Impact of socio-economic status in patients hospitalised for COVID-19 in the Greater Paris area

Lucile Sesé, Yann Nguyen, Etienne Giroux Leprieur, Isabella Annesi-Maesano, Catherine Cavalin, Jeanne Goupil de Bouillé, Louis Demestier, Robin Dhote, Yacine Tandjaoui-Lambiotte, Adeline Bauvois, Marion Pépin, Sonja Curac, Sébastien Beaune, Boris Duchemann, Hilario Nunes

Please cite this article as: Sesé L, Nguyen Y, Giroux Leprieur E, et al. Impact of socio-economic status in patients hospitalised for COVID-19 in the Greater Paris area. Eur Respir J 2020; in press (https://doi.org/10.1183/13993003.02364-2020).

This manuscript has recently been accepted for publication in the European Respiratory Journal. It is published here in its accepted form prior to copyediting and typesetting by our production team. After these production processes are complete and the authors have approved the resulting proofs, the article will move to the latest issue of the ERJ online.

Copyright ©ERS 2020. This article is open access and distributed under the terms of the Creative Commons Attribution Non-Commercial Licence 4.0.
Impact of socio-economic status in patients hospitalized for COVID-19 in the Greater Paris area

Lucile Sesé 1, Yann Nguyen 2, Etienne Giroux Lepriéur 3, Isabella Annesi-Maesano 4, Catherine Cavalin 5, Jeanne Goupil de Bouillé 6, Louis Demestier 7, Robin Dhote 8, Yacine Tandjaoui-Lambiotte 9, Adeline Bauvois 10, Marion Pépin, 11, Sonja Curac 12, Sébastien Beaune 13, Boris Duchemann 14*, Hilario Nunes 15*

1 Department of Physiologie and Pulmonology, Avicenne Hospital, Assistance Publique-Hôpitaux de Paris, Sorbonne University of Paris Nord, Bobigny, France

2 Department of Internal Medicine, Beaujon Hospital, Assistance Publique-Hôpitaux de Paris, University of Paris, Clichy, France

3 Department of Pulmonology and thoracic oncology, Ambroise Paré Hospital, Assistance Publique-Hôpitaux de Paris, France & Paris-Saclay University UVSQ, EA 4340 BECCOH, Boulogne, France

4 Epidemiology of Allergic and Respiratory Diseases Department, Institute Pierre Louis of Epidemiology and Public Health, INSERM, and UPMC Sorbonne Université, Medical School Saint Antoine, Paris, France

5 Social Science Research Institute (IRISSO, UMR CNRS-INRA 7170-1427), Paris-Dauphine University, PSL

6 Department of Infectious Diseases, Avicenne Hospital, Assistance Publique-Hôpitaux de Paris, Sorbonne University of Paris Nord, Bobigny, France

7 Department of Gastroenterology and Pancreatology, Beaujon Hospital, Assistance Publique-Hôpitaux de Paris, University of Paris, Clichy, France

8 Department of Internal Medicine, Avicenne Hospital, Assistance Publique-Hôpitaux de Paris, Sorbonne University of Paris Nord, Bobigny, France

9 Department of Reanimation, Avicenne Hospital, Assistance Publique-Hôpitaux de Paris, Sorbonne University of Paris Nord, Bobigny, France

10 Department of Infectious Diseases, Ambroise Paré Hospital, Assistance Publique-Hôpitaux de Paris, France & Paris-Saclay University UVSQ, EA 4340 BECCOH, Boulogne, France

11 Department of Geriatrics, Ambroise Paré Hospital, Assistance Publique-Hôpitaux de Paris, France & Paris-Saclay University UVSQ, EA 4340 BECCOH, Boulogne, France

12 Emergency Departement, Beaujon Hospital, Assistance Publique-Hôpitaux de Paris, University of Paris, Clichy, France
13 Emergency Department, Ambroise Paré Hospital, Assistance Publique-Hôpitaux de Paris, France & Paris-Saclay University UVSQ, EA 4340 BECCOH, Boulogne, France

14 Department of oncology, Avicenne Hospital, Assistance Publique-Hôpitaux de Paris, Sorbonne University of Paris Nord, Bobigny, France

15 Department of Pulmonology, Avicenne Hospital, Assistance Publique-Hôpitaux de Paris, Sorbonne University of Paris Nord, INSERM1272, Bobigny, France

**Corresponding author:**

Email: hilario.nunes@aphp.fr

Service de Pneumologie, Hôpital Avicenne, 125 rue de Stalingrad, 93009 Bobigny

Cellphone: +33 1 48 95 51 21

*Both authors contributed equally

**Manuscript word count:** words 1294

**Key words:** COVID-19, socioeconomic status, income, deprivation index,

**Funding:** non funding received for the present study

**Competing interests:** All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coiDisclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

**Take home message:** Individual precarity seems to be associated with the initial severity of COVID-19 in hospitalized patients under the age of 70. Low socioeconomic status may contribute to the excess mortality observed in the poorest district of Greater Paris
Introduction:

In the United States, the coronavirus disease 2019 (COVID-19) is more likely to affect and kill African Americans [1], which raises the question of the contribution of several factors, including genetic background, socioeconomic status (SES), and comorbidities [2]. According to the French National Institute of Statistics and Economic Studies (INSEE) the highest excess mortality rate in France, during March and April 2020, linked to COVID-19 is found in the Seine-Saint-Denis (SSD) district [3]. SSD is the poorest district of Greater Paris [4]. We hypothesize that precarity influences the initial severity of COVID-19.

Methods:

We selected patients hospitalized for COVID-19 at Avicenne Academic Hospital, in SSD and at Beaujon and Ambroise Paré Hospitals, two academic hospitals located in the Hauts-de-Seine (HDS) district. HDS is a rich district of Greater Paris, with more hospital beds (56.7 versus 42.5 per 10,000 inhabitants) and intensive care unit intensive (ICU) beds (429 versus 244) than SSD for a number of inhabitants equivalent (1.6 million) [5] [6]. The goal was to compare patient characteristics between the two districts and determine whether precarity is a risk factor for severe COVID-19. All consecutive conscious patients hospitalized in the three hospitals for COVID-19 were prospectively screened on the same day (April 20, 2020). Patients were asked about their SES via a questionnaire (monthly personal self-reported income, deprivation index, insurance coverage, occupation, final educational degree and housing conditions), and information on smoking habits, comorbidities, and respiratory severity at admission was collected. The French deprivation index EPICES (Evaluation of Health Inequalities for Health Insurance Health Examination Centre) is an indicator of precarity taking into account marital status, insurance coverage, family support and leisure activity. The score varies from 0 (absence of precarity) to 100 (maximum precarity). Thirty is considered to be the precarity threshold [7]. The official French poverty line corresponds to a monthly income of less than 1,041 euros. Initial severity was classified as follows: no severity (oxygen requirements < 3L/min), moderate severity (oxygen requirements between 3 and 5 L/min), significant severity (respiratory rate > 30/min, or oxygen requirements > 5L/min, or lung damage on CT scan > 50%), and critical severity (admission to intensive care) [8][9]. Results are expressed as percentages or mean ± SD. Logistic regression was used to identify the factors associated with severe COVID-19 at admission. All patients signed a consent form and the study was approved by the local ethics committee (CLEA-2020-116).
Results:

190 patients hospitalized for COVID-19 were screened, and 41% of these were excluded (for cognitive disorders: 45%, language barrier: 21%, critical state: 15%, tutorship or curatorship: 11%, and lack of consent: 8%). The causes of exclusion differed according to the district, with higher language barrier in SSD but more lack of consent or cognitive disorders in HSD (p=0.02). Excluded patients were significantly older than included patients (74.5 ± 15.8 versus 66.6 ± 16.3 years, p< 0.001), with a higher proportion of patients over 70 years old (66% versus 41%, p< 0.001). The study population included 112 patients (65 (58.6%) men, age: 66.7 ± 16.3 years old, 12 (11.0%) Africans or Afro-Caribbeans, and 8 (7.7%) current smokers). Body mass index was 27.1 ± 6.23, 33 (30.0%) patients had diabetes and 58 (52.7%) arterial hypertension. Regarding SES, 32 (33.0%) patients had an income below the poverty line, and the mean deprivation index was 38.2 ± 24.4. The proportion of patients with at least one infected home co-resident was 12%. COVID-19 was severe in most cases (59.8%).

Patient characteristics are described in Table 1. SSD patients were younger (p=0.002) and had more comorbidities, such as being overweight (p<0.001) and diabetes (p= 0.041), than HDS patients. The SES of SSD patients was lower, with lower incomes (p= 0.004), less private insurance coverage (p=0.043), and a lower educational level (p=0.002). The proportion of SSD patients who owned homes was lower (p=0.039) while the proportion of those in low-income housing as well as the housing population density was higher (p= 0.009 and p =0.027, respectively). The distribution of initial severity was similar in both districts, although SSD patients were about 10 years younger than HDS patients (61.8 ± 14.0 versus 71.0 ± 17.1 years, p= 0.002). Seventeen patients (17%) were transferred in ICU and 3 patients (3%) died at hospital.

No predictive factors of initial severity were found in the overall population. In the sub-group of patients under 70 years of age (n=62), the predictive factors of severity were age (p= 0.002), high EPICES score (p=0.014), being retired (p=0.027), and an absence of private insurance coverage (p= 0.042). On multivariate analysis, age and EPICES score were independently associated to an increased risk of initial severity, with an odds ratio (OR) of 1.099 (95% CI: 1.038-1.178, p=0.003), and 1.029 (95% CI:1.003 - 1.059, p=0.033) per EPICES score point, respectively.
Discussion:

This is the first study to show that precarity is associated with the initial severity of COVID-19 in hospitalized patients under 70 years-old. Moreover, patients hospitalized in SSD, the poorest district in Greater Paris, were 10 years younger than patients hospitalized in the HDS district for the same distribution of initial severity.

First, these results confirmed the precarious conditions of patients hospitalized for COVID-19, even in HDS. Indeed, 24.5% of the cases were living below the poverty line, while this concerns only 12% of the inhabitants of HDS district [4]. As expected, SSD patients were younger, which probably reflects the demographic structure of the district, with the youngest population in the region. Although age has been shown to be strongly associated to COVID-19 morbi-mortality [10], the young age of SSD patients does not seem to protect them from severe forms of the disease. This could be explained, by the increased prevalence of obesity and diabetes in this group, two comorbidities known to be associated with the severity of COVID-19 [11] [12]. Furthermore, patients hospitalized in SSD had substantially lower incomes, a major indicator of life expectancy in literature [13]. These patients also had a lower level of education, a recognized source of health inequalities [14] [15]. Finally, housing conditions differed between the two districts, including more social housing and greater promiscuity in SSD patients, with a trend towards more infected home co-residents. Poor housing conditions could have been a barrier to social distancing.

Noticeably, the EPICES score did not differ between the two districts, and it was not identified as a risk factor for disease severity in the overall population. The EPICES score is strongly correlated to the Townsend index [16]. It is generated as the sum of 11 items including leisure activity. However, this score, which was validated in a 45.5 ± 14.3 year-old cohort [7], may not be suitable for geriatric populations. Indeed, among the elderly, not having leisure activities may be more strongly related to dependency than to precarity. Thus, we focused on the sub-group of patients under the age of 70 in whom a high EPICES score was found to be a significant risk factor for severe COVID-19.

To our knowledge this is the first study to evaluate individual SES in patients hospitalized for COVID-19. However, it is limited by the high exclusion rate. Although this may have created a selection bias, it shows the complexity of this type of investigation in the acute phase of COVID-19. Moreover, the analysis of factors associated with poor survival was limited by the small number of events.
In conclusion, precarity seems to be associated with the initial severity of COVID-19 in hospitalized patients under 70 years of age. In addition to a lack of hospital beds and ICU beds, low SES may contribute to the excess mortality observed in SSD. Particular attention should be paid to more disadvantaged geographic areas to fight against health disparities in the context of the COVID-19 epidemic.

References:

1. Yancy CW. COVID-19 and African Americans. *JAMA* Published Online First: 15 April 2020. doi:10.1001/jama.2020.6548

2. Chowkwanyun M, Reed AL. Racial Health Disparities and Covid-19 — Caution and Context. *N Engl J Med* 2020;:NEJMp2012910. doi:10.1056/NEJMp2012910

3. Evolution of deaths since 1 March – Number of daily deaths | Insee. https://www.insee.fr/en/statistiques/4493806?sommaire=4493845#consulter-sommaire (accessed 20 May 2020).

4. Comparateur de territoire | Insee. https://www.insee.fr/fr/statistiques/1405599?geo=DEP-92+DEP-93+DEP-75+DEP-94+UU2010-00851 (accessed 20 May 2020).

5. Comparateur de territoire – Département des Hauts-de-Seine (92) | Insee. https://www.insee.fr/fr/statistiques/1405599?geo=DEP-92 (accessed 1 Jun 2020).

6. Le Projet Régional de Santé 2018-2022. https://www.iledefrance.ars.sante.fr/le-projet-regional-de-sante-2018-2022 (accessed 31 Aug 2020).

7. Sass C, Guéguen R, Moulin JJ, et al. [Comparison of the individual deprivation index of the French Health Examination Centres and the administrative definition of deprivation]. *Sante Publique* 2006;18:513–22. doi:10.3917/spub.064.0513

8. Zu ZY, Jiang MD, Xu PP, et al. Coronavirus Disease 2019 (COVID-19): A Perspective from China. *Radiology* 2020;:200490. doi:10.1148/radiol.2020200490

9. Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected: interim guidance, 13 March 2020. https://apps.who.int/iris/handle/10665/331446?search-result=true&query=10665%2F331446&scope=&rpp=10&sort_by.score&order=desc (accessed 1 Jun 2020).

10. Docherty AB, Harrison EM, Green CA, et al. Features of 20 133 UK patients in hospital with covid-19 using the ISARIC WHO Clinical Characterisation Protocol: prospective observational cohort study. *BMJ* 2020;369:m1985. doi:10.1136/bmj.m1985

11. Simonnet A, Chetboun M, Poissy J, et al. High prevalence of obesity in severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) requiring invasive mechanical ventilation. *Obesity*;n/a. doi:10.1002/oby.22831
12 Yang J, Zheng Y, Gou X, et al. Prevalence of comorbidities and its effects in patients infected with SARS-CoV-2: a systematic review and meta-analysis. *International Journal of Infectious Diseases* 2020;94:91–5. doi:10.1016/j.ijid.2020.03.017

13 Chetty R, Stepner M, Abraham S, et al. The Association Between Income and Life Expectancy in the United States, 2001–2014. *JAMA* 2016;315:1750–66. doi:10.1001/jama.2016.4226

14 von dem Knesebeck O, Verde PE, Dragano N. Education and health in 22 European countries. *Social Science & Medicine* 2006;63:1344–51. doi:10.1016/j.socscimed.2006.03.043

15 Life expectancy by standard of living: in men, 13 years of difference between the most affluent and the most modest - Insee Première - 1687. https://www.insee.fr/en/statistiques/3533552 (accessed 4 May 2020).

16 Labbe E, Blanquet M, Gerbaud L, et al. A new reliable index to measure individual deprivation: the EPICES score. *Eur J Public Health* 2015;25:604–9. doi:10.1093/eurpub/cku231

**Acknowledgement:** Dr A. Aigron, Dr D. Bouvry, Dr S. Chauveau, Dr A. Claveirole, Pr T. Chinet, Dr A. Costantini, Pr Y. Cohen, Dr L. Cressiot, Dr F. Cymbalista, Dr M. Didier, Dr F.Duperon, Dr C. Duran, Dr J. Darmon, E. Fresnel, Dr T. Fouque, Dr O. Freynet, Dr T. Gille, Dr C. Gilles, Dr S. Greffe, Pr P. Hammel, Dr F. Jeny, Dr W. Khamis, Dr F Khort, Pr V. Levy, Dr M. Lupo, Dr A. Navid, Dr S. Peres, Pr C. Planes, Dr M. Patout, Dr M. Pepin, Dr C. Rotenberg, Dr D.Roche-Lebrec , Dr S. Saadi, Pr Y. Uzunhan, Pr D. Valerye,

**Data sharing:** The data are available on request

|                         | [ALL] N=112 | Hauts de Seine N=60 | Seine-Saint-Denis N=52 | p-value |
|-------------------------|------------|---------------------|------------------------|---------|
| Age (years): mean ± SD  | 66.7 ± 16.3| 71.0 ± 17.1         | 61.8 ± 14.0            | 0.002   |
| Age < 70 years: n (%)   | 65 (58.6%) | 27 (45.8%)          | 38 (73.1%)             | 0.006   |
| Males: n (%)            | 65 (58.6%) | 40 (66.7%)          | 25 (49.0%)             | 0.065   |
| Of African or Afro-Caribbean origin: n (%) | 12 (11.0%) | 9 (15.0%) | 3 (6.1%) | 0.244   |
| Smokers: n (%)          |            |                     |                        | 0.746   |
| Never                   | 59 (56.7%) | 32 (53.3%)          | 27 (61.4%)             |         |
| former                  | 37 (35.6%) | 23 (38.3%)          | 14 (31.8%)             |         |
| current                 | 8 (7.7%)   | 5 (8.3%)            | 3 (6.8%)               |         |
| BMI: mean ± SD          | 27.1 ± 6.23| 25.2 ± 5.67         | 29.6 ± 6.08            | <0.001  |
| Diabetes: n (%)         | 33 (30.0%) | 13 (21.7%)          | 20 (40.0%)             | 0.041   |
| Arterial hypertension: n (%) | 58 (52.7%) | 31 (51.7%) | 27 (54.0%) | 0.958 |
| Socioeconomic status                          | 32 (33.0%) | 12 (24.5%) | 20 (41.7%) | 0.078     |
|----------------------------------------------|------------|------------|------------|-----------|
| Monthly income range: n (%)                  |            |            |            | 0.004     |
| 400-800€                                     | 26 (28.6%) | 9 (19.6%)  | 17 (37.8%) |           |
| 800-1200 €                                   | 20 (22.0%) | 8 (17.4%)  | 12 (26.7%) |           |
| 1200-2500€                                   | 25 (27.5%) | 12 (26.1%) | 13 (28.9%) |           |
| >2500 €                                      | 20 (22.0%) | 17 (37.0%) | 3 (6.7%)   |           |
| EPICES score §: mean ± SD                   | 38.2 ± 24.4 | 39.1 ± 25.5 | 37.3 ± 23.3 | 0.707     |
| High school graduate: n (%)                  | 42 (40.8%) | 30 (56.6%) | 12 (24.0%) | 0.002     |
| Retired: n (%)                               | 64 (57.7%) | 36 (61.0%) | 28 (53.8%) | 0.568     |
| State health insurance: n (%)                | 108 (97.3%) | 58 (98.3%) | 50 (96.2%) | 0.599     |
| Private health insurance: n (%)              | 73 (66.4%) | 44 (75.9%) | 29 (55.8%) | 0.043     |
| Housing                                      |            |            |            |           |
| Owner: n (%)                                 | 44 (40.0%) | 29 (50.0%) | 15 (28.8%) | 0.039     |
| Social housing tenant: n (%)                 | 48 (43.6%) | 18 (31.0%) | 30 (57.7%) | 0.009     |
| Nb of co-residents: mean ± SD                | 1.75 (1.6) | 1.67 (1.6) | 1.85 (1.5) | 0.557     |
| Housing population density * (m² per 1 habitant): mean ± SD | 31.0 ± 33.7 | 37.3 ± 40.4 | 23.7 ± 22.1 | 0.027     |
| Infected co-residents: n (%)                 | 11 (12.0%) | 2 (4.88%)  | 9 (17.6%)  | 0.068     |
| Severity                                    |            |            |            |           |
| Initial severity £                           |            |            |            | 0.821     |
| 0                                            | 44 (39.6%) | 23 (38.3%) | 21 (41.2%) |           |
| I                                            | 39 (35.1%) | 21 (35.0%) | 18 (35.3%) |           |
| II                                           | 25 (22.5%) | 15 (25.0%) | 10 (19.6%) |           |
| III                                          | 3 (2.70%)  | 1 (1.67%)  | 2 (3.92%)  |           |
| Outcomes                                    |            |            |            |           |
| Admission in the intensive care unit         | 17 (16%)   | 12 (21%)   | 5 (10%)    | 0.195     |
| Death                                        | 3 (3%)     | 2 (2%)     | 1 (1%)     |           |

| Table: Characteristics of COVID-19 patients according to the district of hospitalization |

| Abbreviations: BMI: body mass index |

†: The poverty line in France is defined by a monthly income lower than 1 041 euros per person according to INSEE (National Institute for Statistics and Economic Studies) in 2017.

§: Housing population density was measured by the area of the household divided by the number of residents.

*: The EPICES score (Evaluation of Health Inequalities for Health Insurance Examination Centres) is an individual deprivation index that takes into account the multidimensional nature of precariousness. The score is continuous and varies from 0 (absence of precarity) to 100 (maximum precarity). The threshold of 30 is considered as the precarity threshold.

£ Initial severity:
0: Not severe (oxygen requirements < 3L/min)

1: Moderate severity (oxygen requirements between 3 and 5 L/min)

2: Significant severity (respiratory rate > 30/min, or oxygen requirements > 5L/min or lung damage on CT scan > 50%).

3: Critical severity (admission to intensive care)