Lifting dyspnoea invisibility: COVID-19 face masks, the experience of breathing discomfort, and improved lung health perception – a French nationwide survey

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Shareable abstract (@ERSpublications)
Wearing COVID-19 face masks has resulted in the discovery of dyspnoea by the general public and heightened concern for respiratory health. This provides the respiratory community with a major communication opportunity. https://bit.ly/3yKPnGD

Cite this article as: Serresse L, Simon-Tillaux N, Decavèle M, *et al*. Lifting dyspnoea invisibility: COVID-19 face masks, the experience of breathing discomfort, and improved lung health perception – a French nationwide survey. *Eur Respir J* 2022; 59: 2101459 [DOI: 10.1183/13993003.01459-2021].

Received: 23 May 2021
Accepted: 3 Aug 2021

Abstract

Question addressed In contrast with pain, dyspnoea is not visible to the general public, who lack the corresponding experiential baggage. We tested the hypothesis that the generalised use of face masks to fight severe acute respiratory syndrome coronavirus 2 dissemination could change this and sensitise people to respiratory health.

Methods General population polling (1012-person panel demographically representative of the adult French population, quota sampling method; 517 (51%) female). 860 (85%) answered "no" to "treated for a chronic respiratory disease" ("respiratory healthy"), and 152 answered "yes" ("respiratory disease"). 14% of respiratory healthy respondents reported having a close family member treated for a chronic respiratory disease (RH-family^{+}). Respondents described mask-related attitudes, beliefs, inconveniencies, dyspnoea and changes in their respiratory health vision.

Results Compliance with masks was high (94.7%). Dyspnoea ranked first among mask inconveniencies (respiratory disease 79.3%, respiratory healthy 67.3%; p=0.013). "Air hunger" was the main sensory dyspnoea descriptor. Mask-related dyspnoea was independently associated with belonging to RH-family^{+} (OR 1.85, 95% CI 1.16–2.98) and removing masks to improve breathing (OR 5.21, 95% CI 3.73–7.28). It was negatively associated with considering masks effective to protect others (OR 0.42, 95% CI 0.25–0.75). Half the respondents were more concerned with their respiratory health since wearing masks; 41% reported better understanding patients' experiences.

Answer to the question Wearing protective face masks leads to the mass discovery of breathing discomfort. It raises public awareness of what respiratory diseases involve and sensitivity to the importance of breathing. These data should be used as the fulcrum of respiratory health oriented communication actions.

Introduction

Dyspnoea, or breathing discomfort [1], is the ubiquitous symptom of respiratory, cardiac and neuromuscular diseases, and of obesity and deconditioning. For those afflicted, dyspnoea is a life-reducing experience associated with fear and handicap. Yet, in contrast with pain, dyspnoea is not very visible to the general public. Patients with chronic respiratory diseases often report an insufficient understanding of their suffering by others, including caregivers [2], which adds to their burden. This "invisibility" of dyspnoea [3] impedes access to appropriate care [4] and raises human rights issues [5]. It originates, in part, from dyspnoea not being a universal human experience, while pain undoubtedly is. Healthy individuals are likely to have experienced "healthy breathlessness" due to physical exercise, but have no experiential way of understanding the combination of troubled breathing, fear and powerlessness that characterises the daily life of dyspnoeic patients.

As the coronavirus disease 2019 (COVID-19) pandemic continues to surge, barrier measures remain the primary means of limiting viral circulation until mass immunisation is achieved [6]. Face masks are recommended [7] and have been increasingly adopted [8]. They have practical drawbacks [9, 10], which can be an obstacle to their correct use [11]. Face masks slightly increase airway resistance and carbon dioxide concentration in the breathing zone [12, 13]; this can suffice to make breathing conscious, and possibly unpleasant if the sensory experience is associated with negative emotions. This defines dyspnoea [1]. Although dyspnoea is often mentioned conversationally as a mask-related inconveniency, its frequency, intensity, characteristics and risk factors have not been systematically studied. Their description could help improve the use and acceptance of face masks, the protective importance of which cannot be discussed. We hypothesised that mask-related dyspnoea would be a frequent occurrence and would depend on activity levels and individual-related factors. Likewise, we hypothesised that the frequency and intensity of mask-related dyspnoea would be higher in patients being treated for chronic respiratory diseases.

Furthermore, face mask-related dyspnoea is likely to be the first encounter with dyspnoea for most people. It therefore has the potential to change the general public's perception of what it means to experience breathing difficulties [14]; that is, to improve dyspnoea visibility. Within this frame, we predicted that face-mask-related dyspnoea would be described as very intense by healthy individuals, despite the masks not representing a critical physical constraint. In addition, we predicted that patients with a chronic respiratory disease as well as healthy individuals with a family member treated for a chronic respiratory disease would experience more frequent and intense mask-related dyspnoea. Finally, we predicted that healthy individuals reporting mask-related dyspnoea would also report increased concern about their respiratory health and would report a better understanding of the experience lived by patients with chronic respiratory disease [14]. Using a methodology that has previously helped understand some aspects of the epidemiology and characteristics of dyspnoea in the general population [15–17], we tested the above hypotheses by conducting a cross-sectional survey in a sample demographically representative of the French adult population.

Methods

Survey conduct and respondents

The survey was conducted in France by the French Institute of Public Opinion (Institut Français d'Opinion Publique (IFOP)) between 3 and 6 November 2020 using the quota sampling method to ensure demographic representativeness. Respondents aged >18 years were recruited in successive waves from a web-based panel comprising 750 000 persons, in such a way as to constitute a 1000-person sample matching census data of the French population with respect to gender, age, socio-professional categories and place of residence after stratification by region and type of agglomeration. Respondents completed the questionnaire online (10–20 min). All questions had to be answered for participation to be registered.

Ethics

The study was conducted in accordance with the ethical guidelines of the European Society for Opinion and Marketing Research, of which IFOP is a signatory. It was approved by the local ethics committee (comité d'éthique de la recherche Sorbonne Université; #2020–092). Participants read and approved an information notice before completing the questionnaire.

Questionnaire development

A multidisciplinary group of investigators (from respiratory medicine, intensive care, palliative care, psychology, nursing and sociology) developed a first questionnaire. A focus group of eight laypersons, males and females aged 25–88 years, gave feedback on this version, allowing adjustments in the choice of questions and their wording. Two survey experts from IFOP monitored the process, provided input throughout and approved the final version that was adapted to meet IFOP technical requirements.

Questionnaire content

The questionnaire ("English translation of the survey questionnaire" in the supplementary material) explored five domains, as follows.

- Domain 1: demographic characteristics.
- Domain 2: respiratory health (respondent or close family members treated or not for respiratory disease or congestive heart failure; tobacco consumption; practice of a breathing-oriented activity).
- Domain 3: attitudes towards wearing a face mask and perceived inconveniencies.
- Domain 4: mask-related dyspnoea ("Does wearing a face mask cause you any breathing difficulties…")
  - at rest or during very light activities (*e.g.* walking at one's own pace on the flat);
  - during moderate effort (fast walking or walking uphill, climbing stairs, carrying a load, talking when walking) or under emotional stress;
  - during intense effort (sport).

  Respondents who reported mask-related dyspnoea were asked to:
  - rate it on a numerical rating scale (NRS) from 1, "negligible breathing difficulties", to 10 "worst breathing difficulties that you can imagine";
  - choose sensory descriptors among "air hunger/lack of air/smothering", "excessive effort to breathe", "chest tightness", "breathing heavily" and "need to concentrate on breathing", and indicate the one that best applied [18];
  - choose emotional descriptors among "anger/irritation", "frustration", "anxiety", "sadness/depression" and "fear", and indicate the one that best applied.
- Domain 5: impact of wearing a face mask on the perception of one's own respiratory health and the respiratory health of others.

Respondents were also asked to provide three words or expressions associated with the inconveniencies of wearing a protective face mask.

Statistical analyses

Analyses were performed on unweighted data using R v4.0.3. Qualitative data were expressed as numbers and percentages and compared using Fisher's exact test. Quantitative variables were expressed as the median and interquartile range (IQR). Because some of the variables' distributions did not respect the assumptions required to use parametric tests, the comparison between respondents reporting and not reporting being treated for chronic respiratory disease and the comparison of respondents reporting and not reporting having a relative treated for chronic respiratory disease were all performed using the Mann–Whitney U-test, for the sake of consistency. p-values were corrected for multiple comparisons using the Benjamini–Hochberg procedure, with a false discovery rate of 5% [19]. A p-value <0.05 (two-sided) was set as the level of significance. In respondents not reporting being treated for respiratory diseases ("respiratory healthy" group), multivariate logistic regressions were performed to test for risk factors of mask-related dyspnoea (at rest, during exertion, or in either circumstance), intensity of mask-related dyspnoea and change in attitudes regarding diseases. Odds ratios and their 95% confidence intervals were computed. All covariates with a corrected p-value <0.2 were candidates for inclusion in the multivariate models. In addition, we included sex, age, smoking status, having a family member treated for a respiratory disease and the practice of breathing-oriented activities in the models regardless of the univariate p-value, as these variables were considered relevant. All covariates included in the logistic regressions respected the assumptions required for use of parametric procedures. Backward stepwise procedures based on the likelihood-ratio test determined the variables included in the final models. All variables adjusted on the other covariates with a p-value <0.05 were kept in the final model. To corroborate the relevance of the variables selected to conduct the stepwise analysis, we performed a penalised regression of the "Lasso" type (least absolute shrinkage and selection operator) [20]. This approach can estimate the coefficients and select the covariates of the model at the same time (but it has not yet been associated with a consensual approach to provide reliable confidence intervals and p-values for the corresponding coefficients). The fitting is based on a term of penalisation (λ) that eliminates non-informative coefficients by shrinking them to zero [20]. We first fitted the Lasso regression model on 80% of the observations. On this sample, λ was determined by 10-fold cross-validation to minimise the mean squared error. Model accuracy of the Lasso regression, or the probability to predict accurately the observed outcome, was then computed on the remaining 20% observations.

Textual analyses

The words or expressions chosen by each participant in answer to "when you think about difficulties caused by wearing a face mask, which three words come to mind?" were first lemmatised and then merged as individual verbatim to perform a correspondence factorial analysis on the matrix crossing individuals and lemmas as active categories. Then, based on the factorial coordinates produced by this initial step, a descending hierarchical classification was performed. Finally, the resulting classes were tested for statistical

association with reporting or not face mask-related dyspnoea at rest (Chi-squared test) [21, 22]. The textual analysis was conducted using the IRaMuTeQ 0.7 alpha 2 R-based software with a French dictionary (Paul Sabatier, Laboratoire d'Études et de Recherches Appliquées en Sciences Sociales, Université de Toulouse 3, Toulouse, France).

Results

Population

1012 respondents were included (517 (51.1%) female). Of these, 152 (15%) answered "yes" to "are you treated for a chronic respiratory or for congestive heart failure?" ("respiratory disease" population) and 860 (85%) answered "no" ("respiratory healthy" population) (table 1, figure 1). Respiratory disease respondents were more often men (60.5% *versus* 46.9%; p=0.012), were older (57.5 *versus* 49.0; p<0.001), more often ex-smokers (44.7% *versus* 26.2%; p=0.006) and more often retired (53.9% *versus* 36.9%) (table 1). Respiratory healthy respondents more often reported breathing-oriented activities (table 1; list of activities in supplementary table S1). 120 (14%) respiratory healthy respondents reported having a close family member treated for a chronic respiratory disease or congestive heart failure (RH-family^{+} category). There was no significant difference between RH-family^{+} and RH-family^{-}, except for breathing-oriented activities (p=0.006) (supplementary table S2).

TABLE 1 Description of the global study population and of the "respiratory healthy" and "respiratory disease" subgroups

	Whole population	Respiratory healthy group[#]	Respiratory disease group[¶]	p-value[+]
Participants	1012	860 (85)	152 (15)	
Female	517 (51.1)	457 (53.1)	60 (39.5)	**0.012**
Age years	50.00 (34.00–65.00)	49.00 (33.00–62.00)	57.50 (44.00–71.00)	**<0.001**
Socio-professional status				**0.014**
Farm workers	7 (0.7)	5 (0.6)	2 (1.3)	
Artisans or shopkeepers	33 (3.3)	31 (3.6)	2 (1.3)	
Senior management	108 (10.7)	95 (11.0)	13 (8.6)	
Middle management	158 (15.6)	141 (16.4)	17 (11.2)	
Employees	173 (17.1)	157 (18.3)	16 (10.5)	
Labourers	134 (13.2)	114 (13.3)	20 (13.2)	
Retired or not in work	399 (39.4)	317 (36.9)	82 (53.9)	
Education				0.877
Living area[§]				0.187
Tobacco consumption				**0.006**
Active	199 (19.7)	170 (19.8)	29 (19.1)	
Past	293 (29.0)	225 (26.2)	68 (44.7)	
Never	520 (51.4)	465 (54.1)	55 (36.2)	
Treated for chronic respiratory disease or congestive heart failure				
Asthma	58 (5.7)		58 (38.2)	
COPD	24 (2.4)		24 (15.8)	
Heart failure	36 (3.6)		36 (23.7)	
Other	57 (5.6)		57 (37.5)	
Close family member treated for chronic respiratory disease or congestive heart failure				0.330
Overall	135 (13.3)	120 (14.0)	15 (9.9)	
Asthma	62 (45.9)	54 (45.0)	8 (53.3)	
COPD	15 (11.1)	14 (11.7)	1 (6.7)	
Heart failure	35 (25.9)	30 (25.0)	5 (33.3)	
Other	40 (29.6)	4 (26.7)	36 (30.0)	
Breathing-oriented activity[f]				**0.002**
Often or from time to time	316 (31.2)	247 (28.7)	69 (45.4)	
Rarely or never	696 (68.8)	613 (71.3)	83 (54.6)	

Data are presented as n, n (%) or median (interquartile range), unless otherwise stated. Bold type represents statistical significance. [#]: answered "no" to "treated for chronic respiratory disease or congestive heart failure"; [¶]: answered "yes" to "treated for chronic respiratory disease or congestive heart failure": asthma n=38 (5.7% of the overall population), COPD n=25 (3.75% of the overall population), heart failure n=16 (2.4% of the overall population), n=1 mentioned cystic fibrosis (0.15%); [+]: corrected for multiple comparisons (n=69); [§]: three categories: urban, Paris area; urban, outside Paris area; rural; [f]: details are given in supplementary table S1.

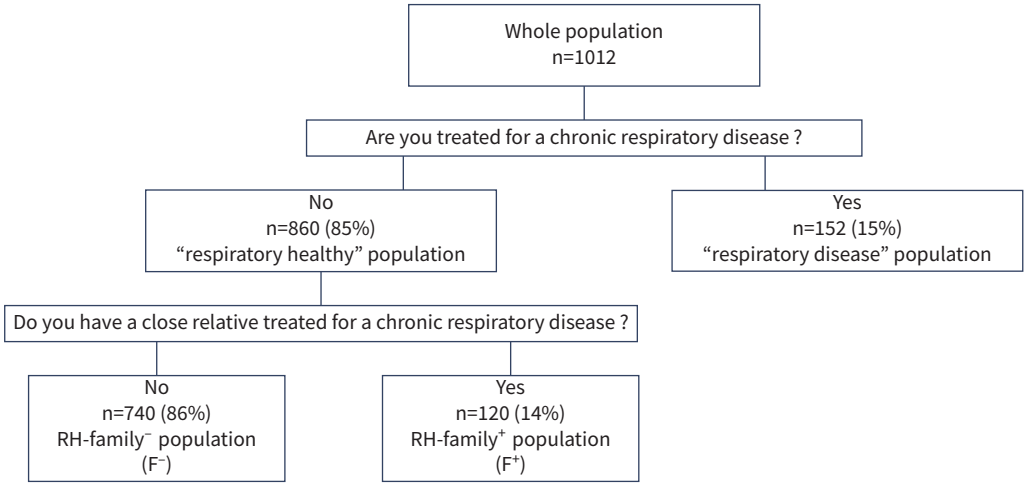

FIGURE 1 Distribution of the study subpopulations.

Attitudes and beliefs toward face masks

Face masks were reportedly used systematically or most often by 94.7% of respondents, similarly in the respiratory healthy and respiratory disease populations (supplementary table S3). The perceived benefit–inconvenience balance was largely favourable (87.2% either completely or somewhat agreed), without differences between the respiratory healthy and respiratory disease groups. Respiratory healthy respondents more often reported a favourable benefit–inconvenience balance for themselves (p=0.003) and others (p=0.003). There was no significant difference between RH-family^{+} and RH-family^{-}.

General inconveniencies

Among general inconveniencies (supplementary table S4), "breathing difficulties" and "glasses steaming up" were most commonly ranked first (25.6% for both). Three classes were identified by textual analysis (figure 2). Class 1 (61.6%) had a dominant "respiratory" connotation, class 2 (21.8%) a "bothering" connotation and class 3 (16.6%) a "positive" connotation. Classes 1 and 2 were significantly associated with reporting face mask-related dyspnoea at rest. Class 3 was significantly associated with reporting the absence of face mask-related dyspnoea at rest.

Dyspnoea

Face mask-related dyspnoea was frequently reported, and more so by the respiratory disease population than by the respiratory healthy population (79.3% *versus* 67.3%; p=0.013) and for each activity level (rest: 58.0% *versus* 37.8%, moderate: 75.3% *versus* 59.9%, intense: 72.3% *versus* 56.4%; p<0.05) (figure 3). Furthermore, in the respiratory healthy population, face mask-related dyspnoea was more frequently reported by RH-family^{+} respondents than by RH-family^{-} respondents during moderate effort (71.7% *versus* 58.0%; p=0.018) (figure 3). There was no difference in face mask-related dyspnoea between RH-family^{+} and respiratory disease (figure 3).

All circumstances considered, 75.4% of the respondents reported removing the mask to breathe more easily at some point (respiratory healthy 73.9%, respiratory disease 83.3%; p=0.012) (supplementary table S3).

Median dyspnoea ratings were generally high with wide dispersion (table 2 and supplementary figure S1). Strikingly, respiratory healthy respondents rated dyspnoea at a median 7.00 (IQR 2.00–10.00). Respiratory disease respondents provided significantly higher ratings, but the differences were of limited magnitude. There was no difference between RH-family^{+} and RH-family^{-}.

Respondents reporting dyspnoea favoured "air hunger" among sensory descriptors (72.5%; best descriptor in 59.3% of cases) (supplementary figure S2). Among emotional descriptors, "anger/irritation" was the most frequently reported (46.5%; best descriptor 37.4%), followed by "frustration" (36.9%; best descriptor 26.7%) and "anxiety" (34.0%; best descriptor 26.0%) (supplementary figure S2). RH-family^{+} respondents chose "fear" more often than RH-family^{-} respondents (16.8 *versus* 7.6%; p=0.012) (supplementary figure S2).

FIGURE 2 Textual analysis of the respondents' answers to the question "when you think about difficulties caused by wearing a face mask, which three words come to mind?". Following lemmatisation of the verbatim responses, correspondence factorial analysis and descendent hierarchical classification identified three semantic classes. Class 1 had a dominant "respiratory" connotation, class 2 had a dominant "bothering" connotation and class 3 had a "positive" connotation (words with a respiratory connotation appear in bold). Class 1 and class 2 were significantly associated with reporting face mask-related dyspnoea at rest (Chi-squared test), whereas class 3 was significantly associated with not reporting face mask-related dyspnoea at rest (Chi-squared test).

In multivariate analysis, mask-related dyspnoea at rest or during moderate effort was independently associated with having a close relative treated for chronic respiratory disease (OR 1.85, 95% CI 1.16–2.98) and with removing face masks to improve breathing (OR 5.21, 95% CI 3.73–7.28) (figure 4). It was negatively associated with considering face masks an effective protection for others (OR 0.42, 95% CI

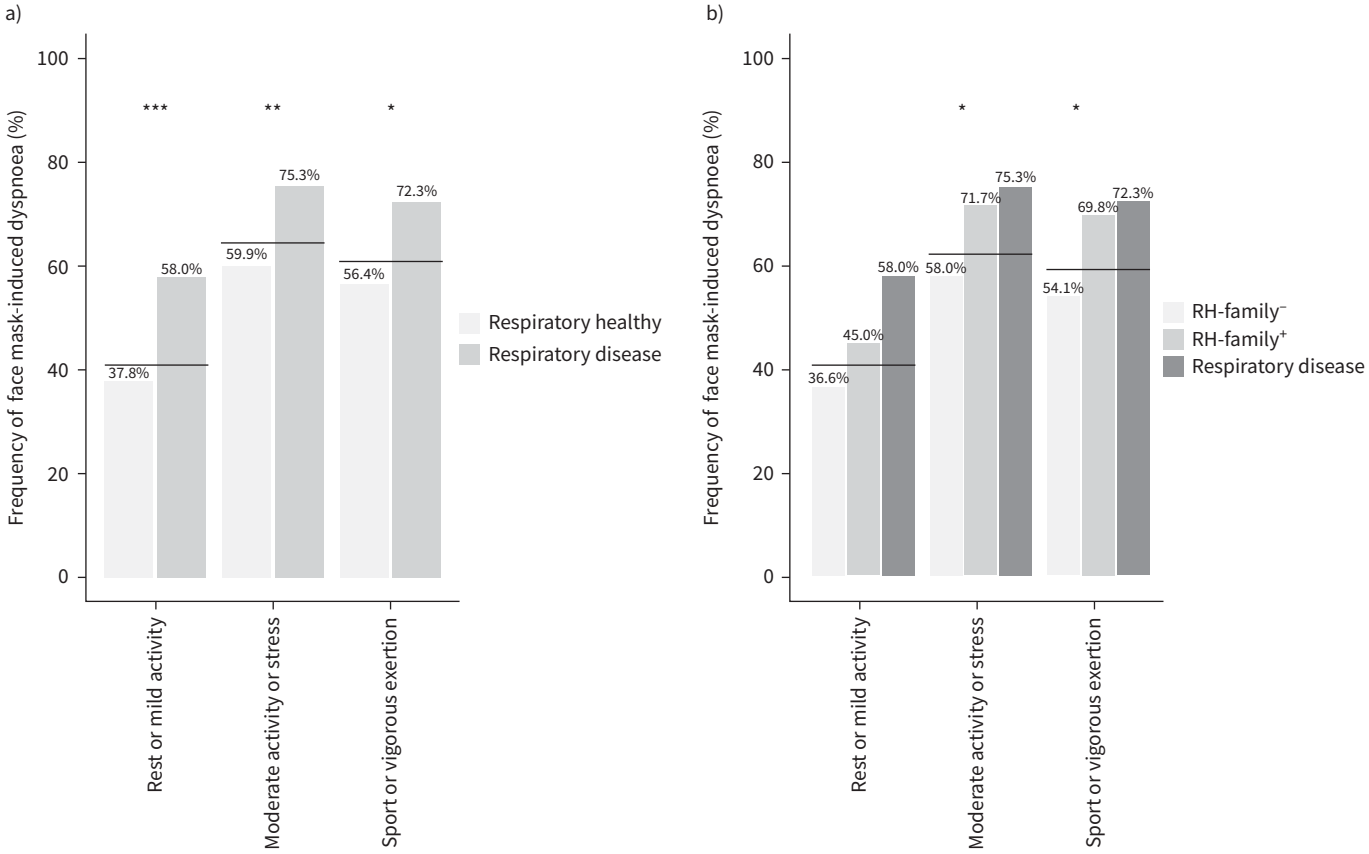

FIGURE 3 Frequency of mask-related dyspnoea. a) Comparison of respiratory healthy and respiratory disease populations (answer no or yes, respectively, to "treated for chronic respiratory disease or congestive heart failure" question). b) Comparison of respiratory healthy (RH)-family^{+} and RH-family^{-} populations (answer no or yes, respectively, to "close relatives treated for chronic respiratory disease or congestive heart failure" question). Note that during intense effort, 55.5% of the respondents reported never wearing a mask; among the 44.5% who wore a mask during intense effort, 59.0% reported mask-related dyspnoea. Horizontal bars represent the mean value in the whole study sample. *: p<0.05; **: p<0.01; ***: p<0.001.

0.25–0.75) (figure 4). The only variable associated with the intensity of mask-related dyspnoea at rest was "air hunger" (OR 2.82, 95% CI 1.74–4.53) (figure 4). For mask-related dyspnoea intensity during moderate effort, independently associated variables were age <65 years (OR 1.62, 95% CI 1.02–2.56), active smoking (OR 1.66, 95% CI 1.01–2.75), removing the mask to breathe more easily (OR 2.62, 95%

TABLE 2 Dyspnoea ratings according to circumstances and respondent categories (for a better apprehension of the differences, the corresponding distributions are provided in supplementary figure S1)

	Whole population	Respiratory healthy group[#]	Respiratory disease group[¶]	p-value[+]	Respiratory healthy group	RH-family^{-} [§]	RH-family^{+} [ƒ]	p-value[+]
Subjects	1012	860 (85)	152 (15)		846[¶¶]	726 (86)	120 (14)	
Dyspnoea rating at rest	7.00 (2.00–10.00)	7.00 (2.00–10.00)	8.00 (2.00–10.00)	**0.035**	7.00 (2.00–10.00)	7.00 (2.00–10.00)	7.50 (3.00–10.00)	0.285
Dyspnoea rating during moderate exertion	7.00 (1.00–10.00)	7.00 (1.00–10.00)	8.00 (2.00–10.00)	**0.020**	7.00 (1.00–10.00)	7.00 (1.00–10.00)	7.50 (3.00–10.00)	0.111
Dyspnoea rating during sport[##]	8.00 (1.00–10.00)	8.00 (1.00–10.00)	8.00 (5.00–10.00)	0.481	8.00 (1.00–10.00)	8.00 (1.00–10.00)	9.00 (3.00–10.00)	0.054

Data are presented as n, n (%) or median (range), unless otherwise stated. Bold type represents statistical significance. [#]: answered "no" to "treated for chronic respiratory disease or congestive heart failure"; [¶]: answered "yes" to "treated for chronic respiratory disease or congestive heart failure"; [+]: corrected for multiple comparisons (n=69); [§]: answered "no" to "close family members treated for chronic respiratory disease or congestive heart failure"; [ƒ]: answered "yes" to "close family members treated for chronic respiratory disease or congestive heart failure"; [##]: n=553 declared never wearing a face mask during this type of activity; [¶¶]: n=14 declared never wearing a mask.

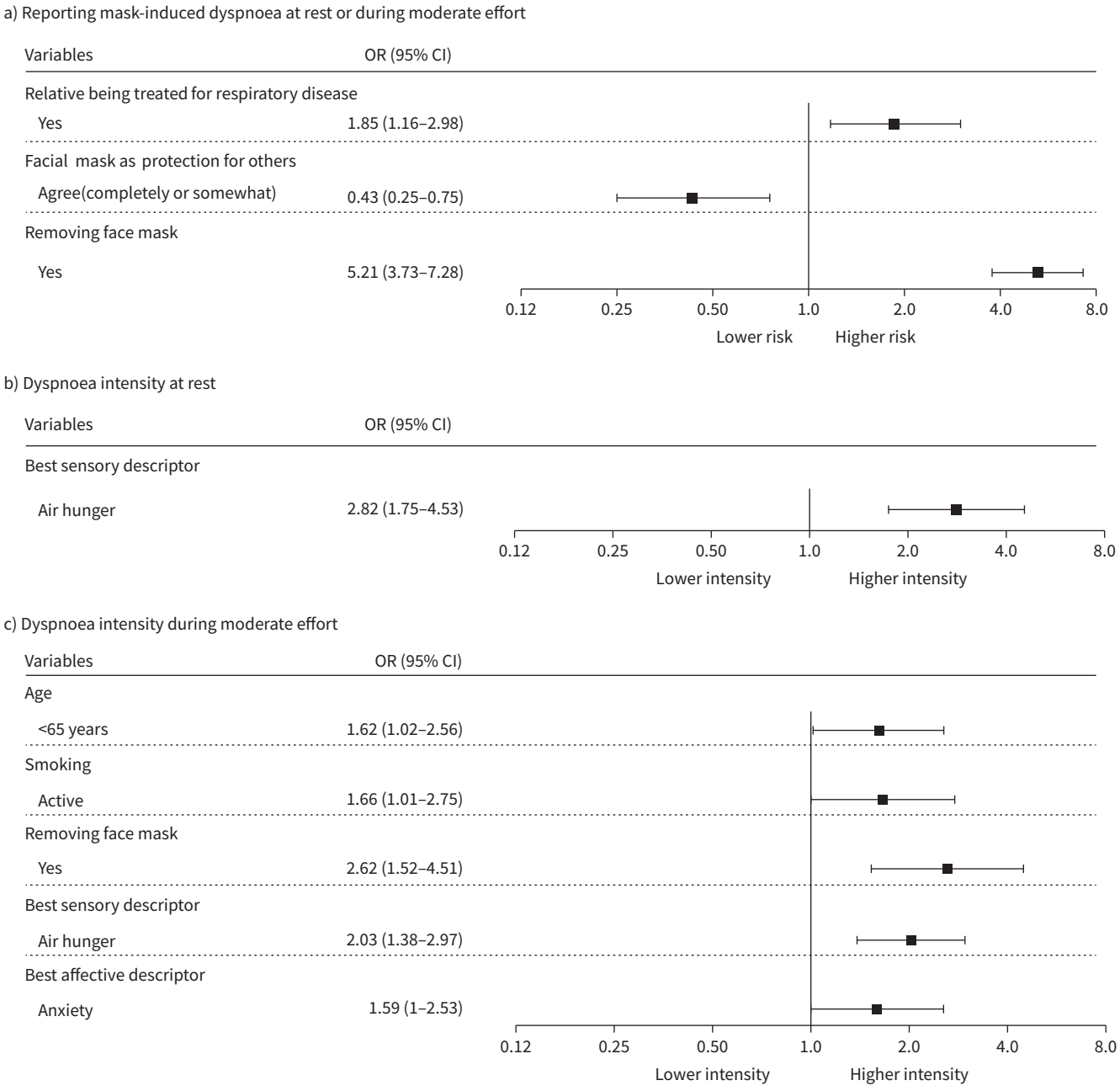

FIGURE 4 Variables independently associated with reporting a) mask-related dyspnoea at rest or during moderate effort, and dyspnoea intensity b) at rest or c) during moderate effort, according to multivariate analysis. a) Relative being treated for respiratory disease p=0.008, facial mask as protection for others p=0.002, removing face mask p<0.001; b) best sensory descriptor p<0.001; c) age p=0.041, smoking p=0.041, removing face mask p<0.001, best sensory descriptor p<0.001, best affective descriptor p=0.044.

CI 1.52–4.51) and using air hunger (OR 2.03, 95% CI 1.38–2.97) and anxiety (OR 1.59, 95% CI 1–2.53) as descriptors (figure 4). The results of the Lasso regressions were consistent with the those provided by the stepwise regressions in terms of the variables and the coefficients (supplementary table S5).

Attitude changes

In the respiratory healthy population, 46.9% of respondents answered "more than before" to "have you become more aware of the importance of your breathing"; 51.2% to "the privilege of not having to worry about one's breathing"; and 30.4% to "fearing a respiratory illness". These changes were significantly associated with being female, reporting dyspnoea at rest and considering face masks effectively protective

(supplementary figure S3 and supplementary table S5). 41% of respiratory healthy respondents answered "more than before" to "have you become more aware of what people with respiratory illnesses may experience" (see associated variables in supplementary figure S3 and supplementary table S5).

Discussion

Main findings

As hypothesised, this study shows that wearing a face mask as a barrier measure is frequently associated with dyspnoea, and that this depends on activity level and health status (respiratory disease respondents experienced dyspnoea more often). The term "dyspnoea" is appropriate: dyspnoea is defined as "breathing discomfort" [1], or the conscious perception of an abnormal breathing activity associated with a negative emotional charge, which is precisely what the survey respondents reported. Indeed, they predominantly chose "air hunger" to characterise mask-related breathing difficulties. This is the main descriptor used by dyspnoeic patients [23–25] and the most strongly associated with anxiety or fear [2, 26, 27]. However, contrary to patients, the respondents did not rank anxiety first, but favoured "anger" and "frustration". This may relate to the knowledge that mask-related dyspnoea is transitory, is not a marker of disease and is possible to control through mask removal. Dyspnoeic patients lack such control.

The respondents ranked breathing difficulties first among mask-related inconveniencies (on a par with "glasses steaming up", the importance of which probably reflects the general public's concern for vision health [28]) and the "respiratory connotation" semantic cluster was the most prevalent. Nevertheless, mask-related dyspnoea did not negatively impact reported compliance with mask-wearing recommendations, which was extremely high, noting that at the time of the study masks were legally prescribed in public places in the country. The proportion of respondents reporting removing their mask to breathe more easily (75.4%) was less than the proportion reporting wearing a mask (94.7%). Positive mask-wearing drivers (compliance with rules, belief in protective value) were thus more potent than negative ones. Notably, believing that face masks effectively protect others from contamination was negatively associated with reporting mask-related dyspnoea. This observation suggests that positive messages about the efficacy of face masks should effectively overcome putative dyspnoea-driven reluctance.

Strength and weaknesses

The study followed state-of-the-art polling methodology, under the auspices of an internationally renowned specialised organisation (IFOP). The quota sampling method ensured demographic representativeness [29], which was further confirmed by the 15% proportion of respondents reporting being treated for a chronic respiratory disease or cardiac insufficiency (and the repartition of the corresponding diseases (table 1)). Indeed, this figure does correspond to French epidemiological data ("Comparison of the frequency of chronic respiratory diseases reported by respondents to the survey with French epidemiological data" in the supplementary material). In the same vein, the 95% proportion of our respondents reporting wearing a face mask "always" or "often" when mandatory may seem high, but it is only slightly higher than the nationwide proportion recorded at the same time by the French national institute for public health (COVIPREV programme, www.santepubliquefrance.fr/). This suggests behavioural representativeness as well as demographic representativeness. Of note, given recently voiced concerns about stepwise regressions [30], we corroborated this approach by using a Lasso penalised regression. The coherence of the corresponding two sets of coefficients lends credibility to the results. Nevertheless, we acknowledge that the study has limitations. Some are inherent to its unsupervised and self-declarative nature. For example, we did not seek any form of corroboration of the diagnostic of chronic respiratory diseases. We did not determine the proportion of respondents who had suffered from COVID-19 (this should have been ∼10%, including asymptomatic forms, at the time of the survey [31]), and we did not ask any questions about mental health, in general or in relation to mask wearing. Furthermore, the study does not describe the impact of masks on activity, particularly in the respiratory disease population, and no information was gathered to evaluate mask misuse (*e.g.* not covering the nose).

Meaning

This study provides insights into dyspnoea invisibility. Firstly, as hypothesised, dyspnoea was described as very intense by healthy individuals. Ratings reported by respiratory healthy respondents for dyspnoea at rest (median 7) are higher than those considered intolerable by hospitalised dyspnoeic patients (ratings of ⩾4 are unacceptable for 54% of hospitalised dyspnoeic patients) [25]. Yet several studies showed that masks do not impair laboratory-evaluated cardiorespiratory performance [12, 32]. We believe that the very high dyspnoea ratings provided by "respiratory healthy" people illustrate an incapacity to imagine what "the worst possible breathing difficulties" could be, namely what disease-related dyspnoea truly represents for afflicted patients. We also believe that this incapacity relates to the lack of previous dyspnoeic

experiential baggage. The contrast between physiological data (insignificant impact of face masks on exercise [32–34]) and psychophysiological data (intense mask-related dyspnoea in this study) exemplifies the rift between "measurement" and "experience" that contributes to dyspnoea invisibility [35]. Secondly, as hypothesised, our data indicate that having a close relative treated for a chronic respiratory disease can influence one's relationship to breathing. Likewise, the RH-family^{+} group was better aligned with the respiratory disease group than with the RH-family^{-} group regarding dyspnoea frequency. RH-family^{+} respondents more frequently chose "fear" to describe mask-related dyspnoea than RH-family^{-} respondents (16.8 *versus* 7.6%; p=0.012). In addition, belonging to the RH-family^{+} group was independently associated with reporting dyspnoea at rest and during moderate effort. These findings are consistent with experimental data indicating that seeing someone experience dyspnoea induces dyspnoea and malaise [36, 37], and with clinical data indicating that seeing a relative die with respiratory difficulties is associated with delayed and difficult grieving [38]. By symmetry, this illustrates the rarity of direct or indirect exposure to dyspnoea in the general population. Thirdly, in line with our predictions [14], a large number of respondents answered that wearing a mask had made them aware of the good fortune of not ordinarily being continually preoccupied by their own breathing and had changed both their degree of preoccupation with their own breathing and their perception of the experience of patients with chronic respiratory disease. We acknowledge that we cannot exclude that fear of the disease also had a role in the reported attitude changes, keeping in mind that our questions were carefully phrased to relate putative attitude changes to the wearing of face masks.

Conclusions and perspectives

From an immediately practical point of view, the frequency and the characteristics of face mask-related dyspnoea call for specific communication actions that should primarily target patients suffering from cardiorespiratory illnesses. For these patients, it should be made clear that face masks can worsen dyspnoea, but that this phenomenon is not threatening and can be controlled: it therefore should not cause people to deprive themselves of an effective protection. Of note, patients suffering from cardiorespiratory illnesses could also be the primary focus of studies evaluating masks designed to make breathing easier. The same message (possibility of breathing discomfort but not threatening and controllable and not worth risking catching or disseminating the virus) should be addressed to the general population.

The survey shows that mask removal is commonly used to relieve dyspnoea. To reduce misuse (*e.g.* not covering the nose), brief temporary mask removal should be promoted as a guilt-free action, provided recommendations similar to those regarding coughing and sneezing (for example, something like "in the event of breathlessness, find an isolated location in a well-ventilated environment or outside and remove the mask briefly").

Most importantly, 95% of the respondents reported wearing masks, and 70% reported mask-related dyspnoea. This equates to ∼35 million French adults discovering what it means to be bothered by one's breathing because of a constraint. This represents a mass experiential discovery of dyspnoea with the positive consequence of making dyspnoea more visible to those free of respiratory diseases. We believe that this provides the respiratory health community with leverage to sensitise the public to respiratory health better and that face mask-related dyspnoea could and should be used positively as a "respiratory communication" tool.

Acknowledgements: The authors are indebted to Andrew Lane (Lane Medical Writing, Lyon, France), for his help with the manuscript. They thank Elizabeth Hewes (Lyon, France) for producing the English translation of the questionnaire (supplementary material). Both were funded by Sorbonne Université, Paris, France. The authors also thank the French "Fondation du Souffle" for its interest in and support for the study.

Data from the survey and the corresponding dictionary will be made available to researchers presenting a research project reasonably in phase with the content of the study.

Conflict of interest: L. Serresse has nothing to disclose. N. Simon-Tillaux has nothing to disclose. M. Decavèle has nothing to disclose. F. Gay has nothing to disclose. N. Nion has nothing to disclose. S. Lavault has nothing to disclose. A. Guerder has nothing to disclose. A. Châtelet is an employee of the IFOP polling institute. F. Dabi is an employee of the IFOP polling institute. A. Demoule reports grants, personal fees and non-financial support from Philips, Respinor and Lungpacer, personal fees from Baxter, Getinge, Lowenstein and Gilead, personal fees and non-financial support from Fisher & Paykel, grants from French Ministry of Health, outside the submitted work. C. Morélot-Panzini reports personal fees for lectures and board membership from AstraZeneca, GSK, SOS Oxygène, ADEP, ISIS, Resmed, Chiesi, Menarini, Vivisol, Air Liquide, Lowenstein, Fisher & Paykel, outside the submitted work.

C. Moricot has nothing to disclose. T. Similowski reports personal fees from AstraZeneca France, Boehringer Ingelheim France, TEVA France, Chiesi France, Lungpacer Inc. and ADEP Assistance, personal fees and non-financial support from Novartis France, grants from Air Liquide Medical Systems, outside the submitted work.

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