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# The relationship between COVID-19-specific health risk beliefs and the motivation to quit smoking: A UK-based survey<sup>☆,☆☆</sup>

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## ABSTRACT

**Background:** In some individuals who smoke, the COVID-19 pandemic has triggered an increase in the motivation to quit smoking due to the potential higher risk of severe COVID-19 infection. However, this change is not universal, and the motivation to quit appears dependent upon factors such as fear of COVID-19 and perceived risk from COVID-19. In the current investigation both COVID-19 severity and infection probability beliefs were measured to isolate which beliefs correlated with the motivation to quit smoking.

**Methods:** UK-based smokers ( $N = 243$ ) completed an online survey between September and October 2020, in which they reported their current motivation to quit smoking, fear of COVID-19, and their beliefs about how severe COVID-19 infection would be and how probable COVID-19 infection was.

**Results:** The only significant predictor of the motivation to quit smoking was the perceived probability of COVID-19 infection,  $\beta = .22$ ,  $p < .001$ , 95CI[.10, .34]. This relationship remained when controlling for the general perceived probability and severity of other smoking-related health risks,  $\beta = .20$ ,  $p = .002$ , 95CI[.08, .32], suggesting a COVID-19-specific effect. Further, perceived probability of COVID-19 infection mediated the positive impact of fear of COVID-19 on motivation,  $\beta = .07$ ,  $p = .006$ , 95CI[.03, .13].

**Conclusions:** The result places the perceived probability of COVID-19 infection as a central predictor of the motivation to quit during the pandemic. Based on this evidence, messaging aiming to facilitate smoking cessation during the pandemic should focus on the highly contagious nature of the virus to increase the motivation to quit.

## 1. Introduction

The COVID-19 pandemic has resulted the loss of millions of lives worldwide, and survivors often left with persistent health conditions after severe illness (del Rio et al., 2020). Evidence from some large scale population studies and meta-analyses suggests that, compared to never-smokers, individuals who are current or former smokers are at higher risk of experiencing more severe COVID-19 symptoms and mortality (Alqahtani et al., 2020; Hopkinson et al., 2021; Patanavanich and Glantz, 2020; Vardavas and Nikitara, 2020; Zhao et al., 2020; Williamson et al., 2020; Bhaskaran et al., 2021; Umnuyapornlert et al., 2021; see Simons et al., 2021 for opposing evidence).

As a direct response to this potential health threat attitudes towards smoking may be changing over the course of the pandemic. For instance, Jackson et al. (2021) found that during the first UK lockdown (beginning March 2020) there was an increase in the motivation to quit smoking and an increased number of attempts to quit. Further, reductions in smoking behaviour have also been observed in a percentage of smokers

in surveys from across the Netherlands, Pakistan, US, Italy, India, South Africa, and UK (Bommele et al., 2020; Klemperer et al., 2020; Kowitz et al., 2020; Siddiqi et al., 2021; Tattan-Birch et al., 2021; White et al., 2021; Yach, 2020; Yingst et al., 2021). Within these samples some participants reported an increase in the motivation to quit smoking, increased quit attempts, or an actual decrease in smoking frequency during the pandemic.

However, this increased engagement with smoking cessation was not universal and, in fact, was limited to a small percentage of the samples, with many participants showing no change or an increase in smoking behaviour. Qualitative reports reveal a complex relationship between smoking and the pandemic, with some of those who smoke reporting that the risk from COVID-19 was a trigger to quit, but the stress during the pandemic was a trigger to smoke as a coping mechanism (Cordon et al., 2021). Indeed, stress and worry during the pandemic have been correlated with smoking as a coping mechanism (Shepherd et al., 2021), and stress during the pandemic positively correlates with smoking frequency in some participants, whilst being negatively correlated with

<sup>☆</sup> Open Science Framework data link: [https://osf.io/qp2n9/?view\\_only=1b5fd6578c1e4be6b509853cb67f10](https://osf.io/qp2n9/?view_only=1b5fd6578c1e4be6b509853cb67f10). <sup>☆☆</sup> Pre-registration link: <https://osf.io/hkcm2>.

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smoking frequency in others (Bommele et al., 2020).

In order to effectively enhance smoking cessation interventions during the COVID-19 pandemic, or potential future pandemics, it is essential to isolate which specific psychological factors mediate the influence of the novel health risk on the motivation to quit. For instance, Gold et al. (2021) found that fear of COVID-19 significantly correlated with higher motivation to quit, even more so than objective risk factors for COVID-19 severity (e.g. age), suggesting an emotional component to the motivation to quit. The emotional fear response to COVID-19, however, is unlikely to act in isolation, as the influence of fearful emotions on health intentions have been found to be mediated through risk beliefs (Paek et al., 2016).

Based on the health belief model, health behaviours are predicted by a range of different beliefs (Glanz and Bishop, 2010; Rosenstock, 1974; Rosenstock et al., 1988), which can be grounded in an emotional response to the risk (Ferrer and Klein, 2015; Janssen et al., 2014). In relation to smoking, these beliefs would include the perceived benefits of quitting, perceived barriers to quitting, perceived quitting self-efficacy, and perceived probability and severity of the smoking-related health conditions. In the current investigation, the subjective beliefs regarding perceived COVID-19 severity and probability were measured to explore their relationship with the motivation to quit, as both these beliefs are related directly to the novel threat of COVID-19, rather than indirectly related to the pandemic in general (e.g. recent unemployment acting as a barrier to quitting).

Indeed, the beliefs regarding the perceived risk of severe COVID-19 infection are also positively correlated with the motivation to quit smoking (Chertok, 2020), and the belief that COVID-19 is a greater risk for those who smoke also correlates with a decrease in smoking since pandemic began (White et al., 2021). However, in these previous studies, the measures of perceived risk did not isolate different risk beliefs, and either asked broadly what the risk was to people who smoked, or averaged severity and probability belief ratings together. When COVID-19 risk beliefs have been measured in more detail it has been found that both perceived severity and probability of COVID-19 infection correlate with higher motivation to quit (Elling et al., 2020).

It is not yet known, however, whether these beliefs independently correlate with motivation to quit, whether they interact, or their role in mediating the effect of fear of COVID-19 on motivation. Both perceived severity and probability are influential in the motivation to quit or persist with smoking (Kaufman et al., 2020), but both do not always correlate with engagement with all health behaviours (Carpenter, 2010). Further, smoking may interact differently with probability and severity beliefs, as evidence from meta-analyses and large sample cohort studies suggest that individuals who currently smoke appear to be less likely to be infected with COVID-19 than former or never smokers, potentially due to nicotine providing protection (Simons et al., 2021; Farsalinos et al., 2020; Paleiron et al., 2021; Lee et al., 2021). This relationship currently remains unclear and has been criticised for its basis on limited data, not controlling for confounding variables such as age, and potential influence of selection/collider bias (Simons et al., 2021; Ummuaypornlert et al., 2021; Griffith et al., 2020; Tattan-Birch et al., 2020). Regardless of the validity of this relationship between smoking and COVID-19 probability, this information was disseminated to the general public and may have reduced the perceived risk of infection. It is therefore essential to isolate which specific belief correlates with the motivation to quit, as messaging of risk to smokers would have to target the specific belief underpinning the motivation to quit when aiming to facilitate smoking cessation.

It was predicted that both perceived severity of COVID-19 infection and perceived probability of COVID-19 infection would positively correlate with the motivation to quit. Further, it was expected that these beliefs would mediate the positive relationship between fear of COVID-19 and the motivation to quit smoking previously found (Gold et al., 2021). Similarly, heavier smoking, as measured with nicotine dependence, was expected to positively correlate with motivation to quit when

mediated through probability and severity beliefs, due to the higher objective risk.

## 2. Methods

The current investigation is based on an existing dataset collected by Brown and Faulkner (2021). Independent of this primary investigation, the current hypotheses, methods, and analyses were pre-registered on the Open Science Framework (OSF: osf.io/qp2n9) prior to data collection, thus enabling independent investigation. All methods were approved by the University of Roehampton ethics committee.

### 2.1. Participants

An initial sample of 259 participants were recruited from Prolific Academic paid online recruitment pool (<https://www.prolific.co/>); for further details see Palan and Schitter, 2018; Adams et al., 2020) between September 28th and 5th of October, in exchange for payment (£2.50). Pre-registered inclusion criteria required participant to be based in the UK, aged 18 or over, and reported regularly smoking at the time signing up to Prolific Academic. Sixteen participants were therefore excluded for subsequently reporting within the survey that they no longer smoked, or failing to complete the whole survey. The final sample consisted of 243 participants, with equal numbers of male ( $n = 120$ ) and female ( $n = 120$ ) participants, and three participants who reported identifying as neither male nor female. For full participant characteristics see Table 1.

A power analysis suggested that the final sample was suitable to detect a significant predictive model with an  $R^2$  of .06 ( $\alpha = .05$ ,  $\beta = .90$ , 5 predictors). Originally, two samples were pre-registered, each group rated the emotion of either COVID-19-related or traditional health warnings. These groups did not differ on any outcome or predictor variables (see Brown and Faulkner, 2021) and were therefore pooled together to increase statistical power. The inclusion of group as a covariate in all analyses did not alter the results.

### 2.2. Materials and procedure

Participants accessed a Qualtrics survey link through a Prolific Academic advert. After providing informed consent, participants completed demographic variables including age, gender, and highest level of education. This was followed by a smoking history questionnaire developed in-house, which measured time of last cigarette, typical number of cigarettes smoked per day and how long they had smoked this number for, what nicotine products they used (e.g. e-cigarettes, rolled cigarettes), age of smoking onset, and number of life-time quit attempts. Participants then reported their level of nicotine dependence with the 6-item Fagerstrom Test for Nicotine Dependence (FTND; Fagerström, 2012), and their current nicotine withdrawal state with the 25-item Shiffman-Jarvik withdrawal scale (Shiffman and Jarvik, 1976).

Participants then completed the single-item motivation to stop smoking scale (MTSS; Kotz et al., 2013). The single item scale ranged from one to seven, each point corresponding to a specific statement of motivation: 1 = "I don't want to stop smoking"; 2 = "I think I should stop smoking but don't really want to"; 3 = "I want to stop smoking but haven't thought about when"; 4 = "I REALLY want to stop smoking but I don't know when I will"; 5 = "I want to stop smoking and hope to soon"; 6 = "I REALLY want to stop smoking and intend to in the next 3 months"; 7 = "I REALLY want to stop smoking and intend to in the next month". The MTSS was suitable for treatment as a continuous variable due to it containing >5 levels (Rhemtulla et al., 2012).

After the MTSS, participants completed measures of perceived probability and severity of smoking-specific health risks. The perceived probability and severity were rated independently. Based on recommendations by Kaufman et al. (2020), participants rated how likely/probable they were to personally experience a range of 11 negative health outcomes along a 7-point scale, ranging from 'very low

**Table 1**

Full outline of participant characteristics,  $N = 243$ . LT Quit attempts = lifetime attempts to quit; FTND = Fagerstrom Test for Nicotine Dependence. Tobacco products refers to all the different combustible products often used by participants when allowed to report multiple products. COVID-19 risk pre-knowledge refers to awareness of the risk of increased COVID-19 mortality for smokers prior to the survey. See Materials and procedure section (2.2) below for motivation to quit smoking response coding. Perceived severity and probability of COVID-19 infection range from 0 – 100, and Fear of COVID-19 ranges from 7 – 35.

Variable	Mean (SD)	Frequency (total N = 243)	Percentage
Gender			
Female		120	49.38%
Male		120	49.38%
Neither male nor female		3	1.23%
Age	35.69 (12.28)		
18 - 25		46	18.9 %
26 - 40		132	54.4 %
41 - 55		40	16.46 %
≥ 56		25	10.29 %
Highest level of education			
GCSE		44	18.11 %
A-level		58	23.87 %
Post-6 <sup>th</sup> form award		22	9.05 %
Undergraduate		76	31.28 %
Masters		27	11.11 %
Doctorate		8	3.29 %
No response		7	2.88 %
Cigarettes per day	10.88 (7.23)		
<1		23	9.5%
1–10		115	47.33%
11–20		96	39.51%
>20		9	3.7%
Hours since last cigarette	83.75 (661.68)		
≤ 2 h		167	63.8%
3–12 hours		38	15.6%
13–24 hours		21	8.7%
25–48 hours		10	4.12%
>48 h		17	7%
Age of smoking onset	17.45 (4.42)		
11 - 13		18	8.07%
14 - 16		101	45.29%
17 - 18		64	28.7%
19 - 21		39	17.49%
>22		21	9.42%
Number of LT Quit attempts	4.32 (3.82)		
1		45	20.18%
2 - 5		142	63.68%
6 - 10		34	15.25%
>10		22	9.87%
FTND	3.23 (2.43)		
0 - 2		100	44.84%
3 - 4		64	28.7%
5		28	12.56%
6 - 7		41	18.39%
8 - 10		10	4.48%
Concurrent E-cigarette user		71	29.22%
All tobacco products used			
Packet cigarettes		158	65.02%
Self-rolled cigarettes		142	58.44%
Other (pipe, cigars, other)		11	4.53%
COVID19 risk pre-knowledge		185	76.1%

**Table 1 (continued)**

Variable	Mean (SD)	Frequency (total N = 243)	Percentage
Motivation to quit Smoking	3.49 (1.74)		
1		26	10.7%
2		68	28%
3		32	13.2%
4		47	19.3%
5		37	15.2%
6		15	6.2%
7		18	7.4%
Perceived Severity of COVID-19	50.75 (23.06)		
Perceived probability of COVID-19	29.92 (24.68)		
Fear of COVID-19	17.53 (6.74)		

possibility' to 'very high possibility'. After, participants reported how severe they expected the same outcomes to be if they experienced them. The ratings were on a 5-point scale ranging from 'not at all severe' to 'extremely severe'. The average probability and severity was calculated for symptoms unrelated to COVID-19 (i.e. reproductive/sexual dysfunction, tooth damage, lung cancer, throat cancer, premature aging, emphysema; Cronbach's alphas: probability = .88; severity = .76), excluding those which were strongly linked to COVID-19 or indicative of COVID-19 (i.e. respiratory illness, increased susceptibility to illness, weakened immune system), or were not well known outcomes from COVID-19 at time of recruitment (i.e. stroke, heart disease).

After completing all smoking-specific measures, participants completed COVID-19-related measures these being the Fear of Coronavirus scale (Ahorsu et al., 2020), which is a 7-item measure reflecting the fear/stress experienced when thinking of COVID-19. The scale included items such as 'It makes me uncomfortable to think about COVID-19' rated along a 5-point scale, ranging from 'strongly disagree' to 'strongly agree'. This was followed by two subscales from the recently developed scale by Di Crosta et al. (2020) which measures the belief of COVID-19 contagion (4-items; i.e. perceived probability of COVID-19 infection; Cronbach's alpha = .75) and belief of COVID-19 consequences (4-items; i.e. perceived severity of COVID-19 infection). For perceived severity, a reliability analysis revealed poor internal consistency, therefore in an adjustment to the pre-registration, two items (items 1 and 2) were removed (final Cronbach's alpha = .75).<sup>1</sup> The COVID-19 probability subscale included items such as "I think I could be infected with COVID-19 in the future". Whilst the COVID-19 severity subscale included items such as "I think it is probable that I would recover after being infected with the virus". Ratings were along Visual Analogue scales ranging between 0 and 100. After completing the COVID-19-related measures, participants were asked whether they were aware of the increased severity of COVID-19 health outcomes for smokers before the study ('yes'/'no'). As part of a separate investigation, participants also rated the arousal and valence of cigarette health warnings, and the 27-item delay discounting monetary choice questionnaire (MCQ; Kirby and Maraković, 1996).<sup>2</sup>

### 2.3. Statistical analysis

The pre-registered primary analysis was a linear hierarchical regression with motivation to quit smoking as the outcome variable, and

<sup>1</sup> Both adjusted and original scale scores produced the same significance and pattern of results.

<sup>2</sup> A cigarette monetary value measure was pre-registered, but due to survey instruction error unreliable responses were recorded and are therefore omitted.

perceived severity and perceived probability of COVID-19 as predictor variables. These were entered as an initial step, with their interaction entered in a second step. In an extension to the pre-registration, bootstrapped 95 % confidence intervals were computed with 5000 resamples to account for violations of normality (Field, 2013). All continuous variables were standardised for regression analyses to allow bootstrapping of standardised  $\beta$ s. All analyses were conducted in JASP software (JASP team, 2020).

In a registered follow-up analysis, to determine whether any relationships in this initial regression were independent of general smoking health beliefs, the perceived probability and severity of other smoking-specific health risks (e.g. cancer) were included as covariates in a separate regression model (see Table 2). If the COVID-19-specific relationships were accounted for by general expectations of other smoking-specific health risks, then it may be that COVID-19 beliefs simply reflect an extension of existing beliefs about other smoking risks.

To assess the impact of fear of COVID-19 upon the motivation to quit smoking, as mediated through beliefs about probability and severity of COVID-19 infection, a mediation analysis was conducted with fear of COVID-19 entered as the predictor variable, motivation to quit as the outcome variable and both perceived probability and severity of COVID-19 infection as mediators (see Fig. 1). The significance of direct and

**Table 2**

Regression analysis with motivation to quit smoking as the outcome variable. Step 1 controls for general negative health risks from smoking; Step 2 reflects the contribution of beliefs about the COVID-19 probability and severity, and step 3 reflects the interaction between these two beliefs. Smoking-specific probability and severity refers to smoking health risks not linked to COVID-19. Confidence intervals were bootstrapped with 5000 resamples.

		$\beta$	<i>t</i>	<i>p</i> -value	95 % CI lower bound	95 % CI upper bound
Step 1: Covariates	Smoking-specific probability	.05	.73	.467	-.10	.20
	Smoking-specific severity	.15	2.29	.023	.01	.28
$R^2 = .03$ , $F(2240) = 3.75$ , $p = .025$						
Step 2: COVID-19 specific beliefs	Smoking-specific probability	.06	.80	.424	-.11	.20
	Smoking-specific severity	.13	1.92	.056	-.02	.26
	COVID-19 probability	.20	3.13	.002	.08	.32
	COVID-19 severity	-.07	1.11	.268	-.19	.04
$R^2 = .07$ , $F(4,238) = 4.30$ , $p = .001$						
Step 3: severity probability interaction	Smoking-specific probability	.05	.80	.426	-.10	.21
	Smoking-specific severity	.13	1.91	.057	-.02	.26
	COVID-19 probability	.20	3.14	.002	.08	.32
	COVID-19 severity	-.76	1.13	.258	-.19	.04
	COVID-19 probability x severity	.02	.26	.799	-.09	.13
$R^2 = .07$ , $F(5,237) = 3.64$ , $p = .003$						

indirect effects were calculated using bootstrapped (5000 resamples), bias-corrected percentile, confidence intervals. As with the initial regression analysis, a follow-up analysis was conducted which controlled for smoking-specific health beliefs. To explore the impact of nicotine dependence on the COVID-19 health beliefs as well as the motivation to quit, the identical mediation analysis was conducted but with the FTND score instead of fear of COVID-19 score.

The overall relationships between all variables are presented using bivariate Pearson's correlations (Table 3). For all correlations, Bayes Factors (BF) were computed using JASP, and were calculated using a default stretched beta prior of 1. Bayes factors above 3 denote moderate evidence for the experimental hypothesis, below .33 denotes moderate evidence for the null. Between .33 and 3 denotes inconclusive results requiring more data (Dienes, 2014).

### 3. Results

#### 3.1. Probability and severity belief regression analysis

When entered into a hierarchical regression model, the independent effects of COVID-19 severity and COVID-19 probability positively correlated with motivation to quit smoking,  $R^2 = .05$ ,  $F(2240) = 6.20$ ,  $p = .002$ . This was, however, driven by the perceived probability of infection,  $\beta = .22$ ,  $t = 3.51$ ,  $p < .001$ , 95 % CI<sub>bootstrapped</sub>[.10, .34], whilst the perceived severity of infection did not covary with motivation to quit,  $\beta = -.05$ ,  $t = .74$ ,  $p = .460$ , 95 % CI<sub>bootstrapped</sub>[-.17, .07]. The interaction term between probability and severity did account for any additional variance,  $R^2_{change} < .01$ ,  $F(1,239) = .70$ ,  $p = .787$ .

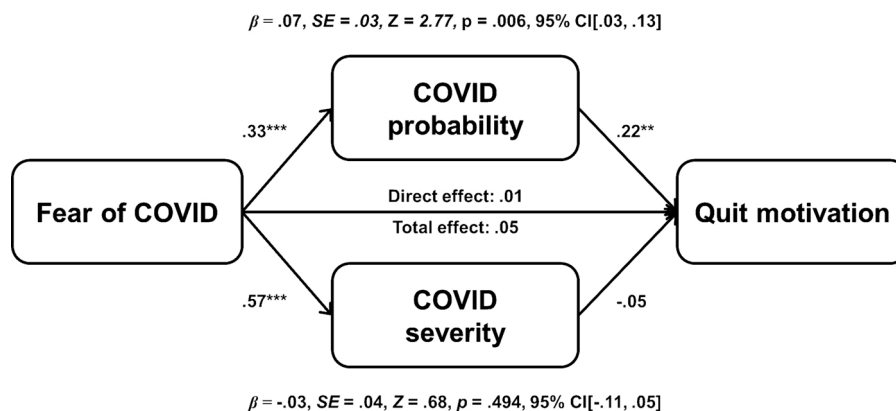
In a pre-registered follow-up analysis, the perceived probability and severity of smoking-specific health risks were included as covariates in an initial step (see Table 2). The initial step with these variables was itself correlated with higher motivation to quit, specifically, the perceived severity of smoking-specific health risks was correlated with motivation to quit. Importantly, inclusion of these variables did not alter the relationship between perceived probability of COVID-19 infection and motivation to quit smoking. The relationships between all variables analysed are presented in Table 3.

The correlation analysis with Bayes factors revealed that the motivation to quit only positively correlated with perceived severity of smoking-specific health risks, and probability of COVID-19. Bayesian analysis of these relationships revealed substantial evidence favouring the experimental hypothesis (BF > 3). However, unexpectedly, fear of COVID-19, perceived COVID-19 severity, and perceived smoking-specific health risk severity were all non-significantly related to the motivation to quit, with Bayes factors favouring null hypothesis suggesting an absence of relationship (BF < .33; Dienes, 2014).

#### 3.2. Fear of COVID-19 mediation analysis

The mediation analysis with fear of COVID-19 as the predictor revealed no significant direct effect of fear of COVID-19 on motivation to quit. However, there was a significant indirect effect when mediated through the perceived probability of COVID-19 infection, as it strongly related to an increase in perceived probability of COVID-19, which in turn correlated with increased motivation to quit. Despite correlating with perceived severity of COVID-19, there was no significant indirect effect through this path.

The inclusion of smoking-specific health risk beliefs as covariates did not change the results. The total effect of fear of COVID-19 on the motivation to quit remained non-significant,  $\beta = .01$ ,  $SE = .07$ ,  $Z = .09$ ,  $p = .926$ , 95 % CI<sub>bootstrapped</sub> [-.12, .14]. The indirect effect remained significant for perceived COVID-19 probability,  $\beta = .06$ ,  $SE = .02$ ,  $Z = 2.54$ ,  $p = .011$ , 95 % CI<sub>bootstrapped</sub> [.02, .12], and remained non-significant for perceived COVID-19 severity,  $\beta = -.03$ ,  $SE = .04$ ,  $Z = .77$ ,  $p = .439$ , 95 % CI<sub>bootstrapped</sub> [-.11, .04].



**Fig. 1.** The mediation model for fear of COVID-19 and motivation to quit (Quit motivation), as mediated through perceived probability of infection from COVID-19 (COVID probability) and perceived severity of COVID-19 infection (COVID severity). Indirect paths are presented adjacent to their variable. Confidence intervals were bootstrapped with 5000 resamples.

**Table 3**

Bivariate correlations coefficients and Bayes Factors (BF) for all Pearson correlation between variables. FTND = Fagerstrom Test for Nicotine Dependence. Smoking-specific refers to smoking health risks not linked to COVID-19.

		1	2	3	4	5	6
1	Motivation to quit	-					
2	Fear of COVID-19	<i>r</i> .05 <i>BF</i> <sub>10</sub> .11	-				
3	COVID-19 probability	<i>r</i> .22*** <i>BF</i> <sub>10</sub> 25.20	.33*** 56 × 10 <sup>3</sup>	-			
4	COVID-19 severity	<i>r</i> -.02 <i>BF</i> <sub>10</sub> .08	.57*** 22 × 10 <sup>19</sup>	.13* .61	-		
5	Smoking-specific probability	<i>r</i> .10 <i>BF</i> <sub>10</sub> .24	.23*** 41.78	.12 <sup>†</sup> .40	.29*** 32 × 10 <sup>2</sup>	-	
6	Smoking-specific severity	<i>r</i> .17** <i>BF</i> <sub>10</sub> 2.43	.24*** 76.53	.16* 1.72	.10 .28	.30*** 77 × 10 <sup>2</sup>	-
7	FTND	<i>r</i> -.10 <i>BF</i> <sub>10</sub> .24	.16* 1.58	-.07 .15	.20** 9.82	.11 .34	.05 .11

Significance levels are signalled thus:  $p < .1 = \dagger$ ;  $p < .05 = *$ ;  $p < .01 = **$ ;  $p < .001 = ***$ . Bayes factors are reported for all correlation coefficients. Bayes factors were calculated using a default stretched beta prior of 1 in JASP. Bayes factors above 3 denote moderate evidence for the experimental hypothesis, below .33 denotes moderate evidence for the null. Between .33 and 3 denotes inconclusive results requiring more data (Dienes, 2014).

### 3.3. Nicotine dependence mediation analysis

When entered as a predictor in the mediation model, with both COVID-19 probability and severity beliefs as mediators, the FTND was non-significantly related to motivation to quit,  $\beta = -.07$ ,  $SE = .06$ ,  $Z = 1.18$ ,  $p = .238$ , 95 %  $CI_{bootstrapped}[-.20, .07]$ . Further, there was no significant indirect effect when mediated through either perceived probability,  $\beta = -.02$ ,  $SE = .01$ ,  $Z = 1.02$ ,  $p = .307$ , 95 %  $CI_{bootstrapped}[-.05, .01]$ , or perceived severity,  $\beta = -.01$ ,  $SE = .01$ ,  $Z = .45$ ,  $p = .651$ , 95 %  $CI_{bootstrapped}[-.04, .02]$ . The FTND was significantly correlated with perceived severity of COVID-19 and fear of COVID-19 (see Table 3), suggesting that those with more dependence perceived more severe outcomes from COVID-19.

### 4. Discussion

Within a UK-based sample, the primary predictor of the motivation to quit smoking was the higher perceived probability of COVID-19 infection. Conversely, the belief that the COVID-19 infection would be severe was not significantly correlated with the motivation to quit

smoking. Interestingly, in contrast to previous findings (Gold et al., 2021), fear of COVID-19 did not significantly correlate with motivation to quit directly; however, it did have a significant indirect effect upon motivation to quit when mediated through the perceived probability of COVID-19 infection, but not perceived severity.

The fact that perceived probability of COVID-19 infection was the only significant predictor of the current motivation to quit was unexpected, as evidence suggests that smoking is associated with an increased risk of severe COVID-19 infections, rather than an increased probability of infection (Simons et al., 2021). Further, in an early meta-analysis, severity of health risks correlated with health behaviours more than probability (Carpenter, 2010). A finding replicated with the beliefs about the severity and probability of other smoking-specific health outcomes in the current data.

One possible reason for this difference could be that severity and probability of COVID-19 beliefs may be dependent on different types of belief. Health beliefs can be divided into deliberative and experiential types, with deliberative beliefs based on declarative knowledge of probabilities, whilst experiential beliefs are grounded in the emotional or ‘gut’ feelings of risk (Ferrer and Klein, 2015; Ferrer et al., 2018).

Importantly, experiential beliefs are more strongly linked to the motivation to quit or reduce smoking (Janssen et al., 2014). It may be, therefore, that perceived COVID-19 severity and probability beliefs have different experiential/declarative underpinnings. One potential reason may be that the experiences of infection risks occur more frequently and require conscious responses to avoid them (e.g. social distancing), creating a more experiential basis. Conversely, experiences of severe COVID-19 infection may be more abstract, as presentation for many occurs indirectly through news or social media, and are only directly experienced by those who are infected, families/friends of severely affected individuals, and frontline medical staff (Gilleen et al., 2021). In the current study, participant history of personal or family/friend COVID-19 infections was not measured, though future work should explore the direct role that COVID-19 may play in health or addictive behaviours.

An alternative interpretation of this cross-sectional data, however, could be that the perceived probability of COVID-19 infection may reflect differences in exposure to the idea that active smoking may protect from COVID-19 infection (Usman et al., 2020). In which case, those who believed that smoking results in a lower probability of COVID-19 infection may have a lower motivation to quit, rather than the higher perceived probability increasing motivation to quit, as hypothesised here. On the other hand, nicotine dependence was uncorrelated with perceived COVID-19 probability, suggesting that heavier consistent smoking did not correlate with a lower perceived risk of COVID-19 as would be expected by this interpretation.

Interestingly, the relationship between the COVID-19 probability and the motivation to quit remained significant when controlling for the general perceived probability of smoking-specific health risks (e.g. cancer). Therefore, the relationship was not limited to individuals with a general expectancy of other negative health outcomes from smoking. Such an effect is consistent with the increase in motivation to quit since the pandemic began being driven by the novel COVID-19 threat, independent of existing health beliefs (Jackson et al., 2021; White et al., 2021).

Further, nicotine dependence did not interact with either COVID-19 probability or severity beliefs in accounting for motivation to quit, suggesting that smoking dependence did not effect the perceived probability of COVID-19 or the relationship with motivation to quit. Nicotine dependence was positively correlated with perceived COVID-19 severity and fear of COVID-19, potentially reflecting awareness of the increased risk of severe COVID-19 in current smokers (Patanavanich and Glantz, 2020), however, this did not translate into a change in motivation.

#### 4.1. Limitations

The cross-sectional nature of the current survey prevented the direction of the relationships from being inferred. For instance, it is possible that the perceived probability of COVID-19 infection increases the fear of COVID-19, rather than the fearful emotions influencing perceived health risks, as hypothesised here and other models of health beliefs (e.g. Paek et al., 2016). In this current investigation, however, a plausible model for how fear of COVID-19 interacts with specific health beliefs to predict the motivation to quit smoking has been presented. Future research using longitudinal analyses across multiple timepoints may explore in more detail how emotions, specific COVID-19 health beliefs, and smoking behaviour and attitudes develop over time, allowing the inference of directional relationships.

Additionally, it is not clear whether the motivation to quit measured here correlates with actual smoking cessation, and whether this will persist beyond the peak of the pandemic, as motivation alone is not enough to result in long-lasting cessation, which is strongly linked to nicotine dependence and context (Borland et al., 2010; Vangeli et al., 2011). It may be that interventions can be utilised to enhance any increase in motivation to quit in response to the novel harm posed by COVID-19, though this will be dependent upon the progression of the

virus (Grummon et al., 2020). It should be noted that the findings may be limited to a UK-based sample, as the international response to COVID-19 has varied (Hale et al., 2020), meaning that replication in other populations is required.

## 5. Conclusion

In the current investigation it was found that only the belief that COVID-19 infection was probable correlated with the motivation to quit smoking. Thus highlighting the different roles that specific health beliefs play in predicting smoking attitudes in light of the novel COVID-19 threat.

The findings provide key information which can enhance the messaging of the COVID-19 health risks to facilitate smoking cessation. The current evidence suggests that smoking is related to the increased risk of COVID-19 severity, rather than probability of infection (Simons et al., 2021). Thus, communication of risk should not falsely imply increased probability of COVID-19, however, messaging the general high contagiousness of COVID-19 in conjunction with the increased COVID-19 severity for those who smoke may be an effective strategy to increase the motivation to quit smoking.

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Nothing declared.

### Contributors

Dr Chris Brown was responsible for the design, recruitment, analysis, interpretation, and write-up of the current investigation.

### Declaration of Competing Interest

The authors report no declarations of interest.

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