even if you do not quit (RRR = 2.54, 95% CI = 1.34 to 4.81, *p* = .004). Men were more likely than women to be unsure about the

Table 2. Relative Risk Ratios and 95% Confidence Intervals of Individual Predictor Variables for Significant Multinomial Logistic Regression Results (Reference Category = Correct Response)

Belief item	RNC cigarettes are safer than regular cigarettes	RNC cigarettes are healthier than regular cigarettes	RNC cigarettes are less addictive than regular cigarettes	RNC cigarettes make it easier to quit smoking completely than regular cigarettes	RNC cigarettes also have less tar than regular cigarettes	A RNC cigarette is safer to smoke than a HNC cigarette, even if you do not quit
Overall significance	$\chi^2(14) = 27.55$ $p = .016$	$\chi^2(14) = 24.17$ $p = .044$	$\chi^2(14) = 42.14$ $p < .001$	$\chi^2(14) = 38.67$ $p < .001$	$\chi^2(14) = 54.57$ $p < .001$	$\chi^2(14) = 25.26$ $p = .032$
INCORRECT						
Age	0.98 (0.96 to 1.01)	0.98 (0.96 to 1.01)	1.04 (1.01 to 1.07)**	1.02 (0.99 to 1.05)	1.06 (1.02 to 1.10)**	1.03 (1.00 to 1.05)
Cigarettes/day	1.00 (0.96 to 1.04)	0.99 (0.95 to 1.03)	1.09 (1.03 to 1.16)**	1.05 (1.00 to 1.10)	0.97 (0.92 to 1.02)	0.99 (0.95 to 1.03)
Dependence	0.95 (0.80 to 1.13)	0.99 (0.83 to 1.19)	0.94 (0.78 to 1.13)	1.08 (0.90 to 1.28)	0.97 (0.79 to 1.20)	0.97 (0.82 to 1.15)
Gender						
Male	1.00 (0.54 to 1.86)	1.29 (0.67 to 2.49)	0.63 (0.32 to 1.27)	0.37 (0.19 to 0.73)**	2.06 (1.00 to 4.26)	1.04 (0.59 to 1.84)
Female	REF	REF	REF	REF	REF	REF
Race						
White	REF	REF	REF	REF	REF	REF
NonWhite	2.92 (1.50 to 5.69)**	3.01 (1.49 to 6.06)**	1.24 (0.60 to 2.57)	0.76 (0.39 to 1.48)	3.12 (1.38 to 7.04)**	2.54 (1.34 to 4.81)**
Education						
≤HS grad/GED	0.58 (0.31 to 1.08)	0.55 (0.29 to 1.06)	0.73 (0.37 to 1.42)	1.60 (0.86 to 2.98)	0.80 (0.40 to 1.60)	0.82 (0.47 to 1.46)
≥ Some college	REF	REF	REF	REF	REF	REF
Study						
Warning labels	0.55 (0.29 to 1.05)	0.41 (0.21 to 0.80)**	1.53 (0.77 to 3.04)	1.09 (0.56 to 2.10)	0.99 (0.46 to 2.13)	0.82 (0.45 to 1.52)
Packaging	REF	REF	REF	REF	REF	REF
UNSURE						
Age	1.00 (0.99 to 1.02)	0.99 (0.97 to 1.01)	1.02 (0.99 to 1.05)	1.00 (0.98 to 1.03)	1.01 (0.99 to 1.03)	1.00 (0.99 to 1.02)
Cigarettes/day	0.97 (0.94 to 1.00)	0.98 (0.95 to 1.01)	1.07 (1.00 to 1.14)*	1.00 (0.95 to 1.05)	0.97 (0.94 to 0.99)*	0.98 (0.95 to 1.01)
Dependence	0.93 (0.82 to 1.05)	1.03 (0.90 to 1.17)	0.92 (0.75 to 1.12)	1.00 (0.84 to 1.20)	0.89 (0.79 to 1.00)	0.94 (0.84 to 1.06)
Gender						
Male	1.20 (0.77 to 1.88)	1.37 (0.86 to 2.18)	1.11 (0.52 to 2.38)	0.63 (0.31 to 1.27)	1.71 (1.14 to 2.56)**	1.40 (0.91 to 2.16)
Female	REF	REF	REF	REF	REF	REF
Race						
White	REF	REF	REF	REF	REF	REF
NonWhite	1.56 (0.97 to 2.51)	1.49 (0.91 to 2.43)	2.12 (0.97 to 4.61)	0.76 (0.39 to 1.48)	1.32 (0.86 to 2.03)	1.10 (0.70 to 1.71)
Education						
≤HS grad/GED	1.15 (0.75 to 1.78)	0.99 (0.63 to 1.55)	0.57 (0.28 to 1.17)	1.52 (0.81 to 2.86)	0.70 (0.46 to 1.03)	1.21 (0.80 to 1.83)
≥Some college	REF	REF	REF	REF	REF	REF
Study						
Warning labels	0.96 (0.60 to 1.55)	0.95 (0.58 to 1.56)	1.56 (0.74 to 3.29)	0.94 (0.48 to 1.82)	1.08 (0.70 to 1.65)	1.15 (0.73 to 1.80)
Packaging	REF	REF	REF	REF	REF	REF

Results are only presented for RNC belief items which had overall significance of $p < .05$. Bolded typeface indicates statistical significance. * $p < .05$; ** $p < .01$.

perception that RNC cigarettes have less tar than regular cigarettes (RRR = 1.71, 95% CI = 1.14 to 2.56, $p = .009$). Men were less likely to be incorrect about the easier to quit item (RRR = 0.37, 95% CI = 0.19 to 0.73, $p = .004$).

Age and CPD were correlated only with the less addictive and less tar risk perception items. Older age was associated with greater likelihood of being incorrect about the less addictive (RRR = 1.04, 95% CI = 1.01 to 1.07, $p = .007$) and less tar (RRR = 1.06, 95% CI = 1.02 to 1.10, $p = .002$) items. Greater CPD was associated with greater likelihood of being incorrect and unsure about the less addictive item (RRR = 1.10 and 1.07, 95% CI = 1.03 to 1.16 and 1.01 to 1.12, $p = .004$ and $.038$, respectively) and lower likelihood of being unsure about the less tar item (RRR = .97, 95% CI = 0.94 to 0.99, $p = .018$).

Study was associated only with the perception that RNC cigarettes are healthier than regular cigarettes (RRR = .41, 95% CI = 0.21 to 0.80, $p = .008$).

Education and nicotine dependence were not associated with any RNC risk perception items.

Discussion

This study provides initial evidence regarding RNC cigarette risk perceptions and their predictors among 500 non-treatment-seeking smokers naive to these products. Contrary to our hypothesis, most of our sample held accurate perceptions of RNC cigarettes' harm relative to regular and high nicotine content cigarettes. However, the majority held misperceptions about their addictiveness and potential as cessation tools. Because the goal of mandated nicotine reduction is to reduce cigarettes' addictiveness and facilitate cessation, these findings highlight a critical need to educate smokers about these domains prior to policy implementation. Without correctly structured, theoretically focused information campaigns, smokers may not perceive RNC cigarettes to have quitting benefits (independent of holding accurate harm perceptions), which may limit the population-level efficacy of this policy in decreasing smoking prevalence.

Contrary to our hypothesis that female smokers would be more likely to hold misperceptions about RNC cigarette risks, we found few gender differences in perceptions: male (vs. female) smokers were more likely to be incorrect about RNC cigarette's potential as a cessation aid, yet less likely to be unsure about tar content. Because we based this hypothesis on industry research on light cigarettes, it is possible that these observations do not generalize to RNC cigarettes, or that efforts to correct misperceptions about light cigarettes have improved overall misperceptions about combustible tobacco products.

More than one in five smokers were unsure about all RNC risk perception items, especially tar content. If a RNC standard is mandated for cigarettes, these findings suggest that educational campaigns are necessary to inform consumers about RNC cigarette risks to clarify uncertainty. Getting this information to consumers now is critically important, before the industry unveils misleading marketing campaigns that could undermine RNC cigarette benefits.

Because most smokers were incorrect about RNC cigarettes' addictiveness and quitting potential, and unsure about tar content, these findings suggest that campaigns may not need to be tailored to specific subgroups of smokers to correct these specific misperceptions. However, separate strategies may be needed to correct non-White smokers' misperceptions about other RNC cigarette risks, as this subgroup was more likely to endorse inaccurate perceptions

across most items. Such strategies would be similar to those already developed and implemented by the FDA to educate Black youth about general risks of tobacco use.²¹ Based on our findings, education level and dependence are not factors that should influence campaigns targeting.

Our findings are tempered by several caveats. First, RNC cigarette risk perceptions among non-treatment-seeking, daily smokers from a single city may not represent the larger US smoking population. Second, although we controlled for previous RNC cigarette experience, some participants may have had undisclosed exposure that influenced their perceptions. Finally, because our data were collected before the FDA's announcement¹ to regulate nicotine while no commercially available RNC cigarette exists, smokers' risk perceptions were assessed in an information vacuum (ie, smokers received no descriptions about RNC cigarettes prior to the questionnaire, as has been recently recommended²²). Perceptions may vary when such a product is publicly available and regulated by the FDA.

Despite these potential limitations, results provide an important first step in assessing RNC cigarette risk perceptions to inform related future educational campaigns. Such campaigns should specifically focus on correcting misperceptions about RNC cigarettes' addictiveness and cessation potential, and inform smokers about RNC cigarette safety risks. Furthermore, campaigns should target specific subgroups of smokers (eg, non-White smokers) to most effectively inform consumers.

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Declaration of Interests

All authors have no conflicts of interest to declare.

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