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Impacts of COVID-19 on cigarette use, smoking behaviors, and tobacco purchasing behaviors

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ABSTRACT

Background: The COVID-19 pandemic has had a significant global impact. As a respiratory illness, COVID-19 may pose unique risks to cigarette smokers. This study used concept mapping, a mixed-method participatory approach, to identify impacts of COVID-19 on cigarette smokers.

Methods: Cigarette smokers across the United States (U.S.) were recruited to complete this online, multi-step study. Of the 126 participants who were invited to participate in this study, 91 participants (mean age = 40.9; SD = 11.3) completed at least one of the three study tasks (i.e., brainstorming, sorting, and rating). Participants completed a brief demographic survey and brainstormed statements that completed a focus prompt: "A specific way that Coronavirus/COVID-19 has impacted/affected my cigarette use, smoking behaviors, tobacco purchasing behaviors, and/or other tobacco-related behaviors is." After duplicate statements were removed, participants sorted the final list of 87 statements by similarity of content and rated how true statements were from them (1-Definitely NOT true to 7-Definitely true).

Results: Nine thematic clusters were identified: Smoking More, Smoking to Cope/Reduce Stress, Change in Smoking Behaviors Due to COVID-19, Concerns about Smoking and COVID-19 Risk, Social Impacts, Maintaining and Rationing Cigarette Supply, Impacts on Obtaining Cigarettes, Use of Other Tobacco Products/Drugs, and Minimal/No Impacts/Concerns of COVID-19. The highest rated cluster (i.e., most true) was the Smoking More cluster followed by the Concerns about Smoking and COVID-19 Risk cluster. The highest rated statement in the study was the statement "Smoking keeps me calm".

Conclusions: Cigarette smokers may endure additional impacts of COVID-19, such as increased COVID-19 health burdens, stressors related to risk of exposure, social stigma and isolation, financial burdens, and increased toxicant exposure from increased smoking frequency.

1. Introduction

In March 2020, COVID-19 was declared a pandemic by the World Health Organization (World Health Organization, 2020) and subsequently, residents of the United States (U.S.), as well as other countries, experienced a dramatic change in their day-to-day lifestyles. Some states entered periods of "lockdown" (that is, staying home and limiting travel outside the home to only essential activities) for periods of time in 2020 and 2021 in an effort to decrease the spread of COVID-19. Additional precautions have included encouraging or mandating people to distance themselves from others or wear masks. Even with these measures, as of

September 2021, nearly 700,000 people died in the U.S. as a result of the COVID-19 (CDC, 2021).

Research has begun to identify risk factors for COVID-19-related morbidity and mortality, including cigarette smoking. Specifically, smoking may increase transmission (Ahmed et al., 2020) and is associated with the severity of COVID-19 infection e.g. (Gupta et al., 2020; Haddad et al., 2021). Surprisingly, some research studies have reported that cigarette smokers are at reduced risk of COVID-19 infection (Simons et al., 2021; Paleiron et al., 2021). However, this research has been criticized for selection bias and may not be generalizable, thus the clinical significance of these findings are unclear (Li Volti et al., 2020).

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Given the potential impact of cigarette smoking on COVID-19 outcomes, researchers have been investigating how smokers have changed their behavior in response to COVID-19. Multiple studies observed increases, decreases, and no changes in smoking behaviors. For example, in a sample of Dutch smokers, 67.7% reported no change in number of cigarettes they smoked while 18.5% reported decreasing and 13.8% reported increasing the number of cigarettes they smoked (Elling et al., 2020). In a study of older U.S. adults recruited from a tobacco and health trial found that 51.7% reported no change to their smoking behavior, while 20.7% reported reducing the amount they smoked and 27.6% reported increasing the amount they smoked (Cordon et al., 2021). Other studies have found similar patterns of increases and decreases in cigarette smoking within samples of Dutch, Belgian, and Australian smokers (Stanton et al., 2020; Vanderbruggen et al., 2020; Bommele et al., 2020). Several studies found that smokers reported smoking more; for example, a study in Poland reported that 45.2% of the smokers indicated smoking more during a lockdown period (Sidor and Rzymiski, 2020). A study of smokers from New Zealand found that 45% of daily smokers reported smoking more, while 16% reported smoking less, and 39% reported no changes (Gendall et al., 2021). Similarly, a study of Italian smokers found that 30% of smokers were smoking more (an average of 5.6 cigarettes per day [CPD] more) and 18% reported smoking less (an average of 4.1 CPD less) (Ferrante and Fearnside, 2020). The majority of a survey sample of U.S. cigarette smokers, 68.9%, reported smoking cigarettes less frequently in the past 28 days when surveyed in April/May 2020 (Gold et al., 2021). The changes in smoking patterns observed in these studies vary dramatically within and across different samples suggesting great variability in smoking behaviors in response to COVID-19.

Numerous studies have investigated the impacts of COVID-19 on motivations to quit smoking and quit attempts (Chertok, 2020; Gold et al., 2021; Klempere et al., 2020; Shepherd et al., 2021). An online survey of U.S. smokers revealed that fear predicted motivations to quit and reductions in smoking behavior (Gold et al., 2021). In a study of Dutch smokers who were motivated to quit, 33.8% reported being more motivated to quit because of COVID-19, while 66.2% reported they were not more motivated to quit due to COVID-19 (Elling et al., 2020). Furthermore, motivations to quit smoking were positively associated with beliefs that COVID-19 is a serious risk to health, smokers are at an elevated risk of transmitting COVID-19, and having more severe complications (Elling et al., 2020). In a sample of U.S. smokers from Ohio, those who were more motivated to quit smoking perceived a higher risk of infection of COVID-19 (Chertok, 2020). Conversely, in a U.S. sample of cigarette smokers, worry about COVID-19 was positively associated with coping motives to smoke, perceived barriers for smoking cessation, and negative smoking abstinence symptom expectancies. This suggests that worry related to COVID-19 may increase the likelihood a smoker continues to smoke cigarettes (Shepherd et al., 2021). This study may help to explain why in a sample of older U.S. adult smokers, 51.7% reported no changes in cigarette consumption and 55.2% reported no motivations to quit despite 64.3% of the sample reporting extreme concern with COVID-19 (Cordon et al., 2021). While fear about COVID-19 may have motivated some smokers to reduce or quit smoking, it may have exacerbate smoking behaviors in others. Taken together, current research suggests the heterogeneity of the impacts of COVID-19 on smoking behaviors and that more research is needed to understand the extent to which COVID-19 affects smokers' behaviors.

Given the continued impact of COVID-19 on many smokers' daily lives, a broader understanding of factors that may impact smokers' behaviors may be helpful to prevent negative health impacts associated with smoking and COVID-19. Therefore, the purpose of this study was to examine the effects of COVID-19 on cigarette smokers' tobacco use, purchasing behaviors, and other related behaviors. This study is an initial attempt to explore the universe of possible cigarette smoking attitudes, beliefs, and behaviors that were impacted due to COVID-19. While we expected to see reports of both increases and decreases in

smoking patterns, we did not have specific hypotheses as the approach used in the current study is intended to be exploratory. Specifically, concept mapping (CM) is an integrative mixed methods approach that uses multidimensional scaling and hierarchical cluster analyses to identify latent constructs and was used in the current study to organize and describe the impacts of COVID-19 on cigarette smokers' behaviors. This process includes generation of statements through a brainstorming task and through a sorting and rating task to create a concept "map" of thematic clusters of statements. CM is well-suited for identifying new domains of smoking behaviors and attitudes because the analyses yield a visual representation of thematic clusters, similar to an exploratory factor analysis, but do not require large sample sizes. This method has also been used to describe the impact of COVID-19 on electronic cigarette users (Soule et al., 2020).

2. Methods

2.1. Participants and procedures

During May through August of 2020, adult current cigarette smokers were recruited through posting advertisements on Craigslist on a city specific board in a total of 12 states, 3 from each region (Northeast, Midwest, South, and West/Pacific; as in Soule et al., 2018). This selection process allows for a more generalizable sample of individuals across the United States. Individuals who were interested in the study contacted study staff via email and were asked to complete a brief online screening questionnaire. Participants who reported being over 18 years of age, had smoked at least 100 cigarettes in their lifetime, and currently smoked at least five cigarettes per day ($n = 126$) were invited to the study website (The Concept Systems® Global MAX©) to participate. Of the 126 individuals that were invited to participate in the study, 91 logged on to the study website and completed at least some of the participant questions related to demographics, cigarette use, and other tobacco product use. Participants were then asked to complete the brainstorming first, and then were invited back after statement reduction to complete sorting, and rating tasks (described below). Of the 91 participants that completed any of the three tasks, 33 completed all three tasks, 25 completed just brainstorming, 1 completed brainstorming and sorting, 17 completed brainstorming and rating, 11 completed sorting and rating, and 4 completed the rating task only. Some participants did not complete the sorting task or did not follow task instructions. Participants were paid in the form of Amazon gift cards; they received \$10 for completing brainstorming, \$25 for sorting, and \$10 for rating. This study was approved by the Virginia Commonwealth University Institutional Review Board.

2.2. Brainstorming

Following the brief participant questions and demographic questionnaire, participants were instructed to provide statements completing the prompt: "A specific way that Coronavirus/COVID-19 has impacted/affected my cigarette use, smoking behaviors, tobacco purchasing behaviors, and other tobacco related behavior is.". Participants were encouraged to provide multiple statements that completed the prompt. Statements were generated anonymously and participants were able to see previous participants' responses and were instructed to review previous statements to prevent duplicating statements. This process allows for interactive brainstorming that results in a greater quantity of ideas (Dennis and Williams, 2003; DeRosa, et al., 2007) and more unique ideas (Dugosh et al., 2000; Dugosh and Paulus, 2005). Researchers monitored and reviewed statements until content saturation was reached (i.e., enrolling additional participants in the brainstorming task no longer yielded unique content). A total of 76 participants completed the brainstorming task, and participants generated 329 statements.

Three reviewers examined the statement list independently to remove redundant content or content unrelated to the focus prompt.

Reviewers discussed the statements in a group discussion and statements were candidates for removal if two or three of the reviewers identified independently that statements were redundant with other statements or did not relate to the focus prompt. For duplicative statements, reviewers retained one statement that best captured the main idea of the redundant statements based on group discussion and consensus. Statements were reviewed for spelling, grammar, and punctuation errors that affected readability, but major revisions were avoided. This review resulted in a final list of 87 statements.

2.3. Sorting

Participants who completed brainstorming were invited back to the study website to complete sorting and rating. Due to attrition, additional eligible participants were contacted to complete only sorting and rating. Of those invited, 45 completed the sorting activity. A pooled analysis of concept mapping studies demonstrates that these sample sizes are sufficient for the multidimensional scaling analysis, with additional participants no longer improving model fit (Rosas and Kane, 2012). For the sorting task, participants organized all 87 statements into piles via 'drag and drop' table top format with similar themes/content on their computers using the following instructions: "1) Do not create categories according to priority, or value, such as 'important', 'doesn't apply to me', or 'true'/'false'. 2) Do not create categories such as 'miscellaneous' or 'other' that group together dissimilar statements. 3) Every statement needs to be sorted into a pile." After being reviewed by the research staff, a total of 45 participant statement sorting arrangements were approved.

2.4. Rating

For rating, participants rated each statement on a scale of 1 (Definitely NOT true) to 7 (Definitely True) based on the prompt, "For me, this is a specific way that COVID-19/Coronavirus has impacted/affected my cigarette use, smoking behaviors, tobacco purchasing behaviors, and other tobacco related behaviors." A total of 65 participants completed the rating task.

2.5. Representation and data analysis

Using participant sorting data and the CM system software, an 87×87 matrix of similarities was created. Each cell within the matrix represented the total number of times two statements were sorted into the same pile by participants. Using nonmetric multidimensional scaling, an algorithm assigned each statement a coordinate (x,y) in two-dimensional space with each statement being represented by a point on a map ("point map"; Kruskal and Wish, 1978). Points on the map that were closer to each other represented statements that were sorted together more often by participants, whereas points on the map that were further apart represented statements that were sorted together less often or not at all by participants. The stress value (0.28) of the current model, which indicates the fit of the multidimensional scaling analysis, fell within the range of stress values reported in previous research (Rosas and Kane, 2012), indicating good fit and congruence between the processed data and the raw data (Davison, 1983; Kruskal, 1964).

Using an algorithm (Ward, 1963) that identified non-overlapping "clusters" of statements by identifying groups of statements that limited the distance from points to the centroid of identified clusters, a hierarchical cluster analysis generated multiple cluster maps. Specifically, CM software first identified quantitatively a two-cluster model, and subsequent models were built by separating one cluster from the previous model into two clusters similarly by identifying clusters by limiting the distance between points and the centroid of the cluster. The goal of this hierarchical cluster analysis is to identify the most parsimonious model (i.e., fewest clusters preferred) in which each cluster only relates to a single theme. The research team continued the hierarchical cluster analysis process and through group discussion

examined if models met interpretability (i.e., each cluster described a single theme) and parsimony criteria. The research team determined that the best fitting model was achieved with 9 clusters (see Fig. 1). Mean cluster ratings were calculated by taking the average of ratings from all participants for all statements within a single cluster.

3. Results

Participant characteristics of the 91 participants that completed at least one of the three study tasks (i.e., brainstorming, sorting, and rating) are displayed in Table 1. Nine thematic clusters of statements were identified (see Fig. 1). A summary of the clusters is presented below and a complete list of clusters and statements including mean cluster and statement ratings are displayed in Table 2.

3.1. Smoking more

The highest rated cluster was the *Smoking More* cluster. This cluster had 16 statements and had an average rating of statements within this cluster (mean cluster rating) of 3.91 (SD = 0.78). Statements in this cluster related to participants increasing their smoking frequency. One of the highest rated statements in this cluster was the statement was "I have increased my smoking since COVID-19/Coronavirus" (M = 4.95). This statement and others such as the statement "I cannot seem to control my tobacco use since COVID-19/Coronavirus" (M = 3.66) indicate participants' general increases in smoking during the COVID-19 pandemic. Other statements such as "I smoke more for something to do" (M = 4.68), "I smoke more because I have less to do" (M = 4.44), and "I smoke several cigarettes in a row/chain-smoke due to boredom" (M = 4.37) indicate smoking has increased as a way to pass the time or entertain oneself during the COVID-19 pandemic. Statements in this cluster such as "I smoke more cigarettes now being off work due to COVID-19/Coronavirus" (M = 4.55), "I smoke more because I am working from home" (M = 3.86), and "I smoke more because it is more convenient now" (M = 3.55) indicate that smoking has increased due to feasibility of smoking more often due to location and schedule. Tied for the highest rated statement in this cluster (M = 4.95) was the statement "I smoke more when I am alone", suggesting that social isolation and a reduction in social activities has also led to an increase in smoking.

3.2. Concerns about smoking and COVID-19 risk

The second highest rated cluster was the *Concerns about Smoking and COVID-19 Risk* that had a total of 12 statements and a mean cluster rating of 3.73 (SD = 0.86). The statements in this cluster included themes of being concerned about the risk of COVID-19 and preventing contracting COVID-19, being more susceptible to COVID-19, or having worse health outcomes due to smoking. The highest rated statement in this cluster was the statement "I believe if I were to get COVID-19/Coronavirus, my smoking would make it worse for me" (M = 4.89). Similar statements included "I worry more about my smoking and its impact on my health" (M = 4.48) and "I am scared that smoking might increase my chances of getting COVID-19/Coronavirus" (M = 3.17). This cluster also includes statements such as "I no longer socially gather and smoke" (M = 4.85), "I have to be more careful and wash my hands after each time I go to smoke" (M = 4.60), and "I sterilize the outside of my cigarette packages" (M = 2.55). Some of the statements in this cluster indicate being uncomfortable smoking in public or due to health mandates such as masks requirements and social distancing such as "I am less likely to smoke in public due to wearing a mask" (M = 3.69), "I feel uncomfortable smoking in public" (M = 3.14) and "I am more aware of the people I smoke around" (M = 4.50).

3.3. Change in smoking behaviors due to COVID-19

The *Change in Smoking Behaviors due to COVID-19* cluster had a total

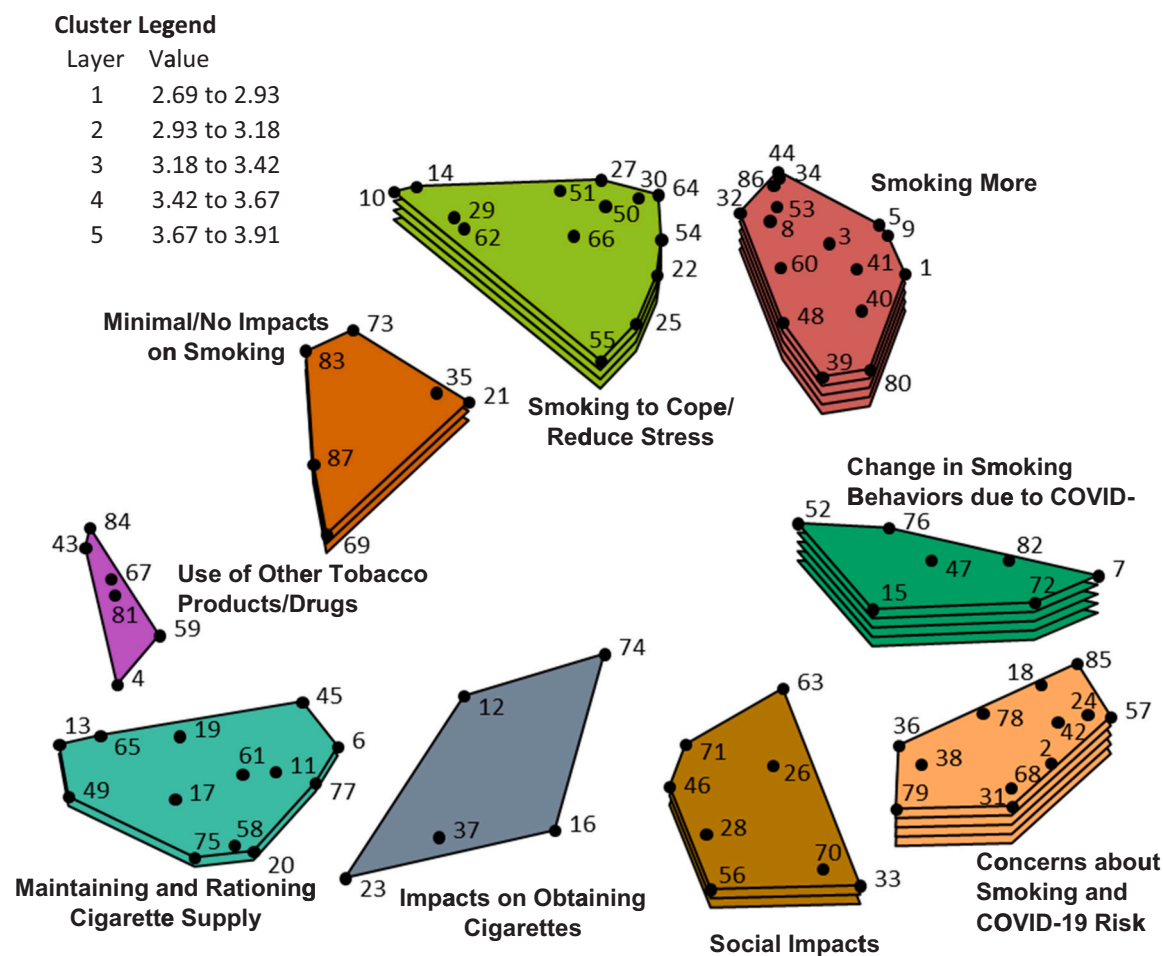


Fig. 1. Displays the study concept map displaying 9 clusters of statements that were identified by cigarette smokers describing the impacts of COVID-19 on smoking behaviors. Number points on the map that are within a closer distance to each other represent statements that were grouped more often together and had similar content, whereas statements that are further apart represent statements that were not grouped together often and had dissimilar content. Layers represent mean ratings of statements from the rating task. Greater number of layers represent higher mean ratings within each cluster. Mean ratings with 1 layer range from 2.69 to 2.93, 2 layers range from 2.93 to 3.18, 3 layers range from 3.18 to 3.42, 4 layers range from 3.42 to 3.67, and 5 layers range from 3.67 to 3.91.

of seven statements and a mean cluster rating of 3.69 ($SD = 1.00$). These statements included themes of feeling stressed about quitting due to COVID-19 and changes to smoking routines and behaviors. The highest rated statement in this cluster was the statement “I know I need to quit, but I am not ready to quit right now” ($M = 5.11$). This statement and the statement “I feel more stress about quitting smoking due to health reasons because of COVID-19/Coronavirus” ($M = 4.00$) suggest that COVID-19 may have brought more attention to the impacts of smoking on one’s health. Other statements in this cluster included smoking behavior changes such as “I am more likely to smoke a cigarette early when I am approaching a public area” ($M = 4.05$) and “I now smoke on the balcony/out the window” ($M = 2.97$), suggesting that participants have changed where they smoke due to the COVID-19 pandemic.

3.4. Smoking to cope/reduce stress

The *Smoking to Cope/Reduce Stress* cluster had a total of 14 statements and had a mean cluster rating of 3.63 ($SD = 0.83$). This cluster contained statements that indicated participants smoked in order to deal with negative emotions/feelings from the impacts of COVID-19 or to elicit positive emotions/feelings during COVID-19. The highest rated statement in the study was in this cluster and that statement was “Smoking keeps me calm” ($M = 5.66$). Other statements in this cluster included “I smoke because I feel sad/depressed” ($M = 4.08$), “I smoke more cigarettes now because COVID-19/Coronavirus gives me stress/

anxiety” ($M = 3.97$), and “I smoke because I feel isolated” ($M = 3.69$). Additional statements in this cluster indicate that smoking was also used to change participants’ physical environment, as illustrated by the statements “I go outside to smoke for a change of scenery” ($M = 4.25$) and “I smoke more at work to get out of the office and take a mental break from stress” ($M = 2.92$). This cluster also contained the statement “I am smoking when I drink, which is more frequently” ($M = 3.22$), which suggests that the use of other substances may also have led to increased cigarette use during the COVID-19 pandemic.

3.5. Social impacts

The *Social Impacts* cluster had a total of eight statements and a mean cluster rating of 3.32 ($SD = 1.18$). Statements in this cluster relate to social smoking behaviors. The highest rated statement in this cluster was “I share fewer cigarettes since I do not come into contact with as many people” ($M = 5.15$). Another highly rated statement in this cluster also pertained to sharing cigarettes: “I do not share cigarettes with anyone anymore” ($M = 4.57$). Other statements in this cluster related to smoking less due to social restrictions, such as “I smoke less since I cannot smoke around my family, and they are home most of the day” ($M = 2.22$). Other statements in this cluster include “I am more mindful/aware of my smoking habits” ($M = 4.42$), “I try quitting with more frequency now” ($M = 2.25$), and “I am less interested in smoking now” ($M = 2.23$).

Table 1
Sample demographics and cigarette and tobacco use characteristics.

Characteristic	N or (M, SD)	%
Age	(40.9, 11.3)	
Gender		
Female	41	45.1
Male	50	54.9
Ethnicity		
Hispanic/Latino(a)	9	9.9
Not Hispanic/Latino(a)	82	90.1
Race		
American Indian/Alaskan Native	4	4.4
Asian	2	2.2
Black/African American	13	14.3
Native Hawaiian/Pacific Islander	1	1.1
White/European American	60	65.9
More than one race	10	11.0
Education		
High school education	1	1.1
High school graduate	13	14.3
GED	7	7.7
Some college (< 1 year)	9	9.9
Some college (> 1 year)	17	18.7
Associates degree	14	15.4
Bachelor's degree	22	24.2
Master's degree	8	8.8
Current cigarette smoking frequency		
Every day	89	97.8
Some days	2	2.2
Cigarettes smoked per day	(13.1, 7.6)	
10 or less	43	47.3
11–20	34	37.4
21–30	8	8.8
31 or more	5	5.5
Duration smoking current number of cigarettes (in years)	(14.8, 12.1)	
Duration smoking on a regular basis (in years)	(18.2, 12.2)	
Cigarette flavor		
Menthol	33	36.3
Non-Menthol	53	58.2
No Usual Brand	5	5.5
FTND Score	(3.6, 1.4)	
Age of first tobacco use	(16.3, 6.0)	
First tobacco product use		
Cigarette	79	86.8
Cigar	6	6.6
Cigarillo/Little Cigar	2	2.2
Smokeless Tobacco	3	3.3
Ever tried to quit smoking		
No	18	20.0
Yes	73	80.2
Current e-cigarette use		
Everyday	12	13.2
Somedays	37	40.7
Not at all	42	46.2
E-cigarette use frequency		
I did not use an e-cigarette/vaping device	44	48.9
At least once per day	12	13.2
Every once in a while throughout the day	20	22.0
Fairly frequently throughout the day	11	12.1
Almost always throughout most of the day	4	4.4
Past 30-day regular/large cigar use		
No	76	83.5
Yes	14	15.4
Past 30-day cigarillo use		
No	62	68.1
Yes	29	31.9
Past 30-day little cigar use		
No	71	78.0
Yes	20	22.0
Past 30-day smokeless tobacco use		
No	83	91.2
Yes	8	8.8
Past 30-day hookah/waterpipe use		
No	80	87.9
Yes	11	12.1
Past 30-day flavored tobacco product use		
No	38	41.8
Yes	53	58.2

Notes. Total N and percentage for sample characteristics is based on the 91 participants who completed the participant questions.

3.6. Minimal/no impacts on smoking behaviors

The *Minimal/No Impacts on Smoking Behaviors* cluster had a total of six statements and had a mean cluster rating of 3.24 (SD = 0.97). Statements in this cluster generally related to having specific feelings during COVID-19 but ones that did not result in behavior changes. The highest rated statement in this cluster was the statement “Even though COVID-19/Coronavirus worries me, my addiction will not let me stop” (M = 5.13). Other statements in this cluster include “COVID-19/Coronavirus did not impact my cigarette use, smoking behaviors, or tobacco purchases” (M = 3.19) and “With extra time for self-reflection, I am less concerned about my smoking habit” (M = 3.15). One statement in this cluster that was particularly concerning and highlights the need for better communication of health information and research finding to the public is the statement “I have read that smokers get sick less with COVID-19/Coronavirus, so I do not feel guilty/worried anymore about my smoking” (M = 2.69).

3.7. Maintaining and rationing cigarette supply

The *Maintaining and Rationing Cigarette Supply* cluster included 13 statements and had a mean cluster rating of 2.95 (SD = 0.98). Statements in this cluster related to cigarette purchasing and rationing behaviors during COVID-19. The highest rated statement in this cluster was the statement “My income is now limited but I am still purchasing tobacco” (M = 4.94). This statement, and the statement “I spend what I have on tobacco” (M = 3.55) suggest that although the COVID-19 pandemic impacted participants' income, purchasing cigarettes remained a priority for participants. The statement “I buy more cigarettes at a time” (M = 4.55) also relates to participants ensuring a supply of cigarettes during the COVID-19 quarantine. Other statements in this cluster suggested that participants were rationing or finding ways to extend their cigarettes to last longer; these statements included “I have started rationing my cigarettes” (M = 2.89), “I sometimes save half-smoked cigarettes to smoke/make another cigarette out of them later” (M = 4.05), “I have started hoarding cigarettes/tobacco products” (M = 2.66), and “I count the cigarettes I smoke to minimize use” (M = 2.51).

3.8. Impacts on obtaining cigarettes

The *Impacts on Obtaining Cigarettes* cluster had a total of five statements and a mean cluster rating of 2.83 (SD = 0.87). This cluster had statements that related to impacts and concerns regarding cigarette supply and statements about smoking less. The highest rated statement in this cluster was the statement “I purchased cigarettes and tobacco products I needed ahead of the stay at home orders” (M = 4.18). Other statements in this cluster included “I worry about running out of cigarettes due to restricted store hours” (M = 3.47) and “I spend more money on cigarettes because I cannot share cigarettes with others” (M = 2.54). This cluster also included statements that related to smoking less such as “I smoke less because I am outdoors less” (M = 2.12) and “I smoke less” (M = 1.85).

3.9. Use of other tobacco products/drugs

Finally, the *Use of Other Tobacco Products/Drugs* cluster had a total of six statements and was the lowest rated cluster with a mean cluster rating of 2.69 (SD = 0.77). Statements in this cluster related to using other tobacco products in addition to or in substitution of cigarettes. The highest rated statement in this cluster was “I will buy any related/similar brand of cigarettes if my usual is not available” (M = 4.26). Other statements in this cluster included “I smoke other tobacco products now” (M = 2.69), “I use electronic cigarette/vape more” (M = 2.66), and “I

Table 2

Cigarette smoker identified clusters and statements describing the impacts of COVID-19 on smoking.

Cluster	Statement	Mean Rating
Smoking More		3.91
	1. I have increased my smoking since COVID-19/Coronavirus.	4.95
	32. I smoke more when I am alone.	4.95
	53. I smoke more for something to do.	4.68
	5. I smoke more cigarettes now being off work due to COVID-19/ Coronavirus.	4.55
	86. I smoke more because I have less to do.	4.44
	8. I smoke several cigarettes in a row/chain-smoke due to boredom.	4.37
	3. I smoke more at night.	4.28
	39. I smoke more inside my home.	4.05
	34. I smoke more during phone/video conversations for something to do while I talk.	3.87
	9. I smoke more because I am working from home.	3.86
	40. I cannot seem to control my tobacco use since COVID-19/ Coronavirus.	3.66
	44. I smoke more because it is more convenient now.	3.55
	80. I smoke more in my car.	3.44
	60. I smoke more when I am at work.	2.98
	41. I smoke more because I spend more time outside.	2.69
	48. I smoke more in the shower/bath.	2.16
Concerns about Smoking and COVID-19 Risk		3.73
	57. I believe if I were to get COVID-19/Coronavirus, my smoking would make it worse for me.	4.89
	38. I no longer socially gather and smoke.	4.85
	2. I have to be more careful and wash my hands after each time I go to smoke.	4.60
	78. I am more aware of the people I smoke around.	4.50
	24. I worry more about my smoking and its impact on my health.	4.48
	36. I am less likely to smoke in public due to wearing a mask.	3.69
	79. I am concerned about the risk of entering a store to buy cigarettes because of COVID-19/Coronavirus.	3.52
	42. I am scared that smoking might increase my chances of getting COVID-19/Coronavirus.	3.17
	18. I feel uncomfortable smoking in public.	3.14
	85. I do not feel safe going to the doctor for help with quitting due to COVID-19/Coronavirus.	2.95
	31. I sterilize the outside of my cigarette packages.	2.55
	68. I am trying to quit smoking to decrease the chances of getting COVID-19/Coronavirus.	2.46
Change in Smoking Behaviors due to COVID-19		3.69
	52. I know I need to quit, but I am not ready to quit right now.	5.11
	72. Wearing a face mask makes it difficult to smoke comfortably.	4.77
	47. I am more likely to smoke a cigarette early when I am approaching a public area.	4.05
	7. I feel more stress about quitting smoking due to health reasons because of COVID-19/Coronavirus.	4.00
	76. I now smoke on the balcony/out the window.	2.97
	82. COVID-19/Coronavirus has made it harder to smoke when I want to.	2.58
	15. I hide my smoking more now.	2.33
Smoking to Cope/Reduce Stress		3.63
	10. Smoking keeps me calm.	5.66
	25. My dependency on cigarettes has increased since COVID-19/Coronavirus.	4.42
	55. I go outside to smoke for a change of scenery.	4.25
	14. I smoke because I feel sad/depressed.	4.08
	27. I smoke more cigarettes now because COVID-19/ Coronavirus gives me stress/anxiety.	3.97
	62. I smoke in response to disturbing news from friends/family.	3.78
	66. I smoke because I feel isolated.	3.69
	22. I am enjoying smoking more now than ever.	3.65
	29. I smoke to get away from thinking about COVID-19/ Coronavirus.	3.40
	51. I am smoking when I drink, which is more frequently.	3.22
	64. I smoke more at work to get out of the office and take a mental break from stress.	2.92

Table 2 (continued)

Cluster	Statement	Mean Rating
	50. I smoke more when I read the news/media since COVID-19/Coronavirus.	2.80
	54. COVID-19/Coronavirus has caused me to smoke more cigarettes being around family/friends.	2.69
	30. I smoke more now due to added stress of homeschooling my children.	2.30
Social Impacts		3.32
	28. I share fewer cigarettes since I do not come into contact with as many people.	5.15
	70. I do not share cigarettes with anyone anymore.	4.57
	63. I am more mindful/aware of my smoking habits.	4.42
	56. I do not give cigarettes to people when they ask anymore.	3.57
	33. I try quitting with more frequency now.	2.25
	26. I am less interested in smoking now.	2.23
	71. I smoke less since I cannot smoke around my family, and they are home most of the day.	2.22
	46. I have others buy my cigarettes now since I try not to leave my house.	2.13
Minimal/No Impacts on Smoking Behaviors		3.24
	73. Even though COVID-19/Coronavirus worries me, my addiction will not let me stop.	5.13
	21. I smoke more because I have an abundance of cigarettes from buying more at one time.	3.35
	87. COVID-19/Coronavirus did not impact my cigarette use, smoking behaviors, or tobacco purchases.	3.19
	35. With extra time for self-reflection, I am less concerned about my smoking habit.	3.15
	83. I have read that smokers get sick less with COVID-19/ Coronavirus, so I do not feel guilty/worried anymore about my smoking.	2.69
	69. I smoke less since I do not have scheduled smoke breaks now that I am laid off from work.	1.92
Maintaining and Rationing Cigarette Supply		2.95
	17. My income is now limited but I am still purchasing tobacco.	4.94
	6. I buy more cigarettes at a time.	4.55
	19. I sometimes save half-smoked cigarettes to smoke/make another cigarette out of them later.	4.05
	65. I spend what I have on tobacco.	3.55
	11. I have started rationing my cigarettes.	2.89
	77. I am trying to switch to vaporizers.	2.83
	45. I have started hoarding cigarettes/tobacco products.	2.66
	58. I count the cigarettes I smoke to minimize use.	2.51
	61. I'm not buying coffee anymore to drink and smoke together.	2.48
	49. I started making/rolling my own cigarettes in order to save money.	2.37
	20. I am purchasing fewer cigarettes.	1.94
	75. I sell single cigarettes to my friends now.	1.88
	13. I have started smoking little cigars because they are cheaper than cigarettes.	1.77
Impacts on Obtaining Cigarettes		2.83
	23. I purchased cigarettes and tobacco products I needed ahead of the stay at home orders.	4.18
	16. I worry about running out of cigarettes due to restricted store hours.	3.47
	37. I spend more money on cigarettes because I cannot share cigarettes with others.	2.54
	74. I smoke less because I am outdoors less.	2.12
	12. I smoke less.	1.85
Use of Other Tobacco Products/Drugs		2.69
	4. I will buy any related/similar brand of cigarettes if my usual is not available.	4.26
	81. I smoke other tobacco products now.	2.69
	59. I use electronic cigarettes/vape more.	2.66
	84. I smoke more marijuana now.	2.52
	43. I smoke more marijuana cigarillos.	2.22
	67. I smoke more cigarillos now.	1.77

Notes: Statements within each cluster. Mean ratings are calculated based on participants' responses to the focus prompt, "A specific way that Coronavirus/COVID-19 has impacted/affected my cigarette use, smoking behaviors, tobacco purchasing behaviors, and other tobacco related behavior is." using a 7-point scale from 1 (definitely NOT true) to 7 (definitely true).

smoke more cigarillos now" ($M = 1.77$). Statements related to other combustible drug use also appeared in this cluster, such as "I smoke more marijuana now" ($M = 2.52$) and "I smoke more marijuana cigarillos" ($M = 2.22$).

4. Discussion

This study identified nine themes describing how COVID-19 impacted cigarette smokers in the U.S. The highest rated cluster in this study was the *Smoking More* cluster. These results are similar to previous studies demonstrating that smokers reported smoking more during the COVID-19 pandemic (Elling et al., 2020; Cordon et al., 2021; Gendall et al., 2021; Ferrante and Fearnside, 2020; Sidor and Rzymiski, 2020; Stanton et al., 2020; Vanderbruggen et al., 2020). Statements that were grouped in this cluster such as "I smoke more for something to do" and "I smoke several cigarettes in a row/chain-smoke due to boredom" were similar to two previous studies that also reported boredom as a reason for increased smoking during in nearly half of both study samples (Bommele et al., 2020; Vanderbruggen et al., 2020). Statements about smoking less and attempting to quit smoking were not highly endorsed by participants in the current study, in contrast to previous findings from online surveys in Italy and the UK e.g. (Niedzwiedz et al., 2021; Di Renzo et al., 2020), but similar to online surveys in Belgium, Poland and Australia that have low reported incidence of smoking less in response to COVID-19 (Sidor and Rzymiski, 2020; Stanton et al., 2020; Vanderbruggen et al., 2020).

Several statements in this *Concerns about Smoking and COVID-19 Risk* cluster suggest that smokers are aware of increasing their risk of complications from COVID-19 by smoking cigarettes. That aside, statements about being unable to quit smoking despite concerns about susceptibility to COVID-19 were also included in this cluster. This could be because smoking is used as a coping method or a stress reduction technique, as suggested by the statements in the current study "smoking keeps me calm" and "I smoke more cigarettes now because COVID-19 gives me stress/anxiety". Other recent work supports the connection between stress and smoking during the COVID-19 pandemic; in a small sample of treatment-seeking smokers in the US, those who reported difficulty quitting during the COVID-19 pandemic indicated this was due to stress (Rosoff-Verbit et al., 2021). Further, statements in the current study such as "I know I need to quit, but I am not ready right now" possibly reflect this difficulty in the current sample of smokers. Other recent work supports this finding; in a sample of Dutch smokers, 24.7% reported that quitting smoking had become more difficult during COVID-19, while only 6.4% reported it had become easier (Bommele et al., 2020).

Increased reliance on cigarettes to combat stress associated with COVID-19, as observed in this study by statements such as "my dependency on cigarettes has increased since COVID-19" and "I cannot seem to control my tobacco use since COVID-19" may explain that despite financial difficulties and income limitations, many participants prioritized purchasing cigarettes during COVID-19 and many extended their cigarette supply through rationing cigarettes. Statements such as those suggesting saving half-smoked cigarettes or making cigarettes out of the tobacco from cigarette butts are concerning due to the added toxicity of smoking previously combusted tobacco (Dark et al., 1963; Rimington, 1974; Zimmermann et al., 2014), thus further increasing the health burden of smoking on this population and possibly increasing the severity of infection of COVID-19.

However, some participants in the current study recognized the added health benefits of quitting smoking during the COVID-19 pandemic as observed by statements such as "I am trying to quit smoking to decrease the chances of getting COVID-19", "I try quitting with more frequency now", and "I am less interested in smoking now". Although these statements were not strongly endorsed in the current study, a US study found that those who felt that smoking was risk factor for COVID-19 were more likely to report interest in quitting, although

only a fifth of participants (21%) indicated that they were actually smoking less (Streck et al., 2021). In other studies of smokers trying to quit, participants indicated that concerns about COVID-19 and smoking increased their motivation to quit (Rosoff-Verbit et al., 2021). Thus, information regarding the health effects of COVID-19 on smokers specifically may increase smokers' motivations to quit and possibly increase quit attempts once their stress levels have been addressed.

Of concern were statements in the *Minimal/No Impacts on Smoking Behavior* cluster that indicated that participants were less concerned about their smoking habits or misinformed that smoking could be a protective factor against COVID-19, as well as statements in the *Use of Other Tobacco Products/Drugs* cluster that indicated that participants used cigarettes more frequently in combination with other tobacco products and other drugs such as alcohol and cannabis during COVID-19. While early reports of COVID-19 infections may have suggested that smoking may be a protective factor for contracting COVID-19 and developing severe infections (De Lusignan et al., 2020; Farsalinos et al., 2020; Paleiron et al., 2021), other reports have demonstrated that cigarette smokers are more susceptible to COVID-19 infections (Cattaruzza et al., 2020; Emami et al., 2020; Patanavanich et al., 2020; Jackson et al., 2020; Lowe et al., 2021; Gaiha et al., 2020; Reddy et al., 2020; Umuaypornlert et al., 2021). The results from the current study demonstrate the need to correct misinformation regarding COVID-19, especially among susceptible populations. Launching public awareness campaigns regarding cigarette smoking and susceptibility to COVID-19 may increase motivations and self-efficacy for some smokers to quit smoking and may reach some smokers who may have otherwise not quit. Finally, the current study and others have found reports of increased use of other substances in addition to increases in cigarette smoking, specifically alcohol (Ferrante et al., 2020; Sidor and Rzymiski, 2020; Stanton et al., 2020; Vanderbruggen et al., 2020) and cannabis (Vanderbruggen et al., 2020). Co-use of substances further increases the likelihood of health burdens faced by smokers.

This study had several limitations. The small sample may limit the generalizability of the findings, however, this sample size is sufficient for concept mapping and participants were recruited from 12 states, 3 from each of the four census tract regions across the U.S. Although this study described a broad range of impacts of COVID-19 on cigarette smokers through the statements provided, this method does not allow for estimates of prevalence of behaviors among the population. However, higher ratings of some statements give indicators of behaviors and beliefs that may be more common among smokers. Future studies would benefit from examining the prevalence of behaviors identified in this study and how the prevalence of these behaviors have changed across time and different populations. The current sample consisted of adults and did not include youth and adolescent smokers who may have been uniquely impacted. Examining the prevalence of these behaviors and any additional smoking behaviors that may be unique to these younger populations, such as ECIG use, would likely be beneficial for public health officials. Finally, future research would also benefit from assessing the links between anxiety, stress, and depression and endorsement of the smoking behaviors identified in the current study to uncover links and associations between smoking and emotional and psychological distress (Stanton et al., 2020). Despite these limitations, this study had many strengths including using a validated mixed methods approach to identify content themes and it included smokers from across the U.S. Finally, this study was conducted in the summer of 2020 shortly after many localities had implemented stay-at-home orders. Thus, recall bias among the sample was likely minimal.

5. Conclusions

The COVID-19 pandemic has had a global impact on society and this study reveals that cigarette smokers have endured unique impacts due to COVID-19. U.S. adult cigarette smokers in the current sample reported smoking more since the COVID-19 pandemic despite many being

concerned about COVID-19. They reported smoking in order to stay calm and deal with negative feelings and social impacts related to COVID-19. Participants also reported making efforts to ensure their cigarette supply, even though some were facing financial difficulties. Future research would benefit from examining the relationship between cigarette smokers' behaviors, beliefs, physical and mental health, and the short- and long-term risk of contracting COVID-19 and developing serious and potentially life-threatening complications.

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CRediT authorship contribution statement

Sarah F. Maloney: Contributed to study conceptualization and design, Contributed to data collection and management, Contributed to data analyses. **Madison Combs:** Contributed to data collection and management, Contributed to data analyses. **Rebecca Lester Scholtes:** Contributed to data analyses. **Megan Underwood:** Contributed to data collection and management. **Barbara Kilgallen:** Contributed to data collection and management. **Eric K. Soule:** Contributed to study conceptualization and design, Contributed to data analyses. **Alison B. Breland:** Contributed to study conceptualization and design, Contributed to data analyses. All authors contributed to writing of the manuscript.

Declaration of Competing Interest

The authors declare that they have no competing interests.

References

- Ahmed, N., Maqsood, A., Abduljabbar, T., Vohra, F., 2020. Tobacco smoking a potential risk factor in transmission of COVID-19 infection. *Pak. J. Med. Sci.* 36 (COVID19-S4), S104.
- Bommele, J., Hopman, P., Walters, B.H., Geboers, C., Croes, E., Fong, G.T., Quah, A., Willemsen, M., 2020. The double-edged relationship between COVID-19 stress and smoking: implications for smoking cessation. *Tob. Induc. Dis.* 18, 63.
- CDC, 2021. CDC, 2021, March. COVID data tracker. Center for Disease Control and Prevention.
- Cattaruzza, M.S., Zagà, V., Gallus, S., D'Argenio, P., Gorini, G., 2020. Tobacco smoking and COVID-19 pandemic: old and new issues. a summary of the evidence from the scientific literature. *Acta Bio Medica: Atenei Parmensis* 91 (2), 106.
- Chertok, I.R.A., 2020. Perceived risk of infection and smoking behavior change during COVID-19 in Ohio. *Public Health Nurs.* 37 (6), 854–862. <https://doi.org/10.1111/phn.12814>.
- Cordon, M., Eyestone, E., Hutchison, S., Dunlap, D., Smith, L., Williams, R.M., Kim, E., Kao, J.Y., Hurtado-de-Mendoza, A., Stanton, C., Davis, K., Frey, J., McKee, B., Parikh, V., Taylor, K.L., on behalf of the Lung Screening, Tobacco, and Health Study, 2021. A Qualitative study exploring older smokers' attitudes and motivation toward quitting during the COVID-19 pandemic. *Prev. Med. Rev.* 101359, 101359 <https://doi.org/10.1016/j.pmedr.2021>.
- Dark, J., O'connor, M., Pemberton, M., Russell, M.H., 1963. Relighting of cigarettes and lung cancer. *BMJ* 2 (5366), 1164–1166.
- Davison, M.L., 1983. *Multidimensional Scaling*. John Wiley and Sons, New York, NY.
- Dennis, A.R., Williams, M.L., 2003. Electronic brainstorming: theory, research, and future directions. In: *Group Creativity: Innovation Through Collaboration*, 2003. Oxford University Press, New York, NY, USA, pp. 160–178. ISBN 978-0-19-514730-8.
- DeRosa, D.M., Smith, C.L., Hantula, D.A., 2007. The medium matters: mining the long-promised merit of group interaction in creative idea generation tasks in a meta-analysis of the electronic group brainstorming literature. *Comput. Human Behav.* 23, 1549–1581.
- De Lusignan, S., Dorward, J., Correa, A., Jones, N., Akinyemi, O., Amirthalingam, G., Andrews, N., Byford, R., Dabrera, G., Elliot, A., Ellis, J., Ferreira, F., Lopez Bernal, J., Okusi, C., Ramsay, M., Sherlock, J., Smith, G., Williams, J., Howsam, G., Zambon, M., Joy, M., Hobbs, F., 2020. Risk factors for SARS-CoV-2 among patients in the Oxford Royal College of General Practitioners Research and Surveillance Centre primary care network: a cross-sectional study. *Lancet Inf. Dis.* 20 (9), 1034–1042. [https://doi.org/10.1016/s1473-3099\(20\)30371-6](https://doi.org/10.1016/s1473-3099(20)30371-6).

- Di Renzo, L., Gualtieri, P., Pivari, F., Soldati, L., Attinà, A., Cinelli, G., De Lorenzo, A., 2020. Eating habits and lifestyle changes during COVID-19 lockdown: an Italian survey. *J. Transl. Med.* 18, 1–15.
- Dugosh, K.L., Paulus, P.B., Roland, E.J., Yang, H.C., 2000. Cognitive stimulation in brainstorming. *J. Pers. Soc. Psychol.* 79, 722–735.
- Dugosh, K.L., Paulus, P.B., 2005. Cognitive and social comparison processes in brainstorming. *J. Exp. Soc. Psychol.* 41, 313–320.
- Elling, J.M., Crutzen, R., Talhout, R., de Vries, H., 2020. Tobacco smoking and smoking cessation in times of COVID-19. *Tob. Prev. Cess.* 6 (39), 1–5. <https://doi.org/10.18332/tpc/122753>.
- Emami, A., Javanmardi, F., Pirbonyeh, N., Akbari, A., 2020. Prevalence of underlying diseases in hospitalized patients with COVID-19: a systematic review and meta-analysis. *Arch. Acad. Emerg. Medicine* 8 (1).
- Farsalinos, K., Barbouni, A., Niaura, R., 2020. Smoking, vaping and hospitalization for COVID-19. *Qeios*.
- Ferrante, L., Fearnside, P.M., 2020. Protect Indigenous peoples from COVID-19. *Science* 368 (6488), 251–251.
- Gaiha, S.M., Cheng, J., Halpern-Felsher, B., 2020. Association between youth smoking, electronic cigarette use, and COVID-19. *J. Adolesc. Health* 67 (4), 519–523.
- Gendall, P., Hoek, J., Stanley, J., Jenkins, M., Every-Palmer, S., 2021. Changes in tobacco use during the 2020 COVID-19 lockdown in New Zealand. *Nicotine Tob. Res.* In Press.
- Gold, A.K., Hoyt, D.L., Milligan, M., Hiserodt, M.L., Samora, J., Leyro, T.M., Otto, M.W., 2021. The role of fear of COVID-19 in motivation to quit smoking and reductions in cigarette smoking: a preliminary investigation of at-risk cigarette smokers. *Cogn. Behav. Ther.* 1–10. Advance online publication: <https://doi.org/10.1080/16506073.2021.1877340>.
- Gupta, A.K., Nethan, S.T., Mehrotra, R., 2020. Tobacco use as a well-recognized cause of severe COVID-19 manifestations. *Respir. Med.* 176, 106233.
- Haddad, C., Bou Malhab, S., Sacre, H., Salameh, P., 2021. Smoking and COVID-19: a scoping review. *Tob. Insights* 14, 1179173X2199461, 1179173X21994612.
- Jackson, S.E., Brown, J., Shahab, L., Steptoe, A., Fancourt, D., 2020. COVID-19, smoking and inequalities: a study of 53 002 adults in the UK. *Tob. Control*.
- Klemperer, E.M., West, J.C., Peasley-Miklus, C., Villanti, A.C., 2020. Change in tobacco and electronic cigarette use and motivation to quit in response to COVID-19. *Nicotine Tob. Res.* 22 (9), 1662–1663.
- Kruskal, J.B., 1964. Multidimensional scaling by optimizing goodness of fit to a nonmetric hypothesis. *Psychometrika* 29 (1), 1–27.
- Kruskal, J.B., Wish, M., 1978. *Multidimensional Scaling*. Sage Publications, Beverly Hills, CA, USA.
- Li Volti, G., Caruso, M., Polosa, R., 2020. Smoking and SARS-CoV-2 disease (COVID-19): dangerous liaisons or confusing relationships? *J. Clin. Med.* 9 (5), 1321–1323.
- Lowe, K.E., Zein, J., Hatipoğlu, U., Attaway, A., 2021. Association of smoking and cumulative pack-year exposure with COVID-19 outcomes in the Cleveland Clinic COVID-19 Registry. *JAMA Intern. Med.* 181 (5), 709–711.
- Niedzwiedz, C.L., Green, M.J., Benzeval, M., Campbell, D., Craig, P., Demou, E., Katikireddi, S.V., 2021. Mental health and health behaviours before and during the initial phase of the COVID-19 lockdown: longitudinal analyses of the UK Household Longitudinal Study. *J. Epidemiol. Community Health* 75 (3), 224–231.
- Paleiron, N., Mayet, A., Marbac, V., Perisse, A., Barazzutti, H., Brocq, F.X., Janvier, F., Dautzenberg, B., Bylicki, O., 2021. Impact of tobacco smoking on the risk of COVID-19: a large scale retrospective cohort study. *Nicotine Tob. Res.*
- Patanavanich, R., Glantz, S.A., 2020. Smoking is associated with COVID-19 progression: a meta-analysis. *Nicotine Tob. Res.* 22 (9), 1653–1656.
- Reddy, R.K., Charles, W.N., Sklavounos, A., Dutt, A., Seed, P.T., Khajuria, A., 2020. The effect of smoking on COVID-19 severity: a systematic review and meta-analysis. *J. Med. Virol.* 93 (2), 1045–1056.
- Rimington, J., 1974. Cigarette smoker's bronchitis: the effect of relighting. *BMJ* 2, 591–593.
- Rosas, S.R., Kane, M., 2012. Quality and rigor of the concept mapping methodology: a pooled study analysis. *Eval. Program Plann.* 35, 236–245.
- Rosoff-Verbit, Z., Logue-Chamberlain, E., Fishman, J., Audrain-McGovern, J., Hawk, L., Mahoney, M., Mazur, A., Ashare, R., 2021. The perceived impact of COVID-19 among treatment-seeking smokers: a mixed methods approach. *Int. J. Environ. Res. Public Health* 18 (2), 505.
- Shepherd, J.M., Fogle, B., Garey, B., Viana, A.G., Zvolensky, M.J., 2021. Worry about COVID-19 in relation to cognitive-affective smoking processes among daily adult combustible cigarette smokers. *Cogn. Behav. Ther.* 50.
- Sidor, A., Rzymiski, P., 2020. Dietary choices and habits during COVID-19 lockdown: experience from Poland. *Nutrients* 12 (6), 1657.
- Simons, D., Shahab, L., Brown, J., Perski, O., 2021. The association of smoking status with SARS-CoV-2 infection, hospitalization and mortality from COVID-19: a living rapid evidence review with Bayesian meta-analyses (version 7). *Addiction* 116 (6), 1319–1368. <https://doi.org/10.1111/add.15276>.
- Soule, E.K., Maloney, S.F., Guy, M.C., Eissenberg, T., Fagan, P., 2018. User-identified electronic cigarette behavioral strategies and device characteristics for cigarette smoking reduction. *Addict. Behav.* 79, 93–101.
- Soule, E.K., Mayne, S., Snipes, W., Guy, M.C., Breland, A., Fagan, P., 2020. Impacts of COVID-19 on electronic cigarette purchasing, use and related behaviors. *Int. J. Environ. Res. Public Health* 17 (18), 6762.
- Stanton, R., To, Q.G., Khalesi, S., Williams, S.L., Alley, S.J., Thwaite, T.L., Fenning, A.S., Vandelandotte, C., 2020. Depression, anxiety and stress during COVID-19: associations with changes in physical activity, sleep, tobacco and alcohol use in Australian adults. *Int. J. Environ. Res. Public Health* 17 (11), 4065.
- Streck, J.M., Kalkhoran, S., Bearnot, B., Gupta, P.S., Kalagher, K.M., Regan, S., Wakeman, S., Rigotti, N.A., 2021. Perceived risk, attitudes, and behavior of cigarette

- smokers and nicotine vapers receiving buprenorphine treatment for opioid use disorder during the COVID-19 pandemic. *Drug Alcohol Depend.* 218, 108438.
- Umnuaypornlert, A., Kanchanasurakit, S., Lucero-Prisno, D.E.I., Saokaew, S., 2021. Smoking and risk of negative outcomes among COVID-19 patients: a systematic review and meta-analysis. *Tob. Induc. Dis.* 19.
- Vanderbruggen, N., Matthys, F., Van Laere, S., Zeeuws, D., Santermans, L., Van den Aemele, S., Crunelle, C.L., 2020. Self-reported alcohol, tobacco, and cannabis use during COVID-19 lockdown measures: results from a web-based survey. *Eur. Addict. Res.* 26 (6), 309–315.
- Ward, J.H., 1963. Hierarchical grouping to optimize an objective function. *J. Am. Stat. Assoc.* 58, 236–244.
- World Health Organization, 2020. World Health Organization, 2020, March. WHO Director-General's opening remarks at the media briefing on COVID-19—11 March 2020. *World Health Organization*. <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19-11-march-2020>.
- Zimmermann, M.H., Richardson, D.L., Manderski, M.T.B., Delnevo, C.D., Steinberg, M.B., 2014. Relighting behaviour among cigarette smokers seeking treatment: implications for tobacco treatment and policy. *Int. J. Clin. Pract.* 68 (11), 1358–1363.