

Social Network Ties and Responses to COVID-19 Among E-Cigarette Users

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Abstract

Social networks can enhance behavioral changes or entrench existing patterns of behavior. We aimed to identify how network ties to other e-cigarette users shaped responses to the pandemic and e-cigarette considerations. A national U.S. survey of 562 e-cigarette users was conducted during April 2020. Participants self-reported network ties to other e-cigarette users and pandemic outcomes: receiving expressions of concern about vaping, risk for a bad COVID outcome, changes in e-cigarette risk perceptions, and considerations of quitting. Each additional e-cigarette user tie was associated with a 0.014 unit increase in expressions of concern ($p < 0.001$), a 0.034 unit increase in perceived risk of a bad outcome ($p < 0.05$), and 3.9% higher odds of quit considerations (OR = 1.039; $p < 0.01$). Family ties to e-cigarette users were particularly important. Additional e-cigarette users within a network shaped risk perceptions in response to COVID-19. Network ties to other e-cigarette users have implications for cessation or reduction of e-cigarette use.

Keywords

e-cigarettes, pandemic, risk, vaping

Introduction

The identification of factors shaping behavioral patterns among e-cigarette users took on new relevance with the emergence of the COVID-19 pandemic. Other concerns about the risks of vaping had recently emerged with the e-Cigarette or Vaping Product Use–Associated Lung Injury (EVALI) scare (Adkins et al., 2020; Reagan-Steiner et al., 2020). Only months later, the emergence of the COVID-19 pandemic and its production of acute respiratory symptoms raised further concerns about the risks of vaping. Some experts suggested that smokers and e-cigarette users may have increased risks related to COVID-19 infection and disease progression (Brake et al., 2020; Lewis, 2020). Although much remains inconclusive, prior research indicates nicotine

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product use is relevant for viral respiratory illnesses with respect to disease transmission and related risk of hospitalization (Han et al., 2019; Lawrence, Hunter, Murray, Lim, & McKeever, 2019). There are also indications that e-cigarette and tobacco users are more likely to become infected with COVID-19 (Gaiha, Cheng, & Halpern-Felsher, 2020). E-cigarette use may shape not only how individuals experience the COVID-19 pandemic, but the pandemic also may have shaped how e-cigarette users reconsider their use of nicotine products during a period when respiratory health is more salient (Majmundar, Allem, Cruz, & Unger, 2020). At present, research on how the pandemic has affected the behaviors and attitudes of e-cigarette users (for better or worse) is still emerging.

Beyond the general relationship between e-cigarette use and pandemic illness experiences, we can consider how social networks may have reshaped how vaping is perceived among e-cigarette users within a pandemic context of heightened risks to e-cigarette use. Social networks—the webs of interrelationships that tie individuals together into social units—have the potential to either enhance the extent to which behavioral changes occur or entrench existing patterns of behavior. Social networks have proven to be durably related to health behaviors, including smoking and e-cigarette use (Barrington-Trimis et al., 2016; Cohen, 2004; Friedman & Aral, 2001; Gentina, Kilic, & Dancoine, 2017; Haas & Schaefer, 2014; Hall & Valente, 2007; Schaefer, Adams, & Haas, 2013; Smith & Christakis, 2008). With respect to substance use behaviors more generally, networks provide opportunities to initiate substance use, either through the direct provision of substances or by creating opportunities to use substances during social occasions, and also contribute to lifestyles in which the use of substances becomes part of social routines (Adams, Lawrence, Goode, Schaefer, & Mollborn, 2022; Wagner & Anthony, 2002). People also share information about substances within their social networks, including information about risks and opportunities to reduce harms associated with use (Jacinto, Duterte, Sales, & Murphy, 2008).

Beyond access and opportunities, networks establish and regulate social norms about appropriate use (Warr, 2002; Schaefer et al., 2013). Notably, role models or reference groups, such as family or friends, shape how people perceive substance use behaviors, which may influence patterns of use over time (Berten & Van Rossem, 2011; Lakon & Valente, 2012). While the role of social networks in shaping patterns of substance use behaviors is considerable, it is also varying. Although some research has highlighted the important role of social networks in the cessation of substance use, and smoking in particular (Christakis & Fowler, 2008), other research has suggested that network processes for initiation into substance use may exceed the effects of networks on cessation (Haas & Schaefer, 2014), thus indicating an asymmetrical network influence on substance use. Overall, social networks shape patterns of substance use and related health behaviors in multi-faceted ways that have differing implications for the uptake, continuance, and cessation of substance use.

We may consider two potential pathways by which networks may shape responses to COVID. First, the presence of other e-cigarette users may reduce perceptions of risk. Greater presence of network ties to other people who use substances typically reduce perceptions of risk (Berten & Van Rossem, 2011). Some of this process may be attributable to networks shaping norms that influence risk perceptions (Li, Gao, Chen, Cao, & Sun, 2018), and the role of networks in the promotion of self-exempting beliefs that enable continued substance use in the face of risks (Yang, Kelly, & Yang, 2014). Extending from these findings, the presence of other e-cigarette users in one's social network may temper perceptions of risk related to e-cigarette use within the context of the pandemic. Given that risk perceptions about e-cigarettes in general are strongly associated with the perceived risks of COVID-19 to e-cigarette users (Kelly et al., 2021), e-cigarette users may be less likely to view their own vaping during the pandemic as a problem in comparison to perceived risks among those who do not use e-cigarettes. The density of a network with other people who use substances influences

substance use (Ennett et al., 2006), and greater presence of other e-cigarette users in one's social network may reduce the odds one considers quitting because of these risks. Additionally, e-cigarette users embedded within networks heavily comprised of other e-cigarette users may receive less social support via expressions of concerns about the risks of COVID to e-cigarette users. In sum, we expect that embeddedness within larger networks of other e-cigarette users will temper concerns about the pandemic and diminish efforts to cease or reduce e-cigarette use. In accordance with these considerations, we consider the following hypothesis: H₁ Increased presence of network ties to other e-cigarette is associated with reduced responses of concern to COVID.

In contrast, we may also consider that the presence of other e-cigarette users may have the opposite effect, i.e. more ties to other e-cigarette users elevates concerns about the pandemic. Social networks, particularly close ties within networks, are the vehicle by which social support can shape health behaviors and outcomes (Berkman, 2000). The experience of social support is particularly important for behavioral change (Zimmerman & Connor, 1989). Accordingly, the presence of other e-cigarette users within one's network may elevate awareness of risks related to nicotine use precisely because they have concerns about their own use and are more likely to verbalize these concerns to other e-cigarette users. In addition, social networks have been shown to be key factors in the diffusion of information, including health information related to emerging risks (Zhang & Centola, 2019). As such, e-cigarette users may be more likely to share information driving concerns about the emerging risks of e-cigarette use during the pandemic. Furthermore, concerns among e-cigarette users within one's network may potentially shift risk perceptions and related behaviors; individuals are more likely to reduce their own nicotine consumption when others' experiences of concern have led to reductions or cessation of nicotine use (Christakis & Fowler, 2008). In accordance with these considerations, we may evaluate a competing hypothesis: H₂ Increased presence of network ties to other e-cigarette is associated with increased responses of concern to COVID.

Beyond the general influence of social networks, certain types of network ties may have particular influences that vary in their impact on risk perceptions and behavioral change. Numerous studies have highlighted the role of specific types of social network ties on smoking, which may have implications for network influences on e-cigarette use. The role of peers and friendship networks has been widely documented as a key factor in shaping smoking and substance use more broadly (Gentina et al., 2017; Haas & Schaefer, 2014; Schaefer et al., 2013). It also has been long established that family influences are strong at early stages of the life course but then are replaced by peer influences as individuals age into adolescence, only for family influences to re-emerge as more significant as individuals marry and start families of their own (Glynn, 1981; Krosnick & Judd, 1982). For instance, in their whole network study of smoking behaviors, Christakis and Fowler (2008) identified that when one's spouse stopped smoking, one is most likely to reduce smoking. Other family members' (e.g. siblings') attitudes and behaviors more broadly also are a strong predictor of smoking cessation (Christakis & Fowler, 2008; Yang, Fisher, Li, & Danaher, 2006; Zhang, Chan, Fong, Malone, & Lam, 2012). Accordingly, ties to e-cigarette users within family, friends, and co-workers may have varying effects on COVID-related risk perceptions and behaviors. Within the context of the early pandemic period, beyond individuals adjusting their own behaviors to reduce exposure to COVID-19, state policies designed to reduce the impact of the pandemic had the effect of limiting both workplace contact with co-workers and social spaces for congregating with friends. As such, family networks may have had a uniquely considerable impact on shaping responses to the pandemic among e-cigarette users during this period.

Current Study

Using data from the early pandemic period in the U.S. when much about COVID-19 was still uncertain, this manuscript identifies relationships between network ties to other e-cigarette users and responses to the COVID-19 pandemic by e-cigarette users. First, we examine the association of the total number of ties to other e-cigarette users in their social networks (controlling for nicotine consumption and individual characteristics) with four pandemic-related outcomes for e-cigarette users: receiving others' expressions of concern about e-cigarette use within the context of the pandemic, beliefs that e-cigarette users are at greater risk for a bad outcome should they contract COVID-19, self-reported changes in e-cigarette use risk perceptions, and considerations of e-cigarette cessation. Additionally, we look at specific types of network ties—friends, family, and co-workers—to assess the relationship of particular network domains to these outcomes.

Methods

Sample

The sample of e-cigarette users was generated during April 2020 through a rapid assessment survey using a national U.S. panel of adults from Prolific Academic. Prolific is an online panel that includes a battery of background characteristics that can be used for sampling. Web-based panels are especially useful for rapid assessment of population groups and Prolific has been shown to offer advantages over alternative sources, including pre-screening and exclusion procedures (Palan & Schitter, 2018). Individuals were identified as potentially available for selection through information reported to Prolific. We included individuals who reported recent vaping (any use of e-cigarettes within past 30 days), but did not limit the sample to daily users to ensure we captured a range of patterns among current e-cigarette users. Within the survey, we defined e-cigarettes for subjects as “any electronic nicotine delivery system that creates vaporized nicotine to inhale.” After the data were cleaned and cases missing data on independent and dependent variables dropped, the final analytic sample size was 562 subjects. Listwise deletion was used with missing data, which was minimal (<1%). IRB approval was obtained prior to the conduct of this research.

Measures

E-cigarette Network Ties – Participants responded to three ego-centric count items about the number of friends, number of family members, and number of co-workers who used e-cigarettes. These were aggregated to the total number of network ties to e-cigarette users. Each of the three domains of network ties was used in sensitivity analyses to assess whether specific network domains had particularly important effects. To avoid biases to those with extremely large networks of e-cigarette users, individuals ($n = 9$) with more than 40 ties across network domains were capped at 40 in the analyses of total network ties.

Network COVID-19 Concern – Participants responded to an item about the extent to which members of their personal network have expressed concern about their e-cigarette use in light of the coronavirus: “How much have your friends or family expressed concern about your e-cigarette use since the coronavirus emerged?” Subjects were given item responses of 0 (Not at All) to 10 (A Great Deal) and asked to report using these scales.

Risk for Bad Outcomes – Subjects indicated the extent to which e-cigarette users were at risk for a worse COVID-19 outcome should they become infected: “As an e-cigarette user, how much do you worry that you are at increased risk for problems if you contracted the coronavirus?”

Subjects were given item responses ranging from 0 (Not at All) to 10 (Extremely) and asked to rate their extent of their perceived risk of harm from COVID to e-cigarette users.

Change in Risk Perception – Subjects self-reported the extent to which they changed their perception of risk of e-cigarette use in light of COVID-19: “In light of the current media reports on coronavirus, how much have you changed the way you think about the risks of vaping?” and asked to rate their change on a scale of zero to ten (0 – Not at all to 10 Completely). The measure provides an assessment of self-reported experience of cognitive reappraisal of risk during the pandemic by considering whether the subject perceives they have altered their own perception of risk. The outcome was recoded as a dichotomous outcome (0 = No/1 = Yes) representing whether or not the individual experienced a change in their perceptions of risk for e-cigarette use in light of the pandemic.

Consider Cessation – Subjects reported the extent to which they considered quitting e-cigarette use in light of COVID-19: “In light of the current media reports on coronavirus, how much have you thought about not vaping anymore?” and asked to rate their change on a scale of 0 to 10 (0 – Not at all to 10 All the Time). The outcome was recoded as a dichotomous outcome (0 = No/1 = Yes) to indicate whether or not they gave any consideration to quitting.

Individual Characteristics – We assessed a range of personal characteristics, included as covariates within all models presented below. These characteristics included personal nicotine use measured as number of days of e-cigarette use during the past 30 days and whether the subject currently smokes tobacco, which allowed us to assess network influences controlling for individuals’ patterns of vaping and tobacco use. In addition, we captured individual factors such as age, educational attainment, whether currently enrolled in school, gender, race/ethnicity, employment status, income group, political views (rated on a scale from 1 - strongly conservative to 5 - strongly liberal), marital status, whether children under 18 are present in the household, and sexual identity. Information regarding categories of individual characteristics are listed in [Table 1](#). We note that with the exception of educational attainment, these demographic characteristics align well with those of current e-cigarette users in the probability-based Population Assessment of Tobacco and Health (PATH) dataset ([Coleman et al., 2017](#)).

Analysis

We utilized multivariable Ordinary Least Squares (OLS) and logistic regression to assess the relationship between e-cigarette use networks and outcome variables of interest. We identified the association of network ties to e-cigarette users to the four outcomes controlling for socio-demographic covariates and nicotine consumption. Additionally, we assessed the relationship between specific network domains and the four outcomes. As all models shown in the tables are full multivariable models, the reported odds ratios are adjusted odds ratios and include 95% Confidence Intervals. Although not shown below, we note that we also ran interaction models to assess the potential for a moderating effect by whether or not the individuals smoked tobacco, but found no significant interactions in these analyses.

Results

[Table 2](#) focuses on the role of total network ties to e-cigarette users on the outcomes of interest. Each additional e-cigarette use network tie was associated with a 0.014 unit increase in experiencing expressions of concern about e-cigarette use ($p < 0.001$). Each additional e-cigarette use network tie was associated with a 0.034 unit increase in perceived risk of a bad outcome for e-cigarette users ($p < 0.05$). The effect of network ties on the odds of self-reported changes in risk perception that was not statistically significant ($p = 0.08$). Each additional

Table 1. Demographic Descriptive Statistics ($n = 562$).

	Mean/%	SD/n
Age	35.43	13.44
Currently student	21.5%	121
Educational Attainment		
<HS degree	0.9%	5
HS diploma	14.8%	83
GED recipient	2.1%	12
Some college	29.0%	163
Associates/2 year degree	12.5%	70
Bachelors/4 year degree	31.7%	178
Masters degree	8.2%	46
Doctorate	0.9%	5
Gender		
Male	57.7%	324
Female	41.6%	234
Non-binary/other	0.7%	4
Race/ethnicity		
White	67.8%	381
Black, African-American	6.8%	38
Hispanic/Latino	17.4%	98
Asian	4.1%	23
Other	3.9%	22
Employment		
Full-time	46.4%	261
Part time	13.9%	78
Unemployed	13.2%	74
Not in labor force	7.7%	43
Retired	3.0%	17
Student	12.5%	70
Disabled	3.4%	19
Political views	3.31	1.23
Strongly conservative	7.8%	44
Moderately conservative	21.5%	121
Neither/Nor	22.4%	126
Moderately liberal	28.3%	159
Strongly liberal	19.9%	112
Income group		
<\$25 k	34.9%	196
\$25–\$50 k	24.2%	136
\$50–\$75 k	23.5%	132
\$75–\$100 k	8.9%	50
Over \$100 k	8.4%	47
Marital status		
Married	33.5%	188
Widowed	0.7%	4
Divorced	10.9%	61
Separated	0.7%	4

(continued)

Table 1. (continued)

	Mean/%	SD/n
Never married	54.3%	305
Children in household	35.3%	198
Sexual identity		
Heterosexual	82.0%	461
Gay, lesbian, queer	5.2%	29
Bisexual	11.7%	66
Other	1.1%	6
Current smoker	38.3%	215
Freq of past 30 day e-cigarette use	19.20	11.29

network tie to e-cigarette users was associated with 3.9% higher odds of considering e-cigarette cessation (AOR = 1.039; $p < 0.01$).

In addition, Table 2 provides the full results of these analyses, showing the association of nicotine use and demographic factors with the respective outcomes. Here, we describe the coefficients for frequency of e-cigarette consumption and smoking status, as there are few additional significant effects among the demographic covariates. The frequency of e-cigarette use was inversely associated with experiencing expressions of concern for e-cigarette use from others in light of the pandemic ($B = -0.013$; $p < 0.001$). Smoking was not associated with this outcome. For the extent to which e-cigarette users are at risk for a worse COVID-19 outcome should they become infected, frequency of e-cigarette use was inversely associated with this outcome ($B = -0.036$; $p < 0.001$); smoking was not associated with this outcome. Each additional day of e-cigarette use was associated with 4.2% lower odds of a change in risk perception in light of the pandemic (AOR = 0.958; $p < 0.001$). Smoking was associated with 50.0% lower odds of a change in risk perception for e-cigarette use (AOR = 0.500; $p < 0.01$). Each additional day of e-cigarette use was associated with 5.0% lower odds of consideration of quitting e-cigarette use in light of the pandemic (AOR = 0.950; $p < 0.001$). Smoking was associated with 36.9% lower odds of considerations to quit e-cigarette use (AOR = 0.631; $p < 0.05$). As noted above, interactions of smoking with the network factors revealed no moderating effects of smoking on these e-cigarette related outcomes.

Table 3 provides results for e-cigarette use ties within specific network domains: friends, family, and co-workers. Although positive in direction, the relationship between each additional e-cigarette using friend and expressions of concern about e-cigarette use was not statistically significant ($p = 0.06$). Network ties to e-cigarette using friends were not associated with other outcomes. Each additional e-cigarette using family member was associated with a 0.057 unit increase in experiencing expressions of concern about e-cigarette use ($p < 0.01$), a 0.162 unit increase in perceived risk of a bad COVID outcome ($p < 0.05$), 19.8% increased odds of a change in risk perception about e-cigarette use in light of the pandemic ($p < 0.05$), and 31.8% higher odds of consideration to quit e-cigarette use ($p < 0.01$). Each additional e-cigarette using co-worker was associated with a 0.019 unit increase in experiencing expressions of concern about e-cigarette use ($p < 0.05$) and 5.6% higher odds of consideration to quit e-cigarette use ($p < 0.05$).

Table 2. E-cigarette Network Ties, Nicotine Use, and COVID-19 Responses among E-Cigarette Users.

	Experience Concern		Risk for Bad COVID Outcome		Change Risk Perception		Consider Quitting	
	B (S.E.)		B (S.E.)		Odds ratio [95% CI]		Odds ratio [95% CI]	
Total E-cig network ties	0.014** (0.004)		0.034* (0.016)		1.022 [†] [0.997–1.048]		1.039** [1.012–1.067]	
E-cig frequency past 30 days	-0.013*** (0.003)		-0.036** (0.013)		0.958*** [0.939–0.977]		0.950*** [0.931–0.969]	
Current smoker	0.061 (0.077)		-0.114 (0.295)		0.500** [0.326–0.765]		0.631* [0.412–0.967]	
Age	-0.010** (0.003)		-0.020 (0.012)		0.985 [†] [0.969–1.002]		0.985 [†] [0.968–1.002]	
Education attained (ref. HS diploma or less)								
Some College/2 year degree	0.005 (0.102)		-0.092 (0.387)		0.737 [0.421–1.289]		0.718 [0.415–1.245]	
Bachelors degree or greater	0.128 (0.114)		0.246 (0.434)		0.827 [0.443–1.544]		1.009 [0.542–1.880]	
Gender (ref. Male)								
Female	-0.052 (0.079)		-0.017 (0.303)		0.911 [0.594–1.398]		1.010 [0.658–1.548]	
Other	-0.482 (0.431)		-1.289 (1.642)		0.452 [0.045–5.765]		0.227 [0.026–1.966]	
Race/ethnicity (ref. White)								
Black, African-American	0.010 (0.148)		0.361 (0.566)		1.569 [0.636–3.869]		0.925 [0.404–2.117]	
Latinx	0.087 (0.101)		-0.405 (0.385)		1.028 [0.584–1.810]		0.732 [0.421–1.272]	
Asian	0.121 (0.186)		-0.643 (0.707)		0.755 [0.268–2.122]		0.650 [0.227–1.857]	
Other	-0.186 (0.186)		0.101 (0.708)		1.368 [0.460–4.065]		1.155 [0.400–3.338]	
Employed full time	0.034 (0.088)		0.668* (0.337)		1.104 [0.688–1.772]		1.143 [0.713–1.830]	
Political views	0.022 (0.032)		0.376** (0.121)		1.143 [0.963–1.355]		1.176 [0.992–1.395]	
Income (ref. <\$25 k)								
\$25–\$50 k	0.259* (0.103)		0.012 (0.391)		1.311 [0.755–2.275]		1.404 [0.814–2.419]	
\$50–\$75 k	0.104 (0.112)		-0.389 (0.427)		0.922 [0.510–1.669]		1.093 [0.602–1.983]	
\$75–100 k	0.349* (0.153)		0.054 (0.582)		2.051 [0.811–5.187]		2.009 [0.810–4.982]	
Over \$100 k	0.301 [†] (0.156)		-0.100 (0.594)		1.198 [0.521–2.752]		1.289 [0.563–2.954]	
Married	0.153 [†] (0.092)		0.402 (0.350)		1.476 [0.902–2.415]		1.423 [0.869–2.328]	
Children in household	0.111 (0.085)		0.229 (0.325)		1.029 [0.648–1.632]		0.866 [0.548–1.368]	
Heterosexual	0.013 (0.104)		-0.079 (0.397)		1.162 [0.662–2.041]		1.549 [0.891–2.692]	
Constant	1.010*** (0.210)		5.027*** (0.799)		5.949** [1.866–18.97]		3.899* [1.246–12.198]	

Note. [†]p < 0.10; *p < 0.05; **p < 0.01; ***p < 0.001. All reported odds ratios are adjusted odds ratios.

Table 3. Networks of E-Cigarette Use and COVID-19 Responses Among E-Cigarette Users.

	Experience Concern		Risk for Bad COVID Outcome		Change Risk Perception		Consider Quitting	
	B	(S.E.)	B	(S.E.)	Odds ratio	[95% CI]	Odds ratio	[95% CI]
Number of e-cigarette user friends	0.007 [†]	(0.004)	0.018	(0.015)	1.007	[0.984–1.030]	1.015	[0.989–1.043]
Number of e-cigarette user family	0.057 ^{***}	(0.019)	0.162 [*]	(0.074)	1.198 [*]	[1.021–1.406]	1.318 ^{**}	[1.105–1.571]
Number of e-cigarette user coworkers	0.019 [*]	(0.008)	0.049 [†]	(0.030)	1.016	[0.972–1.061]	1.056 [*]	[1.003–1.112]

Note. [†]p < 0.10; *p < 0.05; **p < 0.01; ***p < 0.001. All reported odds ratios are adjusted odds ratios. Multivariable models inclusive of all covariates identified in Table 2.

Discussion

The emergence of the COVID-19 pandemic created novel conditions under which e-cigarette users may understand their risks and revise their motivations to use e-cigarettes. Yet, rather than an aspect of isolated psychological processes, these understandings of risk are socially situated. Networks play a key role in many health behaviors and outcomes, including smoking and e-cigarette use (Barrington-Trimis et al., 2016; Cohen, 2004; Friedman & Aral, 2001; Smith & Christakis, 2008). This paper describes how such considerations may extend to the social networks of e-cigarette users, shaping the way they understand their risks within the context of the pandemic and respond to these conditions.

The results described above highlight the relationship between network ties to other e-cigarette users and responses to COVID-19. The literature on networks and risk perceptions suggested that additional network ties to e-cigarette users may reduce perceptions of risk about e-cigarette use within the context of the pandemic (Berten & Van Rossem, 2011; Li et al., 2018). We found no evidence for this hypothesis (H_1). Instead, we find evidence for H_2 , that an increase in the number of e-cigarette users in an individual's personal network is associated with increased responses to the COVID-19 pandemic. Specifically, each additional e-cigarette use network tie is significantly associated with increases in experiencing expressions of concern about e-cigarette use, increased perceived risk of a bad outcome for e-cigarette users, and higher odds of considering ceasing e-cigarette use. In deliberating these findings, we consider that e-cigarette users may have been discussing with one another the potential risks of e-cigarette use during the early pandemic period. Research on Twitter postings about COVID-19 suggests that e-cigarette users expressed more concerns about deaths due to COVID-19 (Gao, Xie, & Li, 2021). These may be indicative of attitudes and norms circulating in e-cigarette user networks, which are reinforced in networks denser with other e-cigarette users. As such, embeddedness within networks of e-cigarette users may have primed individuals for reassessment of their own e-cigarette use and behavioral change, particularly during this early period when so much was unknown and uncertain. Network-based interventions may be able to leverage these shifts in risk perceptions to encourage risk reduction and cessation during the pandemic (Valente, 2012). More research is needed on these processes.

With respect to specific types of ties, as expected, additional network ties to e-cigarette users within the family appear especially important, while friends and co-workers have a less considerable influence. As described earlier, the primary impact of family was anticipated given that the data were collected during a period when many cities and states mandated "lockdowns" and other reductions in interactional activities, leaving family members – particularly those within one's own household – as possibly even more central network influences, particularly with respect to direct personal contact. Beyond the association of networks to the outcomes identified above, additional e-cigarette users within the family also increased odds of recognizing a change in e-cigarette risk perception within the context of the pandemic. Family members often provide critical sources of social support for positive health outcomes (House, Umberson, & Landis, 1988; Thoits, 1986). Future intervention efforts during the pandemic may also account for family contexts to bolster positive behavioral health transitions.

As noted above, moderation analyses by whether or not individuals smoked tobacco cigarettes did not yield any distinctions between the dual users and those who only used e-cigarettes. These network influences may be broadly based across e-cigarette users with differing motives for consumption. Key covariates in the model indicate that smoking was associated with lower odds of changes in risk perception and lower odds of considering quitting vaping. Smokers may be less likely to consider quitting because e-cigarettes serves as a harm reduction tool to reduce their smoking frequency. Frequency of e-cigarette use was inversely associated with all outcomes.

Those with the heaviest consumption have reduced perceptions of risk related to COVID, which is notable in the event medical scientists determine that vaping elevates adverse COVID outcomes.

Limitations

Although these results provide early information on networks, e-cigarette use, and COVID-19 responses, we note some limitations. First, although this rapid assessment survey reached a national sample of e-cigarette users, it is not a probability-based sample. While prevalence from the data cannot be fully generalized, such data collection techniques provide opportunities to assess relationships between variables among people who use substances, particularly when prevalence estimates are not the focal concern (Barratt et al., 2017). Further, as noted above, the data cohere well on demographic characteristics of e-cigarette users in other probability-based national samples such as the PATH dataset (Coleman et al., 2017); this strengthens our comfort that the sample largely approximates that of studies with probability-based sampling methods. Second, as the data are cross-sectional, we cannot fully infer causality, but the results are promising as it is unlikely that the reverse path occurred – i.e. that individuals rapidly formed network ties to other e-cigarette users as a result of pandemic related risk perceptions. Additionally, we note that the social network measure focuses on number of network ties and does not account for the strength of ties. Last, subjects self-reported behaviors, and social desirability or recall biases may shape reports. However, computer-assisted surveys reduce such biases in the self-report of sensitive topics (Williams et al., 2000).

Conclusions

This study identified that additional e-cigarette users within an e-cigarette user's personal network increased experiences of others' expressions of concern about e-cigarette use, increased perceptions of risk to e-cigarette users for a bad outcome related to COVID-19, and increased the odds that an individual would consider quitting e-cigarettes. These findings may occur because networks of e-cigarette users discussed amongst themselves relevant issues of risk within the early pandemic context, but more research on this is needed. Family members who use e-cigarettes had a particularly notable effect on these outcomes, potentially attributable to social restrictions under "lockdown" conditions. Much as they have for intervening on substance use more generally, social networks may enhance opportunities for prevention and intervention work with e-cigarette users within the context of the pandemic (Valente, 2012). The pandemic may have long term effects on wider patterns of behavior; network-based influences for e-cigarette users may be uneven as nations differentially emerge from pandemic threats, and with restrictions ebbing and flowing as new strains emerge. Yet, these issues remain particularly important as the course of the pandemic has shifted unevenly across the world, with people in many nations still hindered by the pandemic.

Author Contributions

BK, MP, and MV contributed to the design, analysis, drafting, and revision of the manuscript. All three authors have approved the final version submitted.

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