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Original article

Prevalence of long COVID in the general adult population according to different definitions and sociodemographic and infection characteristics. A nationwide random sampling survey in France in autumn 2022

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ABSTRACT

Objectives: Long COVID has been recognized since early 2020, but its definition is not unanimous, which complicates epidemiological assessments. This study estimated the prevalence of long COVID based on several definitions and severity thresholds in the adult population of mainland France and examined variations according to sociodemographic and infection characteristics.

Methods: A cross-sectional survey using random sampling was conducted in August–November 2022. Participants declaring SARS-CoV-2 infection were assessed for infection dates and context, post-COVID symptoms (from a list of 31, with onset time, daily functioning impact, and alternative diagnosis), and perceived long COVID. Long COVID prevalence was estimated according to the WHO, National Institute for Health and Care Excellence, United States National Centre for Health Statistics, and United Kingdom Office for National Statistics definitions.

Results: Of 10 615 participants, 5781 (54.5%) reported SARS-CoV-2 infection, with 123–759 (1.2–13.4%) having long COVID, depending on the definition. The prevalence of WHO post-COVID condition (PCC) was 4.0% (95% CI: 3.6–4.5) in the overall population and 8.0% (95% CI: 7.0–8.9) among infected individuals. Among the latter, the prevalence varied from 5.3% (men) to 14.9% (unemployed) and 18.6% (history of hospitalization for COVID-19). WHO-PCC overlapped poorly with other definitions (kappa ranging from 0.18 to 0.59) and perceived long COVID (reported in only 43% of WHO-PCC).

Discussion: Regardless of its definition, long COVID remains a significant burden in the French adult population that deserves surveillance, notably for forms that strongly impact daily activities. More standardized definitions will improve integrated surveillance of, and better research on, long COVID.

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Introduction

Since early 2020, the world has experienced several waves of SARS-CoV-2 infections. Prolonged suffering post-infection, commonly referred to as 'long COVID', was soon recognized and various definitions have since been proposed, mostly based on persistent symptoms and time elapsed from the acute disease phase [1–4]. Faced with large variations in incidence and prevalence estimates because of different methodologies and definitions, the WHO proposed a definition of 'post-COVID-19 condition' (PCC) in October 2021 [5,6]. This definition, resulting from an expert consensus using Delphi methodology, uses a symptom-based approach. A broad spectrum of symptoms was listed by the consensus group, some being very common (e.g. fatigue and dyspnoea) and others more specific (e.g. taste and smell disorders). Other non-specific symptoms were subsequently reported (e.g. hair loss and sexual dysfunction) [7–10].

Despite the WHO definition of PCC, various definitions are still used, not only in clinical research settings [11], but also in population surveys [12–15]. Measures of perceived long COVID, which also vary in conception, have also been used [16,17]. Consequently, prevalence estimates continue to vary widely, compounded by the fact that most studies (and reviews) are based on cohorts of patients hospitalized or treated in health care systems [7,18–23], which differ across countries and have varied throughout the COVID-19 pandemic. To date, general population estimates remain scarce and heterogeneous in terms of definitions [14,24–26], to the detriment of public health decision-making, which needs evidence about the burden of the condition in the population.

A French study was conducted in March–April 2022 using an online questionnaire on a panel of volunteers from the adult population, yielding the first prevalence estimates of WHO-PCC (4% of the general population and 30% of those infected) [14]. However, the limitations of this first study made it necessary to carry out a new study using a more robust methodology (random sampling) and more comprehensive indicators. It was also important to re-assess the situation following the large waves of Omicron variants in 2022, which affected a large part of the French population.

The objective of this study was to estimate the prevalence of long COVID and its main sociodemographic and infection determinants in the adult population living in mainland France while considering several definitions and severity thresholds as well as participants' perception of having had long COVID.

Methods

Study design

The random sampling survey was conducted from 29 August to 26 November 2022. Participants aged ≥ 18 years and living in mainland France were interviewed by computer-assisted telephone interviewing to collect information about their socioeconomic characteristics (age, sex, place of residence, household composition, education level, and household income) and previous SARS-CoV-2 infections (date of onset, confirmation by test or physician diagnosis, workplace infection, hospitalization for at least 24 hours, and intensive care admission because of SARS-CoV-2 infection). Participants reporting previous SARS-CoV-2 infection were further asked about their present symptoms (list of 31 symptoms, with date of onset, impact on daily functioning, and potential explanation by another disease). Participants' overall perception about having had long COVID was also assessed. More details are provided in the [Supplementary Methods](#).

Ascertainment of SARS-CoV-2 infections and long COVID

Participants reporting SARS-CoV-2 infection were classified as having 'confirmed' (formal diagnosis or positive test) or 'probable' infection.

Long COVID was identified using several definitions: WHO-PCC, with five variations according to impact on daily functioning, National Institute for Health and Care Excellence (NICE), United States National Centre for Health Statistics (US-NCHS), and United Kingdom Office for National Statistics (UK-ONS). These definitions are presented in detail in the [Supplementary Methods and Tables S1 and S2](#).

Infections and WHO-PCC were linked to the different epidemic waves, strains, and variants according to their date of onset ([Supplementary Material](#)).

Statistical analyses

Cumulative incidence of SARS-COV-2 and standardized prevalence of long COVID according to the various definitions were computed using appropriate weights. Poisson regression with robust variance was used to derive prevalence ratios associated with the main sociodemographic and infection characteristics at two levels: (a) general population (i.e. identifying the characteristics associated with the overall risk of having long COVID, including the risk of infection) and (b) participants reporting at least one SARS-CoV-2 infection (i.e. identifying the characteristics associated with the prognostic risk of developing long COVID once infected). These analyses were conducted using the WHO-PCC definition (the most widely used symptom-based and only international definition) and perceived long COVID. Agreement between long COVID definitions was expressed using Cohen's kappa statistic ([Supplementary Material](#)).

Ethics

The survey planning, conduct, and reporting were in line with the Declaration of Helsinki. According to French law, this study did not have to obtain the approval of a national ethics committee because it relies only on the analysis of anonymously collected data. The survey was approved by the institutional review board of Santé Publique France, the French Public Health Agency, on 19 August 2022. In accordance with the guidelines of the French Data Protection Authority (Commission Nationale de l'Informatique et des Libertés), all subjects included in this study were informed and gave oral consent to participate before the telephone interview. Data processing complied with the EU Data Protection Regulation 2016/679 (General Data Protection Regulation).

Results

Overall, 10 615 participants with a mean age of 50.3 years (extremes: 18–97 years) were interviewed (participation rate: 55%), of whom 5556 (52.3%) were women and 5781 (54.5%) reported SARS-CoV-2 infection ([Table 1](#)). Infection was more frequently associated with women, middle age, not living alone, employed and especially self-employed status, more educated and wealthier individuals, residents of Paris and its region, and the least deprived areas. Among the 5781 participants infected at least once, 7157 different infections were recorded, including 4165 (58.2%) during the 'Omicron' waves; 5131 participants declared being infected (at least once) more than 3 months before the survey (88.8% of those infected) ([Table S3](#)). Among infected participants, 83 (0.8%) were hospitalized, including 30 (0.3%) in intensive care ([Table 1](#)).

Table 1
Characteristics of the survey sample and cumulative incidence rate of reported SARS-CoV-2 infection (positive test or probable diagnosis) according to socio-demographic factors

	Survey sample characteristics N (%)	Cumulative incidence rate of self-reported SARS-CoV-2 infection (% and 95% CI)
All	10 615	54.5 (53.3–55.6)
Sex		
Men	5059 (47.7)	51.7 (49.9–53.4)
Women	5556 (52.3)	57.0 (55.4–58.6)
Age		
18–24 y	1091 (10.3)	62.7 (58.8–66.6)
25–34 y	1542 (14.5)	64.1 (60.9–67.3)
35–44 y	1686 (15.9)	65.0 (62.0–68.0)
45–54 y	1785 (16.8)	61.4 (58.5–64.4)
55–64 y	1728 (16.3)	50.3 (47.5–53.2)
65–74 y	1544 (14.6)	42.1 (39.2–44.9)
≥75 y	1238 (11.7)	32.0 (28.9–35.0)
Education		
Less than secondary	5268 (49.6)	45.7 (43.8–47.5)
Secondary	3189 (30.0)	60.8 (58.9–62.7)
Tertiary	2158 (20.3)	66.6 (64.7–68.5)
Household size		
1 person	2858 (26.9)	42.7 (40.4–45.0)
2+ persons	7757 (73.1)	58.8 (57.4–60.2)
Employment status		
Paid employment	5574 (52.5)	63.3 (61.7–64.9)
Unemployed	520 (4.9)	53.4 (47.2–59.7)
Retired	3100 (29.2)	38.8 (36.8–40.8)
Other inactive	1421 (13.4)	54.4 (50.8–58.0)
Occupation		
Company manager, entrepreneur	519 (4.9)	63.5 (58.4–68.7)
Senior manager, professional	1511 (14.2)	70.9 (68.5–73.3)
Middle manager, teacher	920 (8.7)	65.5 (61.8–69.2)
Office employee	2498 (23.5)	60.6 (58.0–63.2)
Manual worker	644 (6.1)	44.5 (39.2–49.8)
No occupation, retired or studying (inactive)	4521 (42.6)	43.7 (41.9–45.5)
Employer		
Public employer	1510 (14.2)	63.0 (60.0–66.1)
Private employer	3298 (31.1)	62.5 (60.4–64.5)
Self-employed	765 (7.2)	67.2 (63.3–71.1)
Other	5041 (47.5)	44.7 (43.0–46.4)
Household income		
First tertile	3647 (34.4)	45.6 (43.4–47.9)
Second tertile	3506 (33.0)	56.0 (54.0–57.9)
Third tertile	2709 (25.5)	64.7 (62.7–66.6)
Not reported	753 (7.1)	53.5 (49.0–58.0)
Size of place of residence		
Rural	2447 (23.1)	53.0 (50.6–55.4)
Less than 20 000 inhabitants	1837 (17.3)	52.1 (49.3–54.9)
20 000–99 999 inhabitants	2006 (18.9)	51.9 (49.2–54.6)
>100 000 inhabitants	2540 (23.9)	56.5 (54.1–58.8)
City of Paris	1784 (16.8)	59.0 (55.8–62.1)
Region		
Ile-de-France (Greater Paris)	1970 (18.6)	58.7 (55.8–61.7)
Northeast	2323 (21.9)	53.5 (51.0–56.0)
Northwest	2123 (20.0)	50.4 (48.0–52.9)
Southeast	2206 (20.8)	57.4 (54.8–59.9)
Southwest	1993 (18.8)	52.4 (49.7–55.2)
Deprivation index Fdep ^a		
First quintile	2367 (22.6)	60.4 (58.0–62.8)
Second quintile	1994 (19.0)	55.6 (53.0–58.3)
Third quintile	2041 (19.5)	55.5 (52.8–58.2)
Fourth quintile	1952 (18.6)	51.1 (48.3–53.8)
Fifth quintile	2133 (20.3)	49.2 (46.4–52.0)

Survey sample characteristics
N (%)

Number of reported SARS-CoV-2 infections (N = 10 613)	Survey sample characteristics N (%)
0	4834 (45.5)
1	4632 (43.6)
2	946 (8.9)
3	175 (1.7)

Table 1 (continued)

	Survey sample characteristics N (%)
4	21 (0.2)
5	5 (0.1)
Number of reported positive tests for SARS-CoV-2 infections	
0	5540 (52.2)
1	4320 (40.7)
2	678 (6.4)
3	70 (0.6)
4	5 (0.1)
5	2 (0.0)
Time elapsed since first SARS-CoV-2 infection exceeding 3 mo (if at least one probable infection, N = 5781)	
Yes	650 (11.2)
No	5131 (88.8)
Median (Q1, Q3) time elapsed since last infection (d)	229 (122, 339)
SARS-CoV-2 exposure in the workplace (if probable infection, N = 5781)	
Yes	1335 (23.1)
No	3136 (54.3)
Cannot say	233 (4.0)
Not in employment	1075 (18.6)
Hospitalization for acute COVID-19	
Yes	83 (0.8)
No	10 532 (99.2)
Intensive care for acute COVID-19	
Yes	30 (0.3)
No	10 585 (99.7)

Fdep: French deprivation index. (see supplementary reference [1]).

^a Missing in 94 military subjects.

Symptoms and agreement between definitions

Fatigue was the most common symptom reported by participants declaring probable or confirmed infection with SARS-CoV-2 at least 3 months earlier, followed by sleep disorders, anxiety, and joint pain. However, less than 10% of participants—and often much less—met the WHO-PCC criteria for each symptom, differing from the less stringent NCHS ($\leq 20\%$), NICE ($< 30\%$), and UK NOS definitions (up to 40%) (Table S4).

Among symptom-based definitions of long COVID, UK-ONS had the largest prevalence estimate (13.4%) followed by NICE1 (8.6%), US-NCHS (7.6%), NICE2, and WHO-PCC (4.0%). The prevalence based on participants' perception of having had long COVID was 7.1%.

Agreement between the different long COVID definitions was slight to moderate with kappa coefficients ranging from 0.18 to 0.59 (Figs S1(a) and (b)). For example, 47%, 29%, 38%, and 55% of participants who respectively met the US-NCHS, UK-ONS, NICE1, and NICE2 definitions also met the WHO-PCC definition. Only 43% of participants meeting the WHO-PCC and NICE2 definition considered themselves to have had long COVID. Those meeting the strengthened WHO-PCC definition were more likely to declare having had long COVID, although the endorsement did not exceed 60% (endorsement range 27–33% with other definitions). Discrepancies affected both sexes and all age classes (Table S5). Subjects meeting the different definitions of long COVID were similar, with the exception of workplace infection and hospitalization, which differed more substantially (Table S6).

Prevalence of long COVID prevalence and variations

When considering the WHO-PCC definition, including at least low impact on daily activities, PCC prevalence was 4.0% (430/10 615, 95% CI: 3.6–4.5) in the overall population, with significant variations (Tables S5 and S7; Fig. 1): WHO-PCC prevalence was more than twice as high in women than in men and 68% higher in

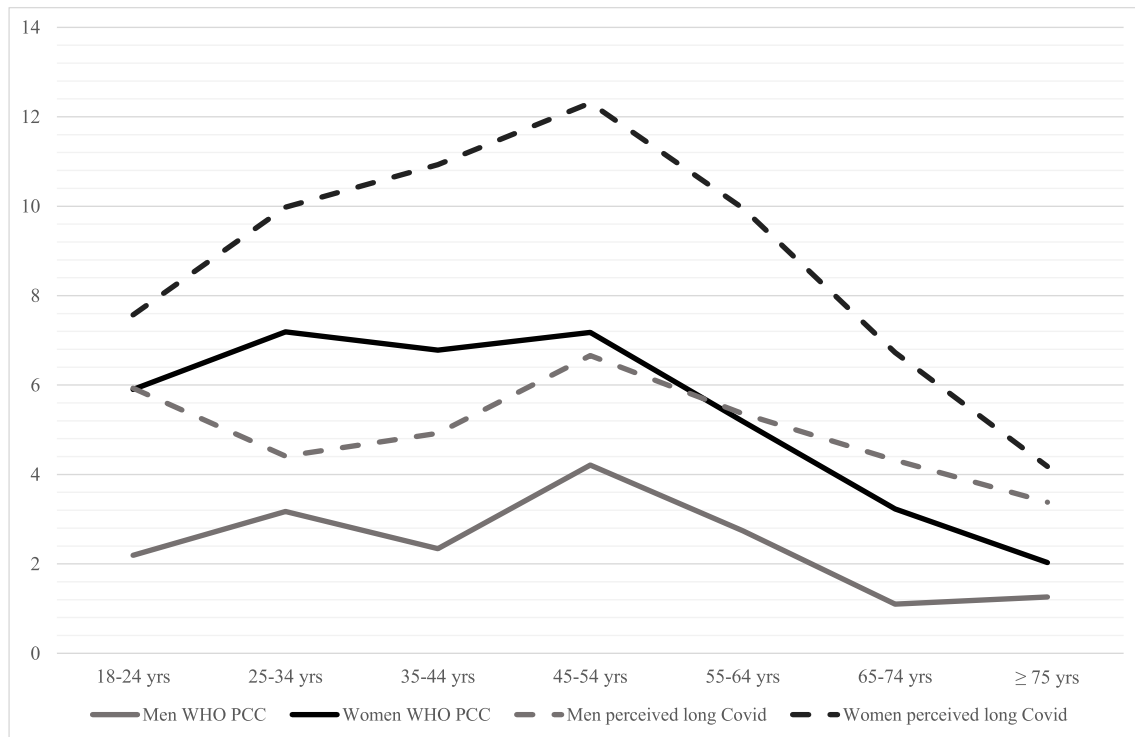


Fig. 1. Prevalence of WHO post-COVID-19 condition (PCC) and perceived long COVID in the general population according to sex and age, in %.

unemployed people; it was two to three times lower among elderly participants and lower among participants living alone.

With the strengthened WHO-PCC definition requiring at least moderate impact on daily activities, the prevalence was 2.4% (257/10 615, 95% CI: 2.1–2.8). This prevalence fell to 1.2% (132/10 615, 95% CI: 1.0–1.5) when only considering participants reporting the strong or very strong impact of symptoms on daily activities, i.e. 30% of participants meeting the WHO-PCC definition had ‘severe’ forms. Limiting the WHO definition in terms of time to onset and symptom duration had less impact on prevalence estimates, ranging between 2.7% and 3.5% (Table S5; Figure S1(a)).

Considering participants’ perceived long COVID, the prevalence was 7.1% (759/10 615, 95% CI: 6.5–7.8), with a higher prevalence among women and self-employed and a lower prevalence among participants over 75 years, retired, or living alone (Tables S5 and S7; Fig. 1).

Participants reporting probable or confirmed infection: long COVID prevalence and variations

Among participants reporting probable or confirmed infection more than 3 months ago, 8.0% (430/5781, 95% CI: 7.0–8.9) met the WHO-PCC definition, with prevalence varying from 5.3% (men) to 14.9% (unemployed) and 18.6% (COVID-19-related hospitalization) (Table S7). Of those with WHO-PCC, 37.9% had symptoms that lasted between 6 and 12 months, 8.5% between 12 and 18 months, and 22.4% for more than 18 months. Around one-fifth (21.3%) of participants with WHO-PCC were infected during the Delta variant wave, a higher proportion than all infections reported in the studied population (13.1%). WHO-PCC accounted for 53.2% of cases after the start of the Omicron waves (with the Omicron waves representing 58.2% of all infections) (Table S3).

A higher prevalence of WHO-PCC was associated with women, unemployment and hospitalization, and intensive care for acute COVID-19 (Table S7).

Considering participants’ perceived long COVID, prevalence was 13.1%, with a higher prevalence in women and participants aged between 45 and 64 years. Perceived long COVID prevalence was also higher among those belonging to certain socioeconomic groups (low income, fourth deprivation quintile, intermediate occupations such as middle manager or teacher, and self-employed workers including entrepreneurs and company managers) as well as those infected in the workplace. Finally, as with WHO-PCC, perceived long COVID was strongly associated with hospitalization and intensive care admission because of acute COVID-19 (Table S7).

Discussion

Burden of long COVID

This study confirms that in late 2022, long COVID represented a significant burden in the French adult population, with prevalence estimates ranging from 1.2% to 13.4% depending on the definition. Retaining the value of 4% based on the standard WHO-PCC definition, this corresponds to 2.06 million adults living in France at the end of 2022. Using the strengthened WHO-PCC definition that requires at least moderate impact on daily activities (probably more relevant in terms of actual morbidity), the prevalence is 2.4% with 1.24 million people being affected.

The standard WHO-PCC estimate of 4% remains unchanged from the estimate obtained in the previous survey, covering the period before the Omicron waves of 2022 [14]. However, this does not mean that this chronic condition is invariable, because half of all cases reported here were from the Omicron waves, whereas all cases were pre-Omicron in the previous study. This suggests that at least half of the long COVID cases associated with pre-Omicron waves had resolved by the time of our study. Moreover, a probably real decrease in WHO-PCC prevalence was observed among participants declaring confirmed or probable infection: 8% vs. 30%

observed in early 2022 using the same WHO definition but a panel sampling [14] This suggests that the Omicron waves were associated with a lower risk of WHO-PCC, which is in full agreement with the literature that highlights a two- to five-fold risk reduction with the Omicron variants (or their context, notably in terms of vaccination coverage) compared with earlier variants [27,28]. Prevalence reports from the US-NCHS and the UK-ONS also point to a stabilization of prevalence figures in 2022–2023 [24,25], resulting from similar dynamics regarding both SARS-CoV-2 infection and the risk of long COVID associated with more recent waves.

Definition of long COVID

This study highlights significant differences depending on the definition of long COVID, not only in terms of prevalence estimates, which may result from quantitative differences in sensitivity, but also with regards to the agreement between definitions, which suggests more fundamental differences. The agreement was at best moderate between the different operationalized symptom-based definitions, with only slight agreement between these definitions and the participant's self-perception. This latter result (already found in our previous comprehensive analysis of the WHO definition [17]) is particularly concerning. This should lead us to question the current symptom-based definitions of long COVID according to which 27–60% of cases based on the definition do not perceive themselves as having had long COVID.

Sociodemographic and infection characteristics and high prevalence groups

The complementary analyses conducted in the overall general population and the population infected with SARS-CoV-2 allowed us to identify and distinguish groups with a higher prevalence of long COVID in terms of the infection risk (overall risk) and/or the risk of developing long COVID once infected (prognostic risk). These two complementary risk-based approaches are in line with the conceptualization of long COVID as both a separate nosological entity, similar to encephalomyelitis/chronic fatigue syndrome [29], and a direct complication of SARS-CoV-2 infection.

Among the sociodemographic and infection characteristics, female sex was associated with an increased risk of long COVID because of both the higher infection risk and the increased risk of long forms once infected. Age over 65 and living alone were associated with a lower cumulative incidence of COVID-19 and thus a lower risk of long COVID, whereas the risk of long COVID in the case of infection was not lower. Socioeconomic characteristics were mostly associated with the risk of SARS-CoV-2 infection (in terms of both testing and positivity rates [30]), although they could be linked to prognostic risks such as employment status (i.e. unemployed people are at greater risk [31]). Nevertheless, the risk of long COVID related to hospitalization and intensive care is typically prognostic, although non-specific mechanisms such as those involved in post-intensive care syndrome [32] cannot be excluded. The difference between regions observed in a previous study [14] did not hold true in the current study. This difference was probably because of exposure variations during the 2020 Wuhan waves: by late 2022, after several large Delta and Omicron waves, all French regions had been similarly affected.

Strengths and limitations

This survey has several strengths that make it unique: its large representative nationwide sample, satisfactory participation rate,

comprehensive symptom assessment (date of occurrence, explanations by alternative diagnoses, and impact on daily activities using a Likert scale), and use of multiple definitions of long COVID with several severity thresholds. The limitations relate to its exclusively self-reported data (even if collected by experienced professionals) and especially its cross-sectional design, which prevents strong causal inferences. Only basic adjustments (for sex and age) were performed because of the study's mainly descriptive aims. The operationalization of several definitions was also problematic because of the presence of adverbs such as 'usually' and 'generally' whose use has long been discouraged for logical reasons [33]. We did not consider these adverbs in our operationalizations. The validity of participants' overall perception of having had long COVID may also be called into question. The lack of previous studies led us to create an *ad hoc* question, similar to our previous study [17], although it was only tested for comprehension in short pilot studies.

Perspectives and recommendations

Despite the stabilization of its prevalence in France in 2022, suggesting the favourable course of many cases over time, long COVID remains one of the most frequent long-standing or 'chronic health conditions' in this country. Insofar as COVID-19 is not set to disappear (as suggested by the current new epidemic waves), long COVID and especially the forms with a strong impact on daily activities will continue to represent a significant burden for the societies and health care systems of most countries, thus warranting ongoing surveillance. Standardized definitions, most probably including WHO-PCC with different severity thresholds, are needed to harmonize surveillance systems and improve knowledge about the risk factors associated with long COVID in order to better inform preventive, screening, and therapeutic strategies.

Author contributions

All authors contributed to the study conception and design. JC and TTM performed the material preparation, data collection, and data validation. JC performed the data analysis and wrote the first draft of the manuscript. JC and TTM have full access to all data used in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Transparency declaration

The authors declare that they have no conflicts of interest. This study was conducted by Santé Publique France, the French Public Health Agency, in line with its mission statement. Santé Publique France is funded by the French Ministry of Health. The study authors were responsible for writing and submitting the paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.cmi.2024.03.020>.

References

- [1] Perego E, Callard F, Stras L, Melville-Jóhannesson B, Pope R, Alwan NA. Why the patient-made term “long COVID” is needed. *Wellcome Open Res* 2020;5: 224. <https://doi.org/10.12688/wellcomeopenres.16307.1>.
- [2] NICE COVID-19 Guideline Scope. Management of the long-term effects of COVID-19. October 2020. <https://www.nice.org.uk/guidance/ng188/documents/final-scope>. [Accessed 9 October 2023].
- [3] The French Haute Autorité de Santé. 2021. <https://www.servicepublic.fr/particuliers/actualites/A14678>. [Accessed 9 October 2023].
- [4] Nalbandian A, Sehgal K, Gupta A, Madhavan MV, McGroder C, Stevens JS, et al. Post-acute COVID-19 syndrome. *Nat Med* 2021;27:601–15. <https://doi.org/10.1038/s41591-021-01283-z>.
- [5] World Health Organization. A clinical case definition of post COVID-19 condition by a Delphi consensus. World Health Organization; October 6, 2021. <https://apps.who.int/iris/handle/10665/345824>. [Accessed 9 October 2023].
- [6] Soriano JB, Murthy S, Marshall JC, Relan P, Diaz JV. WHO Clinical Case Definition Working Group on post-COVID-19 condition. A clinical case definition of post-COVID-19 condition by a Delphi consensus. *Lancet Infect Dis* 2022;22: e102–7. [https://doi.org/10.1016/S1473-3099\(21\)00703-9](https://doi.org/10.1016/S1473-3099(21)00703-9).
- [7] Cares-Marambio K, Montenegro-Jiménez Y, Torres-Castro R, Vera-Uribe R, Torralba Y, Alsina-Restoy X, et al. Prevalence of potential respiratory symptoms in survivors of hospital admission after coronavirus disease 2019 (COVID-19): a systematic review and meta-analysis. *Chron Respir Dis* 2021;18:14799731211002240. <https://doi.org/10.1177/14799731211002240>.
- [8] Nehme M, Braillard O, Alcoba G, Aebischer Perone S, Courvoisier D, Chappuis F, et al. COVID-19 symptoms: longitudinal evolution and persistence in outpatient settings. *Ann Intern Med* 2021;174:723–5. <https://doi.org/10.7326/M20-5926>.
- [9] Robineau O, Wiernik E, Lemogne C, de Lamballerie X, Ninove L, Blanché H, et al. Persistent symptoms after the first wave of COVID-19 in relation to SARS-CoV-2 serology and experience of acute symptoms: a nested survey in a population-based cohort. *Lancet Reg Health Eur* 2022;17:100363. <https://doi.org/10.1016/j.lanepe.2022.100363>.
- [10] Subramanian A, Nirantharakumar K, Hughes S, Myles P, Williams T, Gokhale KM, et al. Symptoms and risk factors for long COVID in non-hospitalized adults. *Nat Med* 2022;28:1706–14. <https://doi.org/10.1038/s41591-022-01909-w>.
- [11] Høeg TB, Ladhani S, Prasad V. How methodological pitfalls have created widespread misunderstanding about long COVID. *BMJ Evid Based Med* 2023;2023. <https://doi.org/10.1136/bmjebm-2023-112338>.
- [12] COVID-19 rapid guideline: managing the long-term effects of COVID-19. London: National Institute for Health and Care Excellence (NICE); 2020.
- [13] Centers for Disease Control and Prevention. Post-COVID conditions. <https://www.covid.gov/longcovid/definitions>. [Accessed 17 December 2023].
- [14] Coste J, Tebeka S, Decio V, Makovski TT, Alleaume C, Gallay A, et al. Prevalence of post-COVID-19 condition in the French general population after the first epidemic waves. *Infect Dis Now* 2023;53:104631. <https://doi.org/10.1016/j.idnow.2022.10.003>.
- [15] Knuppel A, Boyd A, Macleod J, Chaturvedi N, Williams DM. The long COVID evidence gap: comparing self-reporting and clinical coding of long COVID using longitudinal study data linked to healthcare records. <https://www.medrxiv.org/content/10.1101/2023.02.10.23285717v1>. [Accessed 17 December 2023].
- [16] Bonsaksen T, Leung J, Price D, Ruffolo M, Lamph G, Kabelenga I, et al. Self-reported long COVID in the general population: sociodemographic and health correlates in a cross-national sample. *Life* 2022;12:901. <https://doi.org/10.3390/life12060901>.
- [17] Carcaillon-Bentata L, Makovski TT, Alleaume C, Decio V, Beltzer N, Gallay A, et al. Post-Covid-19 condition: a comprehensive analysis of the World Health Organisation definition. *J Infect* 2023;87:e83–7. <https://doi.org/10.1016/j.jinf.2023.08.006>.
- [18] Salamanna F, Veronesi F, Martini L, Landini MP, Fini M. Post-COVID-19 syndrome: the persistent symptoms at the post-viral stage of the disease. A systematic review of the current data. *Front Med (Lausanne)* 2021;8:653516. <https://doi.org/10.3389/fmed.2021.653516>.
- [19] Chen C, Hauptert SR, Zimmermann L, Shi X, Fritsche LG, Mukherjee B. Global prevalence of Post-Coronavirus Disease 2019 (COVID-19) condition or long COVID: a meta-analysis and systematic review. *J Infect Dis* 2022;226: 1593–607. <https://doi.org/10.1093/infdis/jiac136>.
- [20] Alkodaymi MS, Omrani OA, Fawzy NA, Shaar BA, Almamlouk R, Riaz M, et al. Prevalence of post-acute COVID-19 syndrome symptoms at different follow-up periods: a systematic review and meta-analysis. *Clin Microbiol Infect* 2022;28:657–66. <https://doi.org/10.1016/j.cmi.2022.01.014>.
- [21] O'Mahoney LL, Routen A, Gillies C, Ekezie W, Welford A, Zhang A, et al. The prevalence and long-term health effects of Long COVID among hospitalised and non-hospitalised populations: a systematic review and meta-analysis. *EClinicalMedicine* 2022;55:101762. <https://doi.org/10.1016/j.eclinm.2022.101762>.
- [22] Woodrow M, Carey C, Ziauddeen N, Thomas R, Akrami A, Lutje V, et al. Systematic review of the prevalence of long COVID. *Open Forum Infect Dis* 2023;10:ofad233. <https://doi.org/10.1093/ofid/ofad233>.
- [23] European Centre for Disease Prevention and Control. Prevalence of post COVID-19 condition symptoms: a systematic review and meta-analysis of cohort study data, stratified by recruitment setting. <https://www.ecdc.europa.eu/sites/default/files/documents/Prevalence-post-COVID-19-condition-symptoms.pdf>. [Accessed 17 December 2023].
- [24] National Center for Health Statistics. U.S. Census Bureau. Household pulse survey, 2022–2023. Long COVID. <https://www.cdc.gov/nchs/covid19/pulse/long-covid.htm>. [Accessed 17 December 2023].
- [25] Office for National Statistics (ONS). Prevalence of ongoing symptoms following coronavirus (COVID-19) infection in the UK. <https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/bulletins/prevalenceofongoingsymptomsfollowingcoronavirus/covid19infectionintheuk/30march2023>. [Accessed 17 December 2023].
- [26] Adjaye-Gbewonyo D, Vahratian A, Perrine CG, Bertolli J. Long COVID in adults: United States, 2022. Hyattsville, MD: National Center for Health Statistics; 2023.
- [27] Antonelli M, Capdevila Pujol J, Spector TD, Ourselin S, Steves CJ. Risk of long COVID associated with delta versus omicron variants of SARS-CoV-2. *Lancet* 2022;399:2263–4. [https://doi.org/10.1016/S0140-6736\(22\)00941-2](https://doi.org/10.1016/S0140-6736(22)00941-2).
- [28] Morioka S, Tsuzuki S, Suzuki M, Terada M, Akashi M, Osanai Y, et al. Post COVID-19 condition of the Omicron variant of SARS-CoV-2. *J Infect Chemother* 2022;28:1546–51. <https://doi.org/10.1016/j.jiac.2022.08.007>.
- [29] Poenaru S, Abdallah SJ, Corrales-Medina V, Cowan J. COVID-19 and post-infectious myalgic encephalomyelitis/chronic fatigue syndrome: a narrative review. *Ther Adv Infect Dis* 2021;8:20499361211009385. <https://doi.org/10.1177/20499361211009385>.
- [30] Vandentorren S, Smaili S, Chatignoux E, Maurel M, Alleaume C, Neufcourt L, et al. The effect of social deprivation on the dynamic of SARS-CoV-2 infection in France: a population-based analysis. *Lancet Public Health* 2022;7:e240–9. [https://doi.org/10.1016/S2468-2667\(22\)00007-X](https://doi.org/10.1016/S2468-2667(22)00007-X).
- [31] Perlis RH, Lunz Trujillo K, Safarpour A, Santillana M, Ognyanova K, Druckman J, et al. Association of post-COVID-19 condition symptoms and employment status. *JAMA Netw Open* 2023;6:e2256152. <https://doi.org/10.1001/jamanetworkopen.2022.56152>.
- [32] Stam HJ, Stucki G, Bickenbach J. European Academy of Rehabilitation Medicine. Covid-19 and post intensive care syndrome: a call for action. *J Rehabil Med* 2020;52(4):jrm00044. <https://doi.org/10.2340/16501977-2677>.
- [33] Hempel CG. Fundamentals of taxonomy. In: Hempel CG, editor. *Aspects of scientific explanation and other essays in the philosophy of science*. New York: Free Press; 1965.