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Influence of socioeconomic position on the relationship between long COVID and health-related quality of life: A nationwide random sampling survey in France in autumn 2022

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ABSTRACT

Socioeconomic position (SEP) is associated with long COVID risk and health-related quality of life (HRQoL). SEP may influence the relationship between long COVID and HRQoL, but evidence is lacking. Our study therefore evaluated the influence of SEP on the relationship between long COVID or post-COVID-19 condition (PCC) and HRQoL in a representative sample of the general French population.

After the Omicron waves in autumn 2022, a representative sample of 1448 adults infected with SARS-CoV-2 was assessed for post-COVID-19 symptoms, demographics, SEP, health factors and HRQoL using the PROMIS-29 questionnaire measuring HRQoL in eight domains (physical function, anxiety, depression, fatigue, sleep disturbance, ability to participate in social roles and activities, pain interference and pain intensity). PCC was defined according to the World Health Organisation. A conceptual model of the relationship between PCC and impaired HRQoL was proposed. Modifying effects of age, sex and SEP variables (geographic origin, education, household size, occupational category, employment status, household income) on the relationship between PCC and HRQoL were tested in the framework of this model.

PCC, low education level and household income negatively impacted overall HRQoL and 5/8 PROMIS-29 domains (depression, fatigue, sleep disturbance, social participation and pain intensity). PCC-induced HRQoL impairment was significantly higher among people without a long tertiary education, unemployed individuals, business owners and entrepreneurs and people from mainland France.

Healthcare providers and policymakers should better account for the differential impact of long COVID on HRQoL according to SEP. They should promote strategies to reduce health inequalities and lessen the burden of this condition in the general population.

1. Introduction

Since mid-2020, a condition characterised by variable, disabling and persistent symptoms following SARS-CoV-2 infection has become a public health concern in many countries. This condition is diversely known as 'long COVID' (Ladds et al., 2020; Callard and Perego, 2021),

'post-acute COVID-19 syndrome' (Greenhalgh et al., 2020; Nalbandian et al., 2021), 'post-COVID-19 condition' or 'post-acute sequelae of COVID-19' (Al-Aly et al., 2021). The WHO proposed a definition of 'post-COVID-19 condition' (PCC) based on an expert consensus using Delphi methodology and a broad symptom-based approach, as some symptoms are very common but unspecific (e.g., fatigue and dyspnoea),

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while others are more specific (e.g., taste and smell disorders) (Soriano et al., 2022). Pathophysiology of long COVID remains incompletely understood but a multisystem involvement is largely recognized (Davis et al., 2023; Greenhalgh et al., 2024). A recent study conducted in France confirmed 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 (Coste et al., 2024). Several factors are associated with long COVID, many of which are linked to health or COVID-19 infection: physical and mental health status (Sudre et al., 2021; Whitaker et al., 2022; Domènech-Montoliu et al., 2022; Robineau et al., 2022; Wang et al., 2022; Hedberg et al., 2023; Tran et al., 2023; Kataoka et al., 2023; Matta et al., 2023; Tebeka et al., 2023; Milde et al., 2023; Stephens et al., 2024; Mkoma et al., 2024; Pastorello et al., 2025; Coste et al., 2025), infection-related factors (number of infections, severity, number and type of symptoms) (Sudre et al., 2021; Domènech-Montoliu et al., 2022; Robineau et al., 2022; Yoo et al., 2022a, 2022b; Nehme et al., 2022; Tran et al., 2023; Stephens et al., 2024; Coste et al., 2025), health behaviours and lifestyle (smoking and alcohol use, physical activity, vaccination status) (Whitaker et al., 2022; Domènech-Montoliu et al., 2022; Perlis et al., 2022; Robineau et al., 2022; Wang et al., 2023; Lundberg-Morris et al., 2023; Coste et al., 2025) and healthcare system use (Yoo et al., 2022a, 2022b). However, sociodemographic characteristics such as sex, age, ethnicity, education, income and place of residence (Augustin et al., 2021; Søråas et al., 2021; Sudre et al., 2021; Whitaker et al., 2022; Domènech-Montoliu et al., 2022; Subramanian et al., 2022; Perlis et al., 2022; Robineau et al., 2022; Hedberg et al., 2023; Tran et al., 2023; Stephens et al., 2024; Mkoma et al., 2024; Pastorello et al., 2025; Coste et al., 2025), and work-related factors such as occupational status, type of occupation, occupational changes or work-related infection (Westerlind et al., 2021; Whitaker et al., 2022; Perlis et al., 2022; Pastorello et al., 2025; Coste et al., 2025; Rushyizekera et al., 2025) have also been associated with long COVID, thus pointing to the influence of living conditions and socioeconomic position (SEP).

Long COVID has a strong impact on self-perceived health status such as health-related quality of life (HRQoL) that can be defined as “how well a person functions in their life and his or her perceived wellbeing in physical, mental, and social domains of health” (Hays and Reeve, 2010; Karimi and Brazier, 2016). Indeed, people with long COVID or PCC have poorer HRQoL, even several months after acute COVID-19 infection recovery (Poudel et al., 2021; Amdal et al., 2021; Malik et al., 2022; Tsuzuki et al., 2022; Gentilotti et al., 2023; Vélez-Santamaría et al., 2023; Mastroirosa et al., 2023; Kirchberger et al., 2024; van den Hoek et al., 2024; Lapin et al., 2024; Schwartz et al., 2024). Interestingly, it has been shown that self-perceived health status are associated with SEP in many countries (von dem Knesebeck et al., 2006; Eikemo et al., 2008; Alvarez-Galvez et al., 2013). Moreover SEP may influence the relationship between medically objectified health and self-perceived health status. For instance, the impact of specific morbidity or health risk factors on self-perceived health status may vary according to the SEP (Sacker et al., 2008; Delpierre et al., 2009a,b; Dowd and Zajacova, 2010; Stafford et al., 2012; Dionne et al., 2016; Jusot et al., 2017) and the tools used to measure self-perceived health status (Delpierre et al., 2012). Such a phenomenon can be explained by the fact that perceptions of health and well-being result from a balance between a person’s actual state of health and the best possible health that they could expect for themselves. However, people’s expectations about their health may vary depending on their cultural or social background, which can lead to differences in the reporting of perceived health and well-being for the same ‘objective’ state of health. According to comparison processes theory, individuals compare themselves to others to whom they are socially similar (Festinger, 1954; Suls and Wills, 1991). As a result, socially advantaged groups, such as those with a high level of education, have the highest expectations in terms of quality of life and health, and

vice versa (Ross and Van Willigen, 1997), which can then lead to differences in the perception of health status between social groups for the same diagnosed disease ... However, other studies have not found any influence of social position on the relationship between the same medically diagnosed condition and self-perceived health status. (Galenkamp et al., 2019).

Based on the literature, it nevertheless seems relevant to question how the relationship between medically diagnosed condition and self-perceived health status can be influenced or “modified” (Vanderweele, 2019) by SEP. To our knowledge, no studies have explored the relationship between long COVID, as a medically objectified health condition or pathology, and HRQoL, as a measure of self-perceived health status, according to SEP. Understanding the moderating role of SEP in the association between long COVID and HRQoL is crucial for both clinicians and policymakers. For clinicians, recognizing how SEP influences the impact of long COVID on patients’ well-being can lead to more tailored and effective treatment strategies. For policymakers, this research highlights the need for targeted public health initiatives that address the disparities in long COVID outcomes, thereby promoting health equity and improving overall population health. Based on the existing evidence on the influence of SEP on the risk of long COVID and HRQoL on the one hand and on the relationship between medically objectified health and perceived health on the other, we hypothesise that SEP could influence the relationship between long COVID and quality of life. The main aim of this study is to analyse the influence of SEP on the relationship between long COVID and HRQoL, as assessed by the PROMIS-29 in a representative sample of the French general population.

2. Materials and methods

2.1. Study design and stages

This study is based on a large general population survey undertaken between 2 September and December 31, 2022, which aimed to evaluate the prevalence of long COVID (Coste et al., 2024), and associated factors in France (Coste et al., 2025). Briefly, 10,615 participants aged ≥ 18 years and living in mainland France were selected using a random sampling method (digit dialling of landline and mobile telephone numbers) and first interviewed by telephone (computer-assisted telephone interviewing, CATI) to determine, among others, if they had been infected by SARS-CoV-2 and presented PCC according to the WHO definition. All participants with PCC or self-reported long COVID as well as one out of two randomly selected participants who reported SARS-CoV-2 infection without PCC or self-reported long COVID were subsequently invited to complete a self-administered online questionnaire (computer-aided web interview, CAWI). The sampling ratios were chosen to ensure the minimum sample size for each sample group (>150 participants) (Coste et al., 2025).

2.2. Collected data

The CATI phase collected information about participants’ socioeconomic characteristics, previous SARS-CoV-2 infections and present symptoms (from a list of 31) (Coste et al., 2024) with details about the date of onset, alternative diagnoses, and impact on daily functioning, which allowed us to apply (or not) the WHO definition of PCC. The CAWI phase collected detailed information about pre-existing chronic conditions (from a list of 21), health behaviour (smoking, alcohol use, physical activity) and vaccination along with PROMIS-29 scales to measure HRQoL. The validated French version of PROMIS-29 was used (Fischer et al., 2018; Coste et al., 2018).

2.3. WHO definition of long COVID

The standard definition of WHO-PCC was used in this study (Soriano

et al., 2022). To be considered to have PCC, a participant had to present at least one symptom (from a list of 31) that appeared within 3 months of a probable SARS-CoV-2 infection, lasted for at least 2 months, had an impact (even low) on daily functioning and, according to a physician, could not be explained by an alternative diagnosis.

2.4. PROMIS-29 scales and categorization of HRQoL measures

PROMIS-29 is a generic HRQoL measure consisting of eight scales, with four items for each of seven domains (physical function, anxiety, depression, fatigue, sleep disturbance, ability to participate in social roles and activities and pain interference) and a single item for the pain intensity domain. Items have five response categories (1–5), and a total raw score (4–20) is computed for each scale or domain, except for the pain intensity item with 11 response categories (0–10). Due to well-known significant floor and ceiling effects for several PROMIS-29 scales, resulting in asymmetrical and skewed distributions of population reference values, raw scores were dichotomized to identify subjects with impaired HRQoL for each domain using cut-offs corresponding to the **95th percentiles** (depression, anxiety, fatigue, sleep disturbance, pain interference and intensity) or **5th percentiles** (physical function and ability to participate in social roles and activities) of French reference values (Fischer et al., 2018; Coste et al., 2018). These eight assessed scales were finally combined to yield an overall binary assessment of impaired HRQoL when at least two scales were impaired. Due to the frequency of fatigue in patients with PCC (and the likely impact on the corresponding PROMIS-29 scale), a threshold of two impaired domains was found to be more adequate when assessing overall HRQoL so as not to be tautological with the PCC definition.

2.5. Statistical analysis

The modifying effect of demographic and SEP variables (sex, age, geographic origin, education, household size, occupational category, employment status, household income) on the relationship between PCC and HRQoL was tested within the framework of the conceptual model presented in Fig. 1, following the recommendations of Knol and VanderWeele (2012).

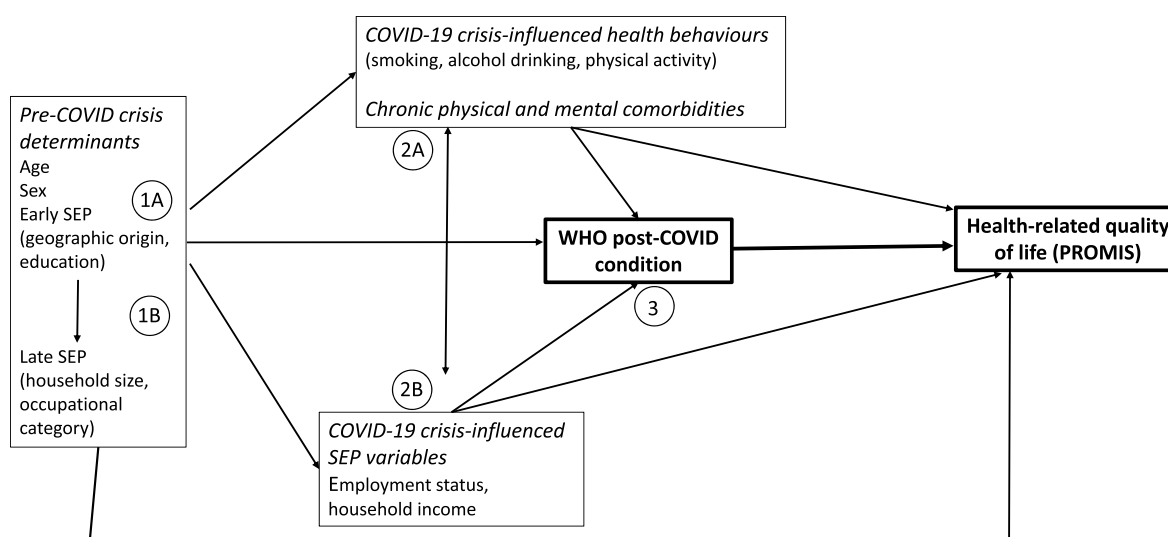
Determinants of HRQoL indicators were tested in **three stages**. The ‘pre-COVID-19 crisis’ determinants were tested in the first stage by

successively considering set 1A comprising age, sex and early determined SEP variables (education, geographic origin) and then set 1B comprising later determined SEP variables (household size and occupational category). The difference between early SEP and later SEP lies in the fact that the two variables of early SEP (geographical origin and educational attainment) are acquired at birth or early in life and are therefore likely to influence social position in adulthood and are not, or only to a limited extent, subject to reverse causality (i.e., the effect of long COVID on social position). ‘COVID-19 crisis-influenced’ determinants were tested in the second stage by successively considering set 2A comprising health behaviours (smoking, alcohol drinking, physical activity) and comorbid chronic mental and physical conditions (0, 1, 2+) and then set 2B comprising SEP variables (employment status, income). PCC was tested during the third stage. Poisson regression with robust (sandwich) variance was constructed hierarchically to derive prevalence ratios (PR) and 95 % confidence intervals (CI) of impaired HRQoL and individual PROMIS-29 domains (Zou, 2004; Spiegelman and Hertzmark, 2005).

The modifying effect of each demographic or SEP variable on the relationship between PCC and HRQoL indicators was further tested by estimating the ratio of prevalence ratios (RoPR). RoPR (and 95 % confidence intervals, CIs) are exponentiated interaction coefficients (and their 95 % CI) of each tested modifier of the relationship between PCC and HRQoL. They may be interpreted as the relative prevalence ratio for an impaired HRQoL associated with PCC *and* a given SEP factor compared to that associated with PCC *without* this particular SEP factor. A value significantly different from 1 indicates a modifying effect.

Each effect modifier was tested with covariates belonging to the same set of early, late or crisis-influenced demographic and SEP determinants (as described above). Significant effect modifiers identified at any stage were **retested**, including all the factors independently associated with HRQoL indicators. This latter analysis aimed to determine whether the modifying effect could be mediated by subsequent factors in the pathway to HRQoL.

All analyses (descriptive and analytical) were performed using SAS, version 9.2, software (SAS Institute Inc.), and appropriate weights were used to provide valid estimates for the French population, while accounting for the unequal probabilities of selection due to the sample design and non-response (Coste et al., 2025).



SEP: socioeconomic position

Circles indicate sets of variables, and arrows indicate the causal influence between sets of variables.

In bold, the association between our main exposure and the outcome.

Fig. 1. Conceptual model and sets of factors of long COVID and health-related quality of life.

3. Results

3.1. Characteristics of participants

A total of 1448 participants infected with SARS-CoV-2 who completed both the CAWI and PROMIS-29 questionnaires were included in this study. The response rate of 43 % to the CAWI phase was similar across groups (PCC and non-PCC) (Supplementary Fig. S1). Among these participants, 178 met the standard WHO definition of PCC (7 %). Table 1 summarises the other characteristics of participants, and Supplementary Table S1 presents raw scores for PROMIS-29 domains.

Subjects with PCC more likely had impaired overall HRQoL (i.e., at least two impaired PROMIS-29 domains, 59 % vs 12 % in subjects without PCC). The most impaired domains were fatigue (29 %), ability to participate in social roles and activities (21 %), sleep disturbance (22 %) and depression (20 %). By contrast, the levels of impairment were slightly above 5 % for all domains in subjects without PCC.

3.2. Factors associated with impaired HRQoL

Factors associated with impaired overall HRQoL and impaired individual PROMIS-29 domains are shown in Table 2 and Supplementary Table S2, respectively.

Regarding overall HRQoL (Table 2), among the SEP variables, lower education (stage 1 model) and lower household income (stage 2 model) were associated with impaired HRQoL with a dose-response relationship. The association of education with HRQoL disappeared after adjusting for COVID-19 crisis-influenced determinants, especially household income and chronic conditions (stage 2 model), whereas the association of household income with HRQoL persisted after adjusting for PCC in stage 3. Geographic origin, household size and employment status were never associated with impaired HRQoL. Regarding the demographic variables, no statistical association with sex was found, and the associations between older age and lower probability of HRQoL impairment observed in the stage 1 model disappeared after adjusting for COVID-19 crisis-influenced determinants (stage 2 model). Regarding the health conditions tested in stages 2 and 3, both chronic physical and mental conditions, particularly the latter, were associated with impaired HRQoL (with dose-response relationships), along with daily smoking and weekly vigorous physical activity. In stage 3, PCC was associated with impaired overall HRQoL (PR = 1.47, 95 % CI: 1.13–1.91).

Regarding the individual PROMIS-29 domains (Supplementary Table S1), lower education (stage 1 model) and lower household income (stage 2 model) were associated with several individual PROMIS-29 domains, notably 5/8 domains for education (physical function, fatigue, sleep disturbance, pain interference and pain intensity) and 6/8 for household income (all except anxiety and social participation). These relationships mostly exhibited dose-response characteristics. For fatigue and sleep disturbance domains, the relationships with lower education were partially mediated by PCC, as they partly disappeared in stage 3. Occupational category, tested in stage 1, was only associated with physical function, with manual workers and middle managers having a higher risk of impaired physical function. Geographic origin, household size, and employment status were never associated with any impaired HRQoL domain. Regarding age and sex, a few associations were observed: higher risk of fatigue in women and higher risk of depression and impaired social participation in men; higher risk of anxiety in those aged 18–24 years, while decreased risk of fatigue, pain intensity, sleep disturbance and impaired social participation in those aged 55–64 and ≥65 years. In stage 2, chronic conditions were strongly associated with HRQoL, especially mental health conditions (7/8 domains except for pain intensity) as well as physical conditions (5/8: physical function, fatigue, sleep disturbance, pain interference and pain intensity, especially for subjects with multimorbidity). However, health behaviours were more rarely associated with HRQoL, namely smoking (1/8: sleep disturbance), moderate physical activity (2/8: physical function,

Table 1

Characteristics of participants according to the presence of post-COVID-19 condition (World Health Organisation's standard definition) with N (±SE) or mean (SE) as appropriate. N for number observed, % for weighted percentage, SE for standard error of the mean or percentage.

	WHO-PCC (N = 178)	Infected non-PCC (N = 1270)
	N (%)	N (%)
Sex		
Men	48 (29 ± 4)	576 (48 ± 1)
Women	130 (71 ± 4)	694 (52 ± 1)
Age		
18–24 years	10 (6 ± 2)	107 (10 ± 1)
25–34 years	26 (17 ± 3)	148 (14 ± 1)
35–44 years	33 (19 ± 3)	248 (18 ± 1)
45–54 years	51 (26 ± 3)	272 (19 ± 1)
55–64 years	39 (20 ± 3)	248 (17 ± 1)
≥65 years	19 (12 ± 3)	247 (21 ± 1)
Geographic origin		
Mainland France	161 (91 ± 2)	1154 (91 ± 1)
French overseas department and foreign countries	17 (9 ± 2)	116 (9 ± 1)
Education		
Less than secondary	43 (30 ± 4)	330 (31 ± 1)
Secondary	30 (19 ± 3)	240 (21)
Tertiary short (university <5 years)	68 (33 ± 3)	419 (29 ± 1)
Tertiary long (university ≥5 years)	37 (18 ± 3)	281 (20 ± 1)
Occupational class		
Company manager, entrepreneur	8 (5 ± 2)	68 (6 ± 1)
Senior manager, professional	49 (24 ± 3)	341 (24 ± 1)
Middle manager, teacher	17 (9 ± 2)	147 (11 ± 1)
Office employee	53 (30 ± 4)	257 (20 ± 1)
Manual worker	5 (4 ± 2)	31 (3 ± 1)
No occupation, retired or studying (inactive)	46 (28 ± 4)	426 (37 ± 1)
Household size		
1 person	27 (16 ± 3)	275 (22 ± 1)
2+ persons	151 (84 ± 3)	995 (78 ± 1)
Employment status		
Paid employment	124 (67 ± 4)	796 (60 ± 1)
Unemployed	8 (5 ± 2)	48 (4 ± 1)
Retired	25 (14 ± 3)	301 (25 ± 1)
Other inactive	21 (14 ± 3)	125 (11 ± 1)
Household income		
First tertile	29 (19 ± 3)	207 (18 ± 1)
Second tertile	65 (37 ± 4)	450 (36 ± 1)
Third tertile	76 (40 ± 4)	561 (42 ± 1)
Not reported	8 (4 ± 1)	52 (4 ± 1)
Number of individual chronic conditions		
0	28 (16 ± 3)	485 (40 ± 1)
1	41 (22 ± 3)	343 (27 ± 1)
2+	109 (62 ± 4)	442 (33 ± 1)
Number of individual chronic conditions (non-mental health)		
0	43 (25 ± 4)	555 (45 ± 1)
1	51 (27 ± 3)	342 (26 ± 1)
2+	84 (48 ± 4)	373 (27 ± 1)
Number of individual chronic conditions (mental health)		
0	100 (54 ± 4)	1040 (83 ± 1)
1	52 (31 ± 4)	172 (13 ± 1)
2	26 (15 ± 3)	58 (4 ± 1)
Alcohol consumption		
Less than one day/week	107 (61 ± 4)	640 (51 ± 1)
1–6 days/week	60 (34 ± 4)	544 (43 ± 1)
Every day	11 (5 ± 2)	86 (7 ± 1)
Daily smoking		
No	139 (77 ± 3)	1096 (86 ± 1)
Yes	39 (23 ± 3)	174 (14 ± 1)
Moderate physical activity		
Several times/week	104 (6 ± 2)	776 (61 ± 1)
At least once/month	64 (36 ± 4)	431 (33 ± 1)
Less than once/month	10 (59 ± 4)	63 (5 ± 1)
Vigorous physical activity		
Several times/week	71 (42 ± 4)	585 (21 ± 1)
At least once/month	74 (39 ± 4)	413 (32 ± 1)
Less than once/month	33 (19 ± 3)	272 (47 ± 1)
PROMIS-29 domain scores		

(continued on next page)

Table 1 (continued)

	WHO-PCC (N = 178)	Infected non-PCC (N = 1270)
	N (%)	N (%)
Physical function	18.2 (0.2)	19.0 (0.1)
Anxiety	9.7 (0.3)	7.1 (0.1)
Depression	9.0 (0.4)	6.2 (0.1)
Fatigue	11.8 (0.3)	8.0 (0.1)
Sleep disturbance	12.3 (0.3)	9.7 (0.1)
Ability to participate in social roles and activities	13.6 (0.4)	16.8 (0.1)
Pain interference	9.5 (0.4)	6.2 (0.1)
Pain intensity	3.9 (0.2)	2.1 (0.1)
Impaired PROMIS-29 domain		
Physical function	23 (14 ± 3)	81 (6 ± 1)
Anxiety	29 (19 ± 3)	90 (7 ± 1)
Depression	32 (20 ± 3)	69 (5 ± 1)
Fatigue	51 (29 ± 4)	108 (7 ± 1)
Sleep disturbance	35 (22 ± 3)	101 (7 ± 1)
Ability to participate in social roles and activities	37 (21 ± 3)	98 (7 ± 1)
Pain interference	25 (17 ± 3)	68 (5 ± 1)
Pain intensity	24 (16 ± 3)	65 (5 ± 1)
<i>2 and more dimensions impaired</i>	59 (36 ± 4)	169 (12 ± 1)

depression) and vigorous physical activity (2/8: fatigue, sleep disturbance) but without a dose-response relationship. PCC was associated with impaired HRQoL for 5/8 domains (depression, fatigue, sleep disturbance, social participation, pain intensity), with a PR of around 2 (Supplementary Table S2).

3.3. Modifiers of the relationship between PCC and HRQoL

Significant interactions were evidenced for overall HRQoL and 5/8 domains: anxiety, depression, fatigue, sleep disturbance and pain interference.

RoPR (exponentiated interaction terms) associated with each significant modifying effect of the relationship between PCC and HRQoL are presented in Table 3. The risk of impaired overall HRQoL due to PCC was much higher for those with shorter education (less than 5 years of university) (RoPR >4) compared to those with the highest level of education (5 years of university), with no dose-response relationship and no significant mediation or confusion with other SEP or health variables. The same modifying effect of education was observed for the association between PCC and several individual HRQoL domains such as depression and fatigue. In this case, other SEP and health variables have likely mediating effects, since RoPR was closer to 1 when adjusting for these variables.

The deleterious impact of PCC on several HRQoL domains such as fatigue and pain interference was much greater among the unemployed, business owners and entrepreneurs (compared to senior managers) as well as those from mainland France. This impact was unlikely mediated by health variables, as RoPR for these variables remained relatively unchanged in the fully adjusted model.

The deleterious impact of PCC on sleep disturbance was moderately lower in women and only partly explained by health variables. The deleterious impact of PCC was lower on anxiety in 45–54 yr olds and higher on fatigue in 55–64 yr olds, not or only partly explained by other SEP and health variables respectively.

No significant interaction was evidenced with household size and household income.

4. Discussion

4.1. Main findings

This study analysed the influence of SEP on the relationship between long COVID and HRQoL in a representative sample of the French adult

Table 2

Factors associated with overall impaired HRQoL (at least two PROMIS-29 domains impaired) at the three stages of modelling (stage 1: pre-COVID-19 crisis determinants, stage 2: pre-COVID-19 crisis and crisis-influenced determinants, stage 3: all determinants and PCC). Poisson regression with robust (sandwich) variance providing prevalence ratios (PR) and 95 % confidence intervals (CI). Bold characters indicate statistically significant associations.

	Stage 1 model	Stage 2 model	Stage 3 model
Long COVID			
WHO-PCC			
No			1.00 (Ref.)
Yes			1.47 (1.13–1.91)
Pre-COVID-19 determinants			
Sex			
Men	1.00 (Ref.)	1.00 (Ref.)	1.00 (Ref.)
Women	1.27 (0.96–1.69)	0.79 (0.60–1.04)	0.80 (0.60–1.05)
Age			
18–24 years	0.92 (0.53–1.59)	1.09 (0.69–1.71)	1.14 (0.73–1.79)
25–34 years	1.00 (Ref.)	1.00 (Ref.)	1.00 (Ref.)
35–44 years	0.63 (0.40–0.99)	0.85 (0.54–1.33)	0.84 (0.54–1.32)
45–54 years	0.66 (0.43–1.02)	0.78 (0.51–1.19)	0.77 (0.50–1.18)
55–64 years	0.45 (0.28–0.74)	0.73 (0.46–1.16)	0.70 (0.44–1.12)
≥65 years	0.44 (0.24–0.80)	1.14 (0.61–2.13)	1.09 (0.59–2.02)
Geographic origin			
Mainland France	1.00 (Ref.)	1.00 (Ref.)	1.00 (Ref.)
French overseas department and foreign countries	0.71 (0.47–1.07)	0.76 (0.53–1.09)	0.77 (0.53–1.12)
Education			
Less than secondary	2.44 (1.44–4.13)	1.39 (0.83–2.33)	1.42 (0.85–2.37)
Secondary	1.67 (0.96–2.89)	1.26 (0.73–2.20)	1.27 (0.73–2.21)
Tertiary short (university <5 years)	1.52 (0.94–2.47)	1.21 (0.77–1.91)	1.23 (0.78–1.93)
Tertiary long (university ≥5 years)	1.00 (Ref.)	1.00 (Ref.)	1.00 (Ref.)
Occupational category			
Company manager, entrepreneur	0.52 (0.22–1.23)	0.63 (0.29–1.36)	0.62 (0.29–1.34)
Senior manager, professional	1.00 (Ref.)	1.00 (Ref.)	1.00 (Ref.)
Middle manager, teacher	0.74 (0.43–1.29)	0.77 (0.46–1.30)	0.76 (0.45–1.28)
Office employee	1.12 (0.71–1.75)	0.96 (0.63–1.49)	0.93 (0.60–1.44)
Manual worker	0.82 (0.32–2.13)	0.82 (0.35–1.89)	0.75 (0.32–1.76)
No occupation, retired or studying (inactive)	1.07 (0.63–1.80)	NT	NT
Household size			
1 person	1.28 (0.93–1.75)	1.04 (0.76–1.41)	1.07 (0.79–1.46)
2+ persons	1.00 (Ref.)	1.00 (Ref.)	1.00 (Ref.)
COVID-19 crisis-influenced determinants			
Employment status			
Paid employment		1.00 (Ref.)	1.00 (Ref.)
Unemployed		1.05 (0.64–1.73)	1.07 (0.66–1.75)
Retired		NT	NT
Other inactive			
Household income			
First tertile		1.81 (1.20–2.74)	1.78 (1.17–2.69)
Second tertile		1.60 (1.16–2.20)	1.57 (1.13–2.17)
Third tertile		1.00 (Ref.)	1.00 (Ref.)
Not reported		0.99 (0.46–2.10)	0.99 (0.47–2.11)
Number of individual chronic conditions (non-mental health)			
0		1.00 (Ref.)	1.00 (Ref.)

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Table 2 (continued)

	Stage 1 model	Stage 2 model	Stage 3 model
1		1.24 (0.85–1.82)	1.23 (0.84–1.80)
2+		2.33 (1.68–3.23)	2.28 (1.64–3.17)
Number of individual chronic conditions (mental health)			
0		1.00 (Ref.)	1.00 (Ref.)
1		2.69 (1.97–3.67)	2.56 (1.87–3.51)
2		4.61 (3.37–6.30)	4.20 (3.04–5.81)
Alcohol consumption			
Less than one day/week		1.00 (Ref.)	1.00 (Ref.)
1–6 days/week		0.82 (0.62–1.08)	0.84 (0.63–1.11)
Every day		0.81 (0.57–1.15)	0.84 (0.59–1.20)
Daily smoking			
No		1.00 (Ref.)	1.00 (Ref.)
Yes		1.51 (1.11–2.04)	1.48 (1.09–2.01)
Moderate physical activity			
Several times/week		1.00 (Ref.)	1.00 (Ref.)
At least once/month		0.98 (0.61–1.57)	0.96 (0.60–1.55)
Less than once/month		1.16 (0.71–1.88)	1.15 (0.70–1.88)
Vigorous physical activity			
Several times/week		1.00 (Ref.)	1.00 (Ref.)
At least once/month		0.69 (0.50–0.95)	0.69 (0.50–0.96)
Less than once/month		0.73 (0.54–0.98)	0.73 (0.54–0.99)

population. Our results show that, as expected, people with PCC have an increased risk of impaired quality of life. This deleterious effect was significant for 5/8 domains of PROMIS-29, notably depression, fatigue, sleep disturbance, social participation and pain intensity. Low levels of education and household income had a negative impact on HRQoL, as did chronic health conditions, particularly mental health conditions. The independent influence of health behaviours on HRQoL was more limited. Regarding SEP-related effect modifiers, we found that the risk of PCC-induced impairment of overall HRQoL was significantly higher in people with a shorter education (less than 5 years of university) (with no dose-response relationship), in the unemployed, business owners and entrepreneurs as well as in people from mainland France. This effect was also observed on specific PROMIS-29 domains such as depression, fatigue and pain interference.

4.2. Study strengths and limitations

The main strengths of this study are its large and representative sample, and the wide array of factors considered with regard to socio-demographic characteristics, health status and health behaviours. Random sampling ensures statistical representativeness, and the use of weights accounts for the unequal probabilities of selection resulting from sample design and non-responses to provide valid estimates for the French population. Furthermore, HRQoL is assessed using a validated multidimensional instrument (PROMIS-29), while long COVID is defined using the WHO-PCC standard definition. Another strength of this study is the use of a conceptual model to analyse the influence of sociodemographic factors on the relationship between long COVID and HRQoL. Results on impaired overall HRQoL and its various domains allow us to better understand the link between long COVID and HRQoL according to SEP.

The study also has several limitations. Firstly, the cross-sectional nature of the study limits the extent to which causal inferences can be made. Although our conceptual model takes into account the chronology of the various factors and makes adjustments accordingly, caution is

still required when making causal interpretations of the associations found in this study. Secondly, the exclusively self-reported nature of the data, despite being collected by experienced professionals during the CATI stage, raises the question of misclassification regarding both long COVID and impaired HRQoL. As the participants were not informed about the precise objectives of the study, these errors are probably non-differential, which tends to attenuate the associations observed. Thirdly, some domains of the PROMIS-29 may overlap too closely with the symptoms characteristic of long COVID (especially fatigue), thus leading to a risk of circularity. However, this risk was limited by the separate analyses of the domains along with the requirement for two impaired domains in the overall measure. Fourthly, the use of the WHO definition of long COVID with a list of symptoms limited to 31 (Coste et al., 2024) may have lacked sensitivity to fully address the whole spectrum of long COVID manifestations (Al Aly et al., 2021; Davis et al., 2023) and may have missed less symptomatic cases. Of course, our results should be interpreted within the framework of the categories and measurements used and their inherent limitations. Fifthly, the sample of people with long COVID is somewhat limited (N = 178), which limits the external validity and the statistical power of certain tests, although a post hoc power analysis showed that the actual sample size of this study (178 PCC and 1270 non PCC subjects) provided a 85 % power to detect a difference in prevalence between groups of 4 % in the worst case ($\alpha = 0.05$, two sided test). However, the interaction tests could have lacked power (VanderWeele and Knol, 2014).

Finally, despite considering a wide range of variables, unmeasured confounding (e.g., health beliefs, COVID-19-related exposure) cannot be ruled out.

4.3. Comparison with other studies

Barring a few exceptions (Schwartz et al., 2024), knowledge regarding the impact of long COVID on HRQoL derives from clinical studies or from samples of infected subjects recruited within the healthcare system (Poudel et al., 2021; Amdal et al., 2021; Malik et al., 2022; Vélez-Santamaría et al., 2023; Mastroiosa et al., 2023; van den Hoek et al., 2024; Kirchberger et al., 2024), which lack population representativeness. Moreover, most elaborate studies focus on the clinical symptoms associated with the most impaired HRQoL (Tsuzuki et al., 2022; Gentilotti et al., 2023; Lapin et al., 2024). Previous studies also failed to consider factors as chronologically or logically ordered and to distinguish the covariates likely to be intermediates, which, if controlled for, would lead to an overadjustment. This problem may be especially serious when addressing demographic and SEP factors that may be determinants of SARS-CoV-2 infection before being determinants of long COVID (Coste et al., 2025; Rushyizekera et al., 2025). Confirming that the symptom burden of long COVID is associated with worse HRQoL, Schwartz et al. emphasized various behavioural, healthcare and socio-economic factors, including financial hardship, interplaying with symptoms (Schwartz et al., 2024). Our study goes even further by considering long COVID as a determinant of HRQoL in interaction with SEP variables according to a conceptual model that accounts for the well-established relationship between SEP and HRQoL. We showed that the relationship between long COVID and HRQoL varied according to SEP. Although long COVID alters HRQoL, its impact is even stronger in more socially disadvantaged individuals (those without tertiary education or the unemployed). These results are in line with numerous articles showing that the relationship between health conditions and perceived health is modulated by SEP (Sacker et al., 2008; Delpierre et al., 2009a, b; Dowd and Zajacova, 2010; Stafford et al., 2012; Dionne et al., 2016; Jusot et al., 2017). More specifically, our results are in line with these studies, which demonstrate that the deleterious impact of morbidity on HRQoL may be greater in lower socioeconomic groups. However, other studies did not observe such differential associations (Galenkamp et al., 2019). The inconsistent results between studies may be due to methodological aspects such as whether or not other comorbidities are

Table 3

Ratios of prevalence ratios (exponentiated interaction terms) associated with each significant effect modifiers of the relationship between PCC and HRQoL. No significant interaction was evidenced for physical function, ability to participate in social roles and activities and pain intensity. Bold characters indicate statistically significant associations.

	Two dimensions		Anxiety		Depression		Fatigue		Sleep disturbance		Pain interference	
	Stage adjusted	Fully adjusted ^d	Stage adjusted	Fully adjusted ^d	Stage adjusted	Fully adjusted ^d	Stage adjusted	Fully adjusted ^d	Stage adjusted	Fully adjusted ^d	Stage adjusted	Fully adjusted ^d
<i>Pre-COVID-19 crisis determinants</i>												
<i>Demographic and early SEP variables^a</i>												
<i>Sex</i>												
Men									(ref.)	(ref.)		
Women									0.45	0.48		
									(0.21–0.95)	(0.22–1.06)		
<i>Age</i>												
18–24 years			0.19	0.47			0.92	1.57				
			(0.03–1.07)	(0.09–2.57)			(0.20–4.12)	(0.35–7.09)				
25–34 years			(ref.)	(ref.)			(ref.)	(ref.)				
35–44 years			1.03	1.01			1.73	1.58				
			(0.23–4.66)	(0.23–4.48)			(0.65–4.58)	(0.51–4.86)				
45–54 years			0.22	0.26			1.78	1.75				
			(0.05–0.94)	(0.07–0.95)			(0.73–4.39)	(0.66–4.62)				
55–64 years			0.76	0.53			2.81	2.09				
			(0.17–3.31)	(0.12–2.42)			(1.11–7.10)	(0.73–6.02)				
≥65 years			0.55	0.60			2.53	1.69				
			(0.13–2.28)	(0.13–2.72)			(0.48–13.34)	(0.34–8.49)				
<i>Geographic origin</i>												
Mainland France							(ref.)	(ref.)			(ref.)	(ref.)
French overseas							0.28	0.39			0.37	0.39
department and foreign country							(0.09–0.86)	(0.13–1.16)			(0.14–0.98)	(0.14–1.13)
<i>Education</i>												
Less than secondary	4.64	3.03			5.23	2.35	2.76	1.83				
	(1.33–16.17)	(0.93–9.80)			(1.01–27.11)	(0.46–12.05)	(0.94–8.12)	(0.60–5.59)				
Secondary	4.26	2.64			3.65	1.23	2.42	1.74				
	(1.15–15.77)	(0.77–9.04)			(0.67–19.94)	(0.22–6.83)	(0.72–8.09)	(0.50–6.10)				
Tertiary short (university <5 years)	5.28	4.97			4.01	2.48	3.12	3.12				
	(1.50–18.63)	(1.51–16.30)			(0.72–22.26)	(0.45–13.73)	(1.13–8.64)	(1.04–9.36)				
Tertiary long (university ≥5 years)	(ref.)	(ref.)			(ref.)	(ref.)	(ref.)	(ref.)				
<i>Late pre-crisis SEP variables^b</i>												
<i>Occupational category</i>												
Company manager, entrepreneur							14.90	10.89				
							(1.53–144.90)	(1.09–109.16)				
Senior manager, professional							(ref.)	(ref.)				
Middle manager, teacher							2.10	1.71				
							(0.70–6.33)	(0.45–6.41)				
Office employee							1.94	1.42				
							(0.81–4.65)	(0.56–3.59)				
Manual worker							7.76	5.02				
							(0.67–89.82)	(0.45–55.76)				
No occupation, retired or studying (inactive)							1.92	1.32				
							(0.75–4.92)	(0.52–3.34)				

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Table 3 (continued)

	Two dimensions		Anxiety		Depression		Fatigue		Sleep disturbance		Pain interference	
	Stage adjusted	Fully adjusted ^d	Stage adjusted	Fully adjusted ^d	Stage adjusted	Fully adjusted ^d	Stage adjusted	Fully adjusted ^d	Stage adjusted	Fully adjusted ^d	Stage adjusted	Fully adjusted ^d
COVID-19 crisis-influenced SEP variables^c												
Employment status												
Paid employment		(ref.)										
Unemployed		4.80 (1.01–22.72)										
Retired		1.12 (0.25–5.10)										
Other inactive		NT										

^a Models include 1A set of variables (sex, age, geographic origin and education) and PCC.

^b Models include 1A and 1B sets of variables (sex, age, geographic origin, education, marital status and occupational category) and PCC.

^c Models include 1A, 1B and 2B sets of variables (sex, age, geographic origin, education, marital status, occupational category, employment status and household income).

^d Models include 1A, 1B, 2A and 2B sets of variables (sex, age, geographic origin, education, marital status, occupational category, employment status, household income, number of non-mental health chronic conditions, number of mental health chronic conditions, alcohol consumption, daily smoking, moderate physical activity and vigorous physical activity).

considered when analysing the impact of a single chronic disease or to the way in which the interaction between health conditions and SEP is measured (additive or multiplicative).

5. Conclusion

As expected, long COVID negatively impacts HRQoL, with this effect being modified by several SEP variables and more pronounced in lower socioeconomic groups. Since SEP is also associated with the risk of long COVID in people infected with COVID-19, healthcare providers and policymakers need to better take into account the role of socioeconomic factors on the long COVID risk and its differential impact on quality of life in order to reduce the burden of this disease in the general population. Clinicians should undertake SEP assessments to ensure that all patients, particularly those from disadvantaged backgrounds, have access to interventions found to be effective in long COVID. Likewise, policymakers should address socioeconomic disparities by enhancing healthcare access and promoting health literacy in order to mitigate the burden of long COVID on vulnerable populations and reduce health inequalities. Future research should explore the mechanisms linking SEP, long COVID and HRQoL using longitudinal studies to evaluate intervention effectiveness and to understand the interaction with other health determinants, thereby informing more equitable healthcare strategies.

CRedit authorship contribution statement

Cyrille Delpierre: Writing – original draft, Methodology, Conceptualization. **Cédric Lemogne:** Writing – review & editing. **Olivier Steichen:** Writing – review & editing. **Sarah Tebeka:** Writing – review & editing. **Tatjana T. Makovski:** Writing – review & editing. **Joël Coste:** Writing – review & editing, Methodology, Formal analysis, Data curation, Conceptualization.

Ethical approval

Informed consent was obtained from all individual participants included in the study. The survey planning, conduct and reporting was in line with the Declaration of Helsinki and French laws. The survey was approved by the institutional review board of Santé Publique France, the French Public Health Agency, on August 19, 2022.

Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.socscimed.2025.118368>.

Data availability

Data will be made available on request.

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