Social Inequalities and Dynamics of the COVID-19 Epidemic. Evidence from France

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Abstract

Background
Our main objective was to study the early social dynamics of the COVID-19 epidemic in France, taking into account gender, class, and ethnicity inequalities in living conditions.
Methods
A random population-based survey was conducted in France in May 2020, during and post COVID-19 lockdown, in which 77,588 participants aged 18-64 were included in this study.
We used multinomial regressions to identify changes in social position and exposure factors associated with symptoms of anosmia/ageusia during the first epidemic peak in late March and thereafter.
Findings
In all, 2,045 (1.53% (95%CI 1.46%-1.61%)) participants reported anosmia/ageusia (1.13% during the epidemic peak and 0.40% after), with strong variations according to regions. Women and ethno-racial minorities remained at higher risk of anosmia/ageusia during and after the peak. Whereas senior executive professionals were more affected than lower social classes at the peak of the epidemic, this effect disappeared afterwards. Adjusting on key exposure factors substantially attenuated these associations, except for gender differences. While high density of the place of residence was associated with anosmia/ageusia during the peak, but no longer after, the opposite trend was observed for living in overcrowded housing. Having worked outside the home during lockdown was the most strongly associated exposure factor, and even more so after the peak.
Interpretation
The shift in the social profile of the epidemic was related to a shift in exposure factors under the implementation of stringent collective prevention measures. Our results notably stress the importance of working outside the home, all the more so in essential occupations.

Introduction

The COVID-19 pandemic that has been hitting the world since the beginning of the year 2020 has reinforced and strengthened social inequalities in health as many authors have pointed out[1-3].

These social inequalities have mainly been studied in the context of mortality in several countries of the world[4,5], and few studies are based on the incidence of COVID-19[6]. Most of these analyses are from the US and the UK and are ecological studies, few of which consider socioeconomic inequalities at the individual level[4]. To our knowledge, the literature on social inequalities in the time of COVID-19 does not address the dynamics of these inequalities as the epidemic evolves, with the exception of Wright's study[7] and Jefferies and colleagues' study[8] which explored the changing patterns of adversity relating to the COVID-19 pandemic among adults in the UK and in New-Zeland by socioeconomic position during the early weeks of the epidemic.

Yet, few studies showed that the prevention policies put in place, in particular the mobility restrictions and the strong incentive to work remotely, were more beneficial to the most privileged classes[9,10], which suggests that the social factors of exposure to risk have changed over time, as has been previously found for other influenza pandemics[11] . At a time when the epidemic is picking up again, it is important to study its social dynamics in order to better inform policies and target prevention strategies that avoid furthering social inequalities.

Our objective was to study the early social dynamics of the epidemic in France. We compared the occurrence of reported anosmia and/or ageusia by social groups and the associated risk factors between the peak of the epidemic, around March 19th, until the beginning of June, when the incidence decreased following the first total lockdown[12]. We focused on population density, overcrowded housing and working outside the home as the main risk factors for

COVID-19[13]. We adopted an intersectional approach[14] that simultaneously takes into account social class, gender, and ethno-racial status[15].

Participants and methods

Study design and participants

The EpiCoV (Epidémiologie et Conditions de Vie) cohort was set-up in April 2020, with the general aim of understanding the main epidemiological, social and behavioural issues related to the COVID-19 epidemic in France.

A random sample of 350,000 people aged 15 and over was drawn from the tax database of the National Institute of Statistics and Economic Studies (INSEE), which covers 96% of the population living in France but excludes people living in institutional settings. People belonging to the lowest decile of income were over-represented. All those selected were sent a letter to participate in the survey. A total of 134,391 (38.4%) participated in the survey. Individuals were invited to answer the questionnaire online, or by phone for those who did not have Internet access. Furthermore, a random sample of 10% of people with Internet access was interviewed by phone in order to take into account a method collection effect.

We used reweighting and marginal calibrations in the survey and sampling design to correct for non-participation bias among those invited. Weights were calculated using socio-demographics characteristics as covariates to estimate participation probability: sex, age group, employment status (active, inactive), and department, that were available in the original sampling frame. Furthermore, we applied a Heckman model to take into account the effect of the response mode (Internet or telephone) on the reporting of COVID-19-Like symptoms[16].

The data collection period ran from May 2nd to June 2nd, 2020. In France, strict lockdown expanded from March the 17th to May the 10th and the epidemic peak was recorded around March 19th [12].

Data collected included socio-demographic characteristics, household size and composition, a detailed description of comorbidities, COVID-19-Like symptoms (such as, cough, fever, dyspnea, ageusia and/or anosmia), health care use for COVID-19 and other symptoms, employment characteristics, smoking, individual prevention measures during outings (alcohol gel, mask, social distancing).

Participants were invited to report COVID-19-Like symptoms, if they were unusual and if they occurred or were present since/at the beginning of the lockdown. They also reported when the first symptom appeared.

We focused on people living in metropolitan France, aged 18-64 years, in order to take into account working arrangements and type of occupation in the analysis.

The survey was approved by the CNIL (French independent administrative authority responsible for data protection) on April 25th 2020 (ref: MLD/MFI/AR205138) and by the "Comité de protection des personnes" (French equivalent of the Research Ethics Committee) on April 24th. The survey also obtained an agreement from the "Comité du Label de la statistique publique", proving its adequacy to statistical quality standards.

Outcome

The main health outcome studied here was reporting symptoms of anosmia and/or ageusia, the most specific symptoms of SARS-CoV2 infection[17]. Among those who did not report anosmia/ageusia, the analysis was restricted to people without reported cough, fever or dyspnea in order to exclude possible COVID-19 cases (n=98,787). Individuals whose symptoms started before lockdown were also not considered in the analysis to avoid overrepresentation of long-lasting forms of COVID-19 (those individuals whose symptoms started *and* ended before lockdown could not be identified in the database) (n=1.53%).

A distinction was made between those people whose first symptoms began more than one month before their response to the survey, likely to have occurred during the epidemic peak, and those whose first symptoms began less than one month before, likely to have occurred during the epidemic decline phase. Our outcome was in three categories: no reported anosmia/ageusia (nor cough, fever or dyspnea), anosmia/ageusia starting during the epidemic peak, anosmia/ageusia starting after the epidemic peak.

Measures

Social variables

We considered the following six variables: age, sex, ethno-racial status (based on migration history), social class (based on current or most recent occupation and education), standard of living (based on decile of income per household consumption unit) and formal education (defined according to the hierarchical grid of diplomas in France). The ethno-racial status distinguished mainstream population, *i.e.* persons residing in metropolitan France who are neither immigrants nor native to French Overseas Departments (DOM, *i.e.* Martinique, Guadeloupe, Reunion Island), nor descendants of immigrant(s) or of DOM native. For the minority population, a distinction was made according to the first (immigrants) and second (descendants of immigrants) generations of immigration, and the country of origin. The term racialized refers to immigrants or descendants of immigrants from the Maghreb, Turkey, Asia and Africa[15].

Exposure risk factors

We considered three main risk factors of exposure to COVID-19: high density of the place of residence (*i.e.* at least 1,500 inhabitants per km^2 and a minimum of 50,000 inhabitants), overcrowded housing (*i.e*. at least two persons living in housing with less than 18 m^2 per person) and having worked outside the home during lockdown. Additional exposure variables considered self-reported essential occupations and number of persons living in the house.

To account for regional variations in incidence, we distinguished between the least affected and the three most affected regions at the time of the survey[12].

Health variables

Health variables included smoking habits, history of chronic diseases and body mass index.

Statistical analyses

We first described the social distribution of the main COVID-19 exposure risk factors. Then we reported the frequency of anosmia/ageusia according of these factors by age, sex, ethno-racial status and social class.

In order to analyse the social dynamics of the epidemic over time, we performed multinomial logistic regressions with the dependent variable in three groups (no symptoms; anosmia/ageusia starting during the epidemic peak; anosmia or ageusia starting after the epidemic peak).

Observations with missing values on main social and exposure variables and anosmia/ageusia were excluded from our analysis (7.5%). All analyses were performed with the SAS software 9.4. A P-value <0.05 was considered statistically significant. All analyses were weighted.

Results

In all, 77,588 individuals were included in our analyses. Among the study population, 38.6% lived in a highly dense zone, 13.2% reported living in overcrowded housing and 47.7% worked outside the home during lockdown, at least partly. These exposure risk factors were unevenly socially distributed (Table 1).

Women less often worked outside the home during lockdown than men (44.7% vs. 50.6%). Compared to the mainstream population, racialized minorities were more likely to report living in highly dense areas (up to 72.6%) and in overcrowded housing (up to 41.4%).

Among working class people, unskilled manual workers were more likely to live in overcrowded housing (17.5%) while skilled manual workers were more likely to have worked outside the home during the lockdown period (66.1% compared to 39.2% in senior executive professionals). The situation of the self-employed and entrepreneurs is worth noting since they more often worked outside the home during lockdown (68.1%). People from the poorest 10% of households were clearly exposed to living in high-density zones (46.9%), overcrowded housing (28.2%), and working outside the home (34.7%).

This differential exposure to major risk factors by social position was related to the occurrence of anosmia/ageusia as shown in Table 2.

Overall, 1.53% (95%CI 1.46%-1.61%) of our population reported anosmia/ageusia. This rate was higher in the regions most affected by the first wave of the epidemic: 2.85% (95%CI 2.61%-3.08%) in the Ile-de-France region and 2.15% (1.88%-2.41%) in the Grand Est region. With the exception of 18-24 years old, frequency decreased with age, from 1.92% in 25-34 years old to 1.07% in those over 55-64 years of age. Women were more likely to report anosmia/ageusia (1.84% compared to 1.21% in men). The mainstream population appeared to be less affected than the other ethno-racial groups (1.35% *versus* up to 2.67% for DOM and descendants of DOM native). The most affected socio-occupational groups were those at the top of the social hierarchy: senior and middle executive professionals (up to 1.89%), followed by skilled employees (1.83%), while the least affected were skilled manual workers (0.99%).

Those who only worked remotely during the lockdown reported more often anosmia/ageusia overall than the others (1.79% *versus* 1.62% for those who worked outside the home and 1.33% for those who did not work). In addition, those living in overcrowded housing reported more often anosmia/ageusia (2.12% *versus* 1.44%) and the difference was also marked regarding density area (2.04% for those living in high density areas *versus* 1.21% in low density areas).

Looking at symptoms in a dynamic way, that is, distinguishing onset *during* and *after* the first epidemic peak, we found a decrease in anosmia/ageusia occurrence in all groups but not of the same intensity (Table 2). Hence, senior executive professionals were the most affected during the epidemic peak (1.45%) and among the least affected after the peak (0.37%), *i.e.* a 74.7% decline compared to 64.2% for the whole population. The same dynamics was observed regarding standard of living (-80.8% for the richest 10%) and those people who worked remotely (-77.3%).

Adjusted Odds Ratios (OR) of anosmia/ageusia, taking into account social, exposure and health variables, are presented in Table 3. While being aged 25-54 was associated with a higher risk of anosmia/ageusia during the peak (up to OR: 1.43, 95%CI (1.14-1.80) for the 25-34 as compared to the 18-24), another profile appeared after the peak where the age progression was linked to a lower risk (down to 0.54 (0.36-0.82) for the 55-65 as compared to the 18-24).

Gender effect remained marked during the epidemic peak (1.51 (1.34-1.70) for women) and after (1.42 (1.14-1.77)). Of note, this gender effect was attenuated after further adjustment for essential occupation (down to 1.27 (1.02-1.59), after the peak) (Supplementary table 1). Compared to the mainstream population, racialized second generation immigrants were at higher odds of anosmia/ageusia during and after the epidemic peak (respectively 1.48 (1.19-

1.83) and 1.42 (1.00-2.01)) while overseas natives and their descendants had increased odds only during the peak (1.50 (1.07-2.12)). The same pattern was observed for non-racialized first-generation immigrants who were more likely to report anosmia/ageusia, particularly after the epidemic peak (1.77 (1.04-3.04)). Unskilled employees and skilled manual workers were at lower odds of anosmia/ageusia than senior executives during the peak (respectively 0.81 (0.67-0.99) and 0.63 (0.47-0.83)), but no longer after the peak, while middle executive professionals were at higher odds of anosmia/ageusia after the peak (1.36 (1.00-1.85)). As expected, healthcare workers had an increased odds of anosmia/ageusia, even more so after the peak as compared to those with non-essential occupations (during: 1.32 (1.05-1.66), after: 3.46 (2.43-4.93)), while other essential workers were at significantly higher odds only after the peak (1.35 (1.04-1.74)) in fully adjusted models (Supplementary Table 1).

Regarding exposure risk factors, while having worked outside the home during lockdown was associated with increased odds of anosmia/ageusia both during (1.19 (1.02-1.40)) and even more so after the peak (1.64 (1.21-2.20)), living in a highly dense area was only related to the occurrence of anosmia/ageusia during the epidemic peak (1.21 (1.06-1.38)), and living in overcrowded housing only after the peak (1.41 (1.05-1.88)).

Discussion

To our knowledge, EpiCov is among the first socio-epidemiological surveys conducted among a very large random sample of a national population that simultaneously takes into account living conditions and health data and allows for an intersectional analysis of social inequalities by gender, class and ethno-racial status.

Our results are based on the first survey wave documenting exposures and symptoms during the first epidemic peak and in the decline phase that followed right after, through the first stay-at-home order. We show that important exposure factors likely to increase contact with the virus, *i.e.* the density of the place of residence, living in overcrowded housing, and having worked outside the home during lockdown[4,13] have not been evenly distributed across social groups, and also that some groups do cumulate these risk factors. Hence, racialized minorities, the least educated, and those with the lowest financial resources are particularly affected by living in densely populated communities and overcrowded housing. These data reflect the well-documented effects of socio-spatial segregation policies[18]. Furthermore, working class groups have been more likely to work outside the home during the epidemic than senior managers who were able to work remotely, to a large extent.

By distinguishing infections which probably occurred at the time of the epidemic peak (just before or in the very first days after the start of lockdown), from those which occurred later (during and early after the lockdown, as the epidemic declined), a change in the social profile of the epidemic emerged and some social characteristics were linked to the risk of reporting an anosmia/ageusia during and/or after the epidemic peak, which would have been masked by an analysis over the whole period.

The lower exposure of people over 55 years of age after the peak of the epidemic could reflect the fact that their social contacts decreased with the lockdown even more than for the rest of the population, probably because family encounters declined.

The persistent increased risk of anosmia/ageusia among women compared to men are likely to reflect occupational specificities, beyond the categories used here. Indeed, women are over-represented in the nursing and care assistant occupations as well as in cleaning activities (ref). In addition, they mainly take care of children and the elderly (ref), which may increase their social contacts. Furthermore, this greater exposure of women raises questions as they are shown to be less likely to die from COVID-19 than men[5]. This may reflect their lower rates of comorbidities than men[12].

With regard to ethno-racial status, the persistent higher risk of reporting anosmia/ageusia among second generation racialized people, as well as the higher likelihood of dying from COVID-19 in many countries[5,8], was not linked to a lower propensity to wear a mask[9]. It may instead be indicative of social contacts in neighbourhoods where the circulation of the virus was and remained higher over time, as suggested by our results, since their increased risk was substantially attenuated after adjusting for density of place of residence and overcrowded housing.

Whereas senior executive professionals were more affected than lower social classes at the peak of the epidemic, this effect disappeared afterwards. Only middle executive professionals were at higher risk during the epidemic decline, which was likely due to the presence of health professionals, particularly nurses, in this group, as this association totally disappeared when further adjusted for essential occupations. The increased risk among essential occupations was particularly sharp for health professionals, due to the continuous care provided to patients with a high viral load[12]. It is important to note that the other so-called essential occupations were overexposed after the peak of the epidemic, this group includes those in regular contact with the public such as cashiers, bus drivers, etc. Such results call for an in-depth analysis of occupational disparities in COVID-19 exposure based on the combination of type of job (e.g. healthcare, high-contact jobs, etc.), working arrangement (remote, on-site, layoff) which may have changed over time, as well as implementation of preventive measures at the worksite. Indeed, the higher risk of infection of people who worked outside the home during lockdown was particularly marked after the peak of the epidemic, *i.e.* during a period of epidemic decline when contact with the virus was proportionally more marked among on-site workers as compared to people who stayed at home.

It should also be noted that the density of the place of residence was no longer related to the reporting of anosmia/ageusia occurring after the peak of the epidemic probably because the virus circulates less in the neighbourhood, thanks to the lockdown. On the contrary, overcrowding was significantly associated after the peak only, probably due to the higher risk of COVID-19 transmission linked to unavoidable close proximity and/or large number of people in the household. Background rates and circulation patterns of SARS-CoV-2 should be considered while looking at the social and spatial dynamics of the epidemic[19], as they influence the relative importance of community and workplace transmission[20].

Data on tobacco and chronic diseases were included in our analyses as potential confounding factors. We found a protective effect of tobacco over the whole period[21] and an expected excess risk of infection in case of chronic renal disease[22], which reinforces the validity of our analyses.

Our analysis has nevertheless some limitations. First, as any national population-based survey, the study fails to capture highly vulnerable groups such as undocumented migrants and homeless people, who are particularly affected by the pandemic[23].

Additionally, our analyses are based on reported symptoms of anosmia/ageusia rather than on biologically confirmed cases, thus excluding infected people reporting other symptoms, and of course asymptomatic individuals who represent one out of six of the infected population according to a recent meta-analysis[24]. However, the shortage of tests at the national level did not permit the use of testing as the basis for case definition in this study conducted in the early stages of the epidemic, when the use of RT-PCR testing was limited to patients with severe symptoms.

Although anosmia/ageusia reporting may be socially differentiated, especially due to differences in recognition of symptoms, it is reasonable to assume that such a bias did not vary during the month of the survey. One might also think that women are more likely to report anosmia/ageusia since they have a heightened sense of smell compared to men, as shown by sociological studies[25]. Nevertheless, the ratio of women to men reporting such symptoms is only slightly larger than that recorded for seroprevalence in a sub-sample of the same cohort[26] and was also found in other European countries[27].

We could also have incorporated other symptoms of COVID-19 such as fever and breathing difficulties. However, we chose to focus on anosmia/ageusia, which is the most specific symptom of COVID-19[17], so that our analyses would be more robust[28]). Our anosmia/ageusia symptom-based analysis is also consistent with epidemiological surveillance data by region[29] and with data on increased risk of infection of individuals with chronic respiratory diseases[12].

Finally, while it was not possible to build clear-cut periods of "likely infection" based on the timing of symptoms reported by the participants, the broad distinction made between people for whom symptoms started during the epidemic peak *versus* after it, allowed us to compare an early stage of the epidemic with the phase of decline in the incidence corresponding to the first lockdown in France.

In all, the associations reported during the epidemic peak – lower exposures among low skill jobs than senior executives, over-exposure among all ethno-racial minorities compared to the majority population, with a strong influence of overcrowding and population density – are likely to reflect the social profile and associated risk factors that prevailed just before the implementation of stay-at-home measures and national lockdown. By contrast, those observed after the peak point to a shift in the social profile of the epidemic related to a shift in exposure factors under the implementation of stringent collective prevention measures. They notably stress the importance of working outside the home, all the more so in essential occupations, particularly, though not exclusively, for healthcare workers[30]. The persistent excess risk among women and some ethno-racial minorities call for further research.

Our results show the importance of closely monitoring social changes over time to implement prevention policies that do not contribute to increasing the already significant social inequalities in health.

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Research in context

Evidence before the study

The COVID-19 pandemic has reinforced and strengthened social inequalities in health as many authors have pointed out. To our knowledge, the literature on social inequalities in the time of COVID-19 does not address the dynamics of these inequalities as the epidemic evolves. At a time when the epidemic is picking up again, it is important to study its social dynamic in order to better inform policies and target prevention strategies that avoid furthering social inequalities.

Added value of the study

A random population-based socio-epidemiological survey of 135,000 people in France provided proportions of COVID-19-Like symptoms in the general population. We identified associated risk factors, depending on whether individuals had likely been contaminated during *or after the epidemic peak taking into account gender, class, and ethnicity inequalities in living conditions.*

Women and ethno-racial minorities remained at higher risk of anosmia/ageusia during and after the peak. Whereas senior executive professionals were more affected than lower social classes at the peak of the epidemic, this effect disappeared afterwards.

While high density of the place of residence was associated with anosmia/ageusia during the peak, but no longer after, the opposite trend was observed for living in overcrowded housing.

Having worked outside the home during lockdown was the most strongly associated exposure factor and even more so after the peak.

Implications of all the available evidence

The shift in the social profile of the epidemic was related to a shift in exposure factors under the implementation of stringent collective prevention measures. Our results notably stress the importance of working outside the home, all the more so in essential occupations.

Table 1. Socio-demographic characteristics associated with COVID-19 risk factors

	High density of the place of residence *n=27,104 (38.6%)*	Overcrowded housing *n=8,430 (13.2%)*	Worked outside the home during lockdown *n=37,129 (47.7%)*
Region			
Least affected regions	11,829 (26.8)	4,186 (10.3)	24,673 (51.0)
Grand Est	1,829 (26.4)	551 (9.1)	3,814 (49.3)
Hauts de France	2,294 (34.2)	858 (12.3)	3,631 (44.5)
Ile-de-France	11,152 (83.4)	2,835 (24.8)	5,011 (37.8)
Age (years)			
18-24	3,506 (38.5)	1,225 (13.9)	2,794 (27.5)
25-34	5,504 (47.2)	2,051 (18.1)	6,366 (50.1)
35-44	6,128 (39.8)	2,786 (19.8)	9,239 (56.0)
45-54	6,298 (35.7)	1,748 (11.6)	11,374 (59.0)
55-64	5,668 (33.5)	620 (4.5)	7,356 (39.1)
Sex			
Men	12,404 (38.1)	3,880 (13.1)	18,148 (50.6)
Women	14,700 (39.0)	4,550 (13.4)	18,981 (44.7)
Ethno-racial status			
Mainstream population	18,772 (31.8)	4,823 (8.7)	30,625 (49.0)
Non-racialized first-generation immigrants	1,128 (51.0)	432 (21.3)	1,100 (47.0)
Non-racialized second-generation immigrants	1,391 (40.1)	360 (11.0)	1,815 (48.1)
Racialized first-generation immigrants	2,894 (72.6)	1,655 (41.4)	1,744 (41.4)
Racialized second generation immigrants	2,297 (68.0)	954 (29.2)	1,303 (37.4)
DOM or descendants of DOM native	622 (56.6)	206 (20.5)	542 (48.5)
Social class			
Self-employed and entrepreneurs	1,133 (32.0)	390 (11.7)	2,671 (68.1)
Senior executive professionals	7,959 (53.5)	1,373 (10.3)	6,448 (39.2)
Middle executive professionals	4,633 (36.4)	1,235 (10.2)	8,142 (57.9)
Skilled employees	2,494 (41.2)	708 (12.2)	3,543 (52.0)
Unskilled employees	3,885 (36.1)	1,498 (13.7)	7,562 (58.1)
Skilled manual workers	1,589 (28.7)	862 (15.0)	4,466 (66.1)
Unskilled manual workers	743 (27.4)	515 (17.5)	1,843 (56.9)
Never worked and others	4,668 (38.9)	1,849 (16.7)	2,454 (16.6)
Standard of living (in deciles)			
D1	3,068 (46.9)	1,794 (28.2)	2,796 (34.7)
D2-D3	4,082 (40.4)	2,317 (22.1)	5,405 (45.5)
D4-D5	3,761 (33.1)	1,506 (12.8)	7,065 (53.4)
D6-D7	4,512 (31.9)	1,262 (8.5)	8,595 (54.6)
D8-D9	6,586 (37.7)	1,100 (6.3)	8,973 (47.7)
D10	4,773 (49.8)	385 (4.3)	4,032 (40.1)
Formal education			
No diploma	1,790 (42.9)	1,065 (24.7)	2,052 (42.3)
Primary education	1,093 (34.8)	455 (13.5)	1,375 (39.4)
Vocational secondary	3,670 (27.0)	1,613 (12.1)	8,848 (56.9)
High school	5,356 (34.4)	2,036 (13.2)	8,810 (48.9)
High school +2 to 4 years	8,007 (39.0)	1,991 (10.5)	11,252 (49.0)
High school +5 or more years	7,188 (61.1)	1,270 (11.7)	4,792 (36.5)

All socio-demographic variables were significantly associated with each three COVID-19 risk factors (P-value <0.001, Chi-2 tests), except sex with high density (P-value=0.051) and overcrowded housing (P-value=0.30).

Table 2. Socio-demographic characteristics associated with anosmia/ageusia

	Anosmia /ageusia n=2,052 (1.53%)	*P-value**	*Anosmia/ageusia during peak n=1,521 (1.12%)*	*Anosmia/ageusia after peak n=531 (0.41%)*	*Relative change (-64.19%)*
Region		**<0.001**			
Least affected regions	866 (1.04)		622 (0.73)	244 (0.31)	-58.05
Grand Est	305 (2.15)		242 (1.72)	63 (0.43)	-74.65
Hauts-de-France	215 (1.50)		147 (1.03)	68 (0.47)	-53.76
Ile-de-France	666 (2.85)		510 (2.16)	156 (0.68)	-68.54
Age		**<0.001**			
18-24	253 (1.27)		168 (0.86)	85 (0.41)	-52.05
25-34	431 (1.92)		322 (1.43)	109 (0.48)	-66.22
35-44	510 (1.83)		379 (1.33)	131 (0.50)	-62.32
45-54	521 (1.57)		407 (1.22)	114 (0.35)	-70.94
55-64	337 (1.07)		245 (0.76)	92 (0.31)	-59.15
Sex		**<0.001**			
Men	773 (1.22)		570 (0.88)	203 (0.34)	-61.23
Women	1,279 (1.84)		951 (1.37)	328 (0.47)	-65.45
Ethno-racial status		**<0.001**			
Mainstream population	1,454 (1.35)		1,075 (0.98)	379 (0.36)	-63.14
Non-racialized first-generation immigrants	94 (2.20)		69 (1.48)	25 (0.72)	-51.50
Non-racialized second-generation immigrants	108 (1.79)		80 (1.37)	28 (0.42)	-69.31
Racialized first-generation immigrants	164 (1.86)		127 (1.43)	37 (0.43)	-69.82
Racialized second generation immigrants	170 (2.62)		125 (1.95)	45 (0.67)	-65.61
DOM or descendants of DOM native	62 (2.67)		45 (1.95)	17 (0.72)	-62.93
Social class		**<0.001**			
Self-employed and entrepreneurs	92 (1.39)		63 (0.91)	29 (0.48)	-47.13
Senior executive professionals	454 (1.81)		365 (1.45)	89 (0.37)	-74.68
Middle executive professionals	434 (1.89)		313 (1.35)	121 (0.54)	-60.24
Skilled employees	203 (1.83)		160 (1.44)	43 (0.39)	-72.63
Unskilled employees	356 (1.56)		254 (1.10)	102 (0.45)	-59.03
Skilled manual workers	125 (0.99)		87 (0.68)	38 (0.31)	-55.20
Unskilled manual workers	62 (1.11)		38 (0.76)	24 (0.34)	-54.89
Never worked and others	326 (1.28)		241 (0.93)	85 (0.35)	-62.91
Standard of living (in deciles)		**0.003**			
D1	209 (1.41)		140 (0.92)	69 (0.49)	-47.25
D2-D3	316 (1.33)		221 (0.94)	95 (0.39)	-57.93
D4-D5	349 (1.49)		255 (1.10)	94 (0.39)	-64.54
D6-D7	389 (1.47)		295 (1.10)	94 (0.37)	-66.72
D8-D9	519 (1.77)		388 (1.32)	131 (0.45)	-66.31
D10	247 (1.74)		209 (1.46)	38 (0.28)	-80.79
Formal education		**<0.001**			
No diploma	123 (1.43)		82 (0.89)	41 (0.54)	-39.89
Primary education	74 (1.03)		53 (0.77)	21 (0.25)	-67.08
Vocational secondary	335 (1.17)		229 (0.80)	106 (0.36)	-55.19
High school	467 (1.48)		330 (1.03)	137 (0.44)	-57.13
High school +2 to 4 years	663 (1.82)		502 (1.38)	161 (0.44)	-68.00
High school +5 or more years	390 (1.95)		325 (1.62)	65 (0.33)	-79.78

Working arrangement during lockdown		**<0.001**			
Not working and others	669 (1.33)		484 (0.96)	185 (0.38)	-60.55
Remote working only	376 (1.79)		308 (1.46)	68 (0.33)	-77.29
Working outside the home partly or only	1,007 (1.62)		729 (1.16)	278 (0.45)	-61.05
High density of the place of residence		**<0.001**			
No	1,078 (1.21)		778 (0.85)	300 (0.36)	-58.32
Yes	974 (2.04)		743 (1.56)	231 (0.49)	-68.61
Overcrowded housing		**<0.001**			
No	1,719 (1.44)		1,280 (1.07)	439 (0.37)	-65.36
Yes	333 (2.12)		241 (1.47)	92 (0.64)	-56.38
Number of persons living in the house		**<0.001**			
1	232 (1.34)		175 (1.01)	57 (0.33)	-67.66
2	472 (1.28)		348 (0.94)	124 (0.35)	-63.18
3-4	979 (1.61)		720 (1.17)	259 (0.44)	-62.03
5 or more	369 (1.95)		278 (1.46)	91 (0.49)	-66.50
Essential occupation		**<0.001**			
No	1,193 (1.39)		908 (1.05)	285 (0.34)	-67.66
Healthcare workers	205 (2.94)		131 (1.78)	74 (1.16)	-34.57
Others	654 (1.61)		482 (1.18)	172 (0.43)	-63.75

Significant Chi-2 tests are indicated in bold.

*Chi-2 test for anosmia/ageusia during the whole period (yes, no).

Table 3. Factors associated with anosmia/ageusia during or after the epidemic peak (as compared to no reported anosmia/ageusia starting after lockdown). Multinomial logistic regressions.

	Crude model		Adjusted model	
	During peak OR (95% CI)	*After peak OR (95% CI)*	*During peak OR (95% CI)*	*After peak OR (95% CI)*
Region				
Least affected regions	1	1	1	1
Grand Est	**2.37 (2.01-2.79)**	**1.43 (1.05-1.95)**	**2.41 (2.04-2.85)**	**1.43 (1.05-1.94)**
Hauts-de-France	**1.41 (1.14-1.73)**	**1.55 (1.15-2.10)**	**1.45 (1.18-1.78)**	**1.54 (1.14-2.09)**
Ile-de-France	**3.01 (2.64-3.43)**	**2.26 (1.79-2.84)**	**2.47 (2.13-2.86)**	**2.18 (1.69-2.81)**
Age				
18-24	1	1	1	1
25-34	**1.68 (1.36-2.07)**	1.18 (0.87-1.60)	**1.43 (1.14-1.80)**	0.93 (0.66-1.32)
35-44	**1.56 (1.27-1.91)**	1.22 (0.91-1.65)	**1.37 (1.10-1.72)**	0.90 (0.64-1.27)
45-54	**1.43 (1.17-1.74)**	0.86 (0.63-1.18)	**1.31 (1.05-1.63)**	**0.63 (0.44-0.90)**
55-64	0.89 (0.71-1.11)	0.76 (0.54-1.06)	0.84 (0.66-1.07)	**0.54 (0.36-0.82)**
Sex				
Men	1	1	1	1
Women	**1.57 (1.40-1.76)**	**1.40 (1.14-1.71)**	**1.51 (1.34-1.70)**	**1.42 (1.14-1.77)**
Ethno-racial status				
Mainstream population	1	1	1	1
Non-racialized first-generation immigrants	**1.52 (1.16-2.00)**	**2.00 (1.14-3.53)**	1.26 (0.95-1.66)	**1.77 (1.04-3.04)**
Non-racialized second-generation immigrants	**1.40 (1.07-1.82)**	1.16 (0.77-1.76)	1.26 (0.96-1.64)	1.07 (0.71-1.62)
Racialized first-generation immigrants	**1.46 (1.18-1.80)**	1.20 (0.82-1.75)	1.12 (0.89-1.40)	0.95 (0.64-1.42)
Racialized second generation immigrants	**2.01 (1.63-2.48)**	**1.87 (1.34-2.63)**	**1.48 (1.19-1.83)**	**1.42 (1.00-2.01)**
DOM or descendants of DOM native	**2.01 (1.43-2.81)**	**2.02 (1.21-3.36)**	**1.50 (1.07-2.12)**	1.50 (0.89-2.52)
Social class				
Self-employed and entrepreneurs	**0.62 (0.47-0.83)**	1.30 (0.77-2.19)	0.79 (0.58-1.07)	1.25 (0.74-2.11)
Senior executive professionals	1	1	1	1
Middle executive professionals	0.93 (0.79-1.10)	**1.47 (1.09-1.98)**	1.05 (0.88-1.24)	**1.36 (1.00-1.85)**
Skilled employees	0.99 (0.81-1.21)	1.07 (0.73-1.58)	0.95 (0.77-1.17)	0.91 (0.61-1.35)
Unskilled employees	**0.76 (0.64-0.91)**	1.23 (0.90-1.68)	**0.81 (0.67-0.99)**	1.00 (0.71-1.41)
Skilled manual workers	**0.47 (0.35-0.62)**	0.83 (0.55-1.24)	**0.63 (0.47-0.83)**	0.79 (0.51-1.21)
Unskilled manual workers	**0.52 (0.35-0.79)**	0.93 (0.57-1.54)	0.67 (0.44-1.02)	0.82 (0.49-1.39)
Never worked and others	**0.64 (0.54-0.77)**	0.94 (0.67-1.33)	0.81 (0.64-1.01)	0.80 (0.51-1.25)
High density of the place of residence				
No	1	1	1	1
Yes	**1.83 (1.64-2.05)**	**1.38 (1.14-1.68)**	**1.21 (1.06-1.38)**	0.95 (0.76-1.20)
Overcrowded housing				
No	1	1	1	1
Yes	**1.38 (1.19-1.62)**	**1.74 (1.32-2.31)**	1.04 (0.88-1.22)	**1.41 (1.05-1.89)**
Working arrangement during lockdown				
Remote working only	1	1	1	1
Not working and others	**0.65 (0.56-0.76)**	1.13 (0.84-1.53)	0.99 (0.82-1.21)	1.34 (0.95-1.88)

Working outside the home partly or only	**0.80 (0.69-0.92)**	**1.36 (1.03-1.81)**	**1.19 (1.02-1.40)**	**1.64 (1.21-2.20)**
Smoking				
Daily	1	1	1	1
Occasionally	**1.63 (1.25-2.13)**	1.13 (0.74-1.73)	**1.50 (1.15-1.97)**	1.10 (0.72-1.69)
No longer	**1.40 (1.18-1.67)**	0.90 (0.69-1.17)	**1.41 (1.18-1.68)**	0.93 (0.71-1.22)
No	**1.28 (1.09-1.51)**	0.82 (0.64-1.06)	1.14 (0.96-1.34)	**0.76 (0.59-0.98)**
Chronic disease				
No	1	1	1	1
Kidney disease	1.00 (0.46-2.17)	**3.19 (1.11-9.15)**	1.20 (0.55-2.62)	**4.03 (1.39-11.7)**
Other disease	1.09 (0.96-1.23)	**1.52 (1.23-1.88)**	**1.18 (1.04-1.35)**	**1.69 (1.37-2.09)**
Body mass index				
Normal	1	1	1	1
Underweight	0.96 (0.72-1.28)	0.98 (0.60-1.59)	0.99 (0.74-1.33)	0.93 (0.56-1.52)
Overweight	**0.86 (0.75-0.98)**	1.08 (0.86-1.34)	0.91 (0.79-1.04)	1.11 (0.89-1.40)
Obese	1.06 (0.89-1.25)	**1.44 (1.09-1.91)**	1.07 (0.90-1.28)	**1.38 (1.04-1.83)**

Significant associations are indicated in bold