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Brief Report

Concurrent Choice Assessment of Preference and Substitutability of E-cigarettes and Heated Tobacco Products for Combustible Cigarettes Among African American and White Smokers

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Abstract

Introduction: Alternative nicotine delivery products, including electronic cigarettes (e-cigarettes) and heated tobacco products (HTPs), contain fewer toxicants than combustible cigarettes and offer a potential for harm reduction. Research on the substitutability of e-cigarettes and HTPs is crucial for understanding their impact on public health. This study examined subjective and behavioral preferences for an e-cigarette and HTP relative to participants' usual brand combustible cigarette (UBC) in African American and White smokers naïve to alternative products.

Aims and Methods: Twenty-two adult African American (n = 12) and White (n = 10) smokers completed randomized study sessions with their UBC and study provided e-cigarette and HTP. A concurrent choice task allowed participants to earn puffs of the products but placed UBC on a progressive ratio schedule, making puffs harder to earn, and e-cigarette and HTP on a fixed ratio schedule to assess behavioral preference for the products. Behavioral preference was then compared to self-reported subjective preference.

Results: Most participants had a subjective preference for UBC (n = 11, 52.4%), followed by an equal preference for e-cigarette (n = 5, 23.8%) and HTP (n = 5, 23.8%). During the concurrent choice task, participants showed a behavioral preference (i.e., more earned puffs) for the e-cigarette (n = 9, 42.9%), followed by HTP (n = 8, 38.1%), and UBC (n = 4, 19.1%). Participants earned significantly more puffs of the alternative products compared to UBC (p = .011) with no difference in earned puffs between e-cigarettes and HTP (p = .806).

Conclusions: In a simulated lab setting, African American and White smokers were willing to substitute UBC for an e-cigarette or HTP when the attainment of UBC became more difficult.

Trial Registration: NCT04646668.

Implications: Findings suggest that African American and White smokers are willing to substitute their UBC for an alternative nicotine delivery product (e-cigarette or HTP) when the attainment of cigarettes became more difficult in a simulated lab setting. Findings require confirmation among a larger sample under real-world conditions but add to growing evidence suggesting the acceptability of alternative nicotine delivery products among racially diverse smokers. These data are important as policies that limit the availability or appeal of combustible cigarettes are considered or enacted.

Introduction

For smokers unable or unwilling to quit cigarettes, the possibility of switching from combustible cigarettes to non-combustible alternative nicotine delivery products like electronic cigarettes (e-cigarettes) and heated tobacco products (HTPs) may offer a potential for harm reduction.[1,2] For smokers to switch, they need to find alternative products to be as reinforcing and appealing as their usual brand combustible cigarette (UBC),[3,4] yet relatively little is known about smokers' experience of alternative nicotine delivery products and few studies on potentially reduced harm products have actively recruited minoritized smokers, despite known smoking-related inequities.[5–7] While longer-term studies are still underway, short-term studies suggest harm reduction potential from e-cigarettes and HTPs for combustible cigarette smokers.[2,8–11] Based on this and consistent with the "end-game" approach, the marketplace should be set up to include numerous harm-reduction products, including e-cigarettes

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and HTPs.[12] As additional alternative products enter the market, it is critical to understand how minoritized populations will use and view these products.

This study used a concurrent choice task paradigm to examine and compare subjective and behavioral preferences for an e-cigarette and HTP relative to participants' UBC in African American and White smokers naïve to alternative nicotine delivery products. We hypothesized that participants would demonstrate a subjective preference for their UBC but, as access to UBC becomes more difficult, behavioral preference (i.e., puffs earned) for the alternative nicotine delivery products relative to UBC would emerge.

Methods

Participants were recruited for a two-component study assessing the pharmacokinetic profile of combustible cigarettes, e-cigarettes, and HTPs (component one) and the acceptability of non-combustible alternative products via a concurrent choice task (component two) (Supplementary Figure 1). African American (n = 12) and White (n = 10) adult smokers who were not interested in quitting cigarettes but were interested in trying e-cigarettes and HTPs completed three in-laboratory study visits. Recruitment occurred from September 2020 to August 2021. Eligible participants were adult (>21 years), non-Hispanic African American or White, daily smokers who smoked five or more cigarettes per day (CPD) for a least 6 months and were interested in trying an e-cigarette and HTP but were unable or unwilling to quit smoking combustible cigarettes. Participants were excluded if they were interested in quitting cigarettes in the next 30 days, had used smoking cessation pharmacotherapy in the previous 30 days, were e-cigarette or HTP users (>5 times in their lifetime or >4 of the previous 30 days), had used other tobacco products (i.e., cigars, smokeless tobacco, etc.) in the previous 30 days, or had medical contraindications to product use or study procedures (i.e., uncontrolled hypertension, pregnant, weighed less than 110 pounds). All participants provided informed consent prior to completing the study procedures. Study procedures were approved by the university's Institutional Review Board.

Behavioral preference was measured using standard methodology.[13–16] Specifically, the 90-minute computerized concurrent choice task allowed participants to earn up to a total of 20 puffs of the UBC, a 5% nicotine salt-based e-cigarette from JUUL (choice of menthol or tobacco pods), and an iQOS HTP (choice of fresh menthol, smooth menthol, or non-menthol heatsticks) by clicking boxes on the computer screen corresponding to the products. Prior to the concurrent choice task (component two) participants were instructed on how to properly use and charge the devices and were given at least 2 days to practice using the devices with their chosen pod or heatstick flavor before completing pharmacokinetic session (component one) visits. The trial period allowed exposure to and practice with the novel devices and allowed time for reflection on what participants did and did not like about each product. During the concurrent choice task, the e-cigarette and HTP were placed on a fixed ratio schedule. To earn a puff from the e-cigarette or HTP, participants were required to click the corresponding box 10 times. To simulate proposed policy solutions in which cigarettes may lose their appeal (e.g., low nicotine standard) and to test for relative demand of participants' UBC, the UBC was placed on a progressive ratio schedule, which increased the number of clicks (or effort) necessary to earn a puff with each trial of the task after a puff of the UBC was earned.[17] Per the progressive ratio schedule, 10 mouse clicks were required to earn one puff of the UBC and clicks increased with each trial the UBC was chosen: 160, 320, 640, 1280, 2400, 3600, 4800, 6000, 7200, and 8400 clicks.[13,14] The number of puffs allocated to each product was measured. Participants were not required to complete all 20 trials and, therefore, to account for the variance in the number of trials completed, the percentage of puffs allocated to each product was calculated by dividing the number of puffs allocated to the respective product by the total number of trials completed during the task. The product with the greatest percentage of allocated puffs was defined as participants' preferred product or their behavioral preference.

Subjective effects of the products were collected at the end of each corresponding pharmacokinetic session (component one) using a 10-item questionnaire.[18] Items included "How pleasant would the product you just used be to use again right now" and "How much do you need to use the product you just used right now, just for relief." Responses were provided on a series of visual analog scales with options ranging from 0 ("not at all") to 100 ("extremely"). Total scores were calculated and averaged for each product. The product with the highest self-reported score was defined as participants' preferred product or their subjective preference.

Participants completed baseline measures of age, gender, race, education level, annual household income, employment status, homeownership, and CPD and nicotine dependence.[19]

Statistical Analyses

Cohen's kappa coefficient was calculated to assess the concordance between participants' subjective and behavioral preferences. Signed rank tests were used to assess differences between participants' proportion of puffs allocated to UBC compared to either of the alternative products (e-cigarette or HTP) and to assess the proportion of puffs allocated to the e-cigarette compared to the HTP. Statistical significance was set as $\alpha < 0.05$. Analyses were conducted using SPSS Version 27 and SAS Version 9.4.

Results

Participant sociodemographic characteristics and markers of nicotine dependence are presented in Table 1. During the concurrent choice task, participants showed a behavioral preference for the e-cigarette (n = 9, 42.9%), followed by HTP (n = 8, 38.1%) and UBC (n = 4, 19.1%; Table 2). However, most participants showed a subjective preference for their UBC (n = 11, 52.4%), followed by an equal preference for the e-cigarette (n = 5, 23.8%) and HTP (n = 5, 23.8%; Table 2). There was a poor degree of agreement and statistically non-significant concordance (κ = 0.19, p = .083) between participants' subjective and behavioral preferences.[20] Specifically, of the 11 participants who reported a subjective preference for UBC, only two showed a congruent behavioral preference for UBC while five showed a behavioral preference for the e-cigarette and four showed a behavioral preference for the HTP. During the concurrent choice task, participants allocated a significantly greater number of puffs to the alternative products compared to UBC (e-cigarette or HTP; p = .011). There was no statistically significant difference between the number of puffs allocated to the e-cigarette versus HTP (p = .806).

Table 1. Participant Sociodemographic Characteristics and Markers of Nicotine Dependence

Characteristic	*N*	% / Mean (SD)
Total	22	
Age, mean (SD)		54.1 (12.0)
Gender		
Male	9	40.9%
Female	13	59.1%
Race		
African American	12	54.5%
White	10	45.5%
Education		
Some high school	4	18.2%
Grade 12 or GED	7	31.8%
College 1 year to 3 years	8	36.4%
College 4 years or more	3	13.6%
Annual household income		
Less than $25 000	14	63.6%
$25 000 to less than $50 000	5	22.7%
$50 000 to less than $75 000	1	4.5%
$100 000 or more	1	4.5%
Refused	1	4.5%
Employment status		
Unemployed	7	31.8%
Employed full time	3	13.6%
Retired	7	31.8%
Other	5	22.7%
Homeownership		
No	20	90.9%
Yes	2	9.1%
Cigarette smoking status		
Menthol	15	68.2%
Non-menthol	7	31.8%
EC flavor choice		
Menthol	19	86.4%
Tobacco	3	13.6%
HTP flavor choice		
Menthol	14	63.6%
Tobacco	8	36.4%
Nicotine dependence* (range 0–10)		4.5 (2.5)
Cigarettes per day		15.9 (9.2)

Nicotine dependence measured using the Fagerström test for nicotine dependence (FTND)

Table 2. Product Preference

Characteristic	*N*	% / Mean (SD)
Subjective preference*		
UBC	11	52.4%
EC	5	23.8%
HTP	5	23.8%
Behavioral preference*		
UBC[a]	4	19.1%
EC[b]	9	42.9%
HTP[b]	8	38.1%

*One participant allocated the same number of puffs to the EC and HTP during the concurrent choice task, thereby exhibiting no clear behavioral preference. Therefore, the participant was excluded from analyses investigating product substitutability but was retained in all other analyses. Subjective effects = self-reported product satisfaction value from 10-item questionnaire; Subjective preference = preferred product based on self-reported subjective effects; Behavioral preference = preferred product based on percentage of allocated puffs from the concurrent choice task.
[a]UBC was placed on a progressive ratio schedule.
[b]EC and HTP were placed on a fixed ratio (10 clicks) schedule.

Discussion

The current study investigated the potential substitutability of e-cigarettes and HTPs for combustible cigarettes using both self-report and behavioral measures among a sample of racially diverse smokers. As hypothesized, we found that smokers subjectively rated their UBC more favorably compared to the e-cigarette and HTP but showed a behavioral preference for the alternative study products when the UBC was placed on a progressive ratio schedule and required greater effort to obtain. Overall, participants earned a greater proportion of puffs from the e-cigarette and HTP than from the UBC. The lack of concordance between participants' subjective and behavioral preferred products indicates that as the UBC became harder to access (greater number of clicks), participants were willing to use an alternative product. Interestingly, while participants showed an overall willingness to choose the alternative products as the UBC became more difficult to earn, they did not show a preference for one of the alternative products over the other.

Findings are hypothesis-generating but may have implications for tobacco control. The Food and Drug Administration has proposed efforts to reduce the appeal (i.e., implementation of a very low nicotine content product standard, removal of menthol flavoring) and access (i.e., increased taxation) of combustible cigarettes while allowing the sale of alternative, likely reduced harm, nicotine delivery products.[12,17] Tobacco regulation efforts that limit the appeal and access of combustible cigarettes may discourage smoking and facilitate switching to alternative products. Findings from the current study suggest that both the e-cigarette and HTP are potentially viable substitutes.

The present study is not without limitations. The study was not powered to detect a significant difference between behavioral preferences for the e-cigarette versus HTP. Findings require confirmation among a geographically representative sample of racially diverse smokers both within and outside of the lab setting. Additionally, future fully powered trials should consider the impact of race, gender, flavor preference, and other individual characteristics (e.g., nicotine dependence) on outcomes.

In conclusion, this study found that African American and White smokers saw e-cigarettes and HTPs as viable substitutes when the attainment of UBC became more difficult. Findings add to growing evidence suggesting the acceptability of alternative nicotine delivery products among racially diverse smokers and are encouraging given proposed policies that may decrease the appeal of combustible cigarettes. Specifically, for smokers who are unable or unwilling to quit, decreasing the appeal of combustible cigarettes may encourage a switch to alternative nicotine delivery products like e-cigarettes and HTP, which offer a possibility for harm reduction.

Supplementary Material

A Contributorship Form detailing each author's specific involvement with this content, as well as any supplementary data, are available online at https://academic.oup.com/ntr.

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Declaration of Interests

Ahluwalia received sponsored funds for travel expenses as a speaker for the 2021 Global Tobacco and Nicotine Forum (GTNF). Dr. Ahluwalia serves as a consultant and has equity in a start-up company, Respira Technologies.

Data Availability

The data underlying this article will be shared on reasonable request to the corresponding author.

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