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3 **Low income and outcome in idiopathic pulmonary fibrosis: an association to**
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Abstract:

97 **Background:** Low income, a known prognostic indicator of various chronic respiratory diseases, has
98 not been properly studied in idiopathic pulmonary fibrosis (IPF). We hypothesize that a low income
99 has an adverse prognostic impact on IPF.

100 **Methods:** Patients were selected from the French national prospective cohort COFI. Patients' income
101 was assessed through the median city-level income provided by the French National Institute of
102 Statistics and Economic Studies according to their residential address. Patients were classified in two
103 groups as "low income" vs. "higher income" depending on whether their annual income was
104 estimated to be < or ≥ 18 170 €/year (the first quartile of the income distribution in the study
105 population). The survival and progression-free survival (PFS) of the groups were compared by a log-
106 rank test and a Cox model in multivariate analysis.

107 **Results:** 200 patients were included. The average follow-up was 33.8±22.7 months. Patients in the
108 low income group were significantly more likely to be of non-European origin (p<0.006), and to have
109 at least one occupational exposure (p<0.0001), and they tended to have a higher cumulative
110 exposure to fine particles PM_{2.5} (p=0.057). After adjusting for age, gender, forced vital capacity at
111 inclusion, **geographical origin, and occupational exposure** having a low-income level **was** a factor
112 associated with a worse PFS (**HR: 1.81; CI_{95%}: 1.24 - 2.62, p=0.001**) and overall survival (**HR: 1.49;**
113 **CI_{95%}: 1.0006 - 2.23, p=0.049**).

114 **Conclusions:** Low income appears to be a prognostic factor in IPF. IPF patients with low incomes may
115 also be exposed more frequently to occupational exposures.

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117

118 **Background:**

119 Socioeconomic status (SES) is an important health determinant. SES is an individual economic and
120 sociological standing indicator that combines income, education and occupation. Health disparities,
121 defined as a significant difference in health between populations, are common for diseases of the

122 respiratory system, and socioeconomic background is considered one of the major causes of these
123 disparities[1]. While many epidemiological studies have demonstrated a substantial impact of SES on
124 the severity of chronic lung diseases such as chronic obstructive pulmonary disease (COPD), asthma
125 and lung cancer[2][3][4], little data is available for interstitial lung diseases (ILDs) except for
126 sarcoidosis [5]. Idiopathic pulmonary fibrosis (IPF) is one of the most frequent and severe ILDs, with a
127 gradual deterioration of respiratory function, a median survival of 3 to 5 years, and few therapeutic
128 options. Its natural history and physiopathology are yet to be elucidated[6]. Although of unknown
129 cause, IPF is believed to be due to repeated alveolar injury on a senescent lung, in response to aero-
130 contaminants, followed by an aberrant repair. Genetic factors are associated to sporadic and family
131 IPF[6]. Moreover, several exposures are associated with an increased risk of IPF: tobacco smoke,
132 occupational exposures (wood or metal dust, crystalline silica, agricultural environment/farming
133 activities, asbestos) and air pollution[7].

134 Available data on the role of socioeconomic factors are exceedingly rare in IPF. A study
135 conducted in the United States (US) on lung transplant IPF candidates showed an increased mortality
136 in “Black” and “Hispanic” compared to “White” and “Asian” patients, whether or not they were
137 listed, probably because of more disadvantaged SES[8]. From a US database of hospitalized patients,
138 Gaffney et al. suggested that IPF patients with lower income or poorer insurance coverage had
139 reduced access to transplantation, rehabilitation and lung biopsy, but no difference in hospital
140 mortality[9]. However, data from registries have significant limitations, including measurement
141 biases and risk of diagnosis misclassification. Moreover, no such study has been carried out so far in
142 Europe.

143 We hypothesize that a low SES may have an impact on IPF prognosis. For that purpose, we
144 conducted an ancillary study including patients from a national prospective cohort of incident
145 patients with well-characterized IPF, named COFI (“COhorte Fibrose”), and we used median city
146 incomes from the French National Institute of Statistics and Economic Studies (INSEE). The main
147 objective of the study was to determine the role of income on IPF survival. The secondary objective

148 was to evaluate the relationship between income and IPF severity, occupational exposure and air
149 pollution.

150

151 **Patients and methods:**

152 For our study we selected patients from COFI, a multicentre prospective cohort involving the 24
153 respiratory departments from all University Hospitals in France. The enrolment period extended
154 from 2007 to 2010, with a 5-year follow-up. The study was approved by the ethics committee
155 (Comité de Protection des Personnes Ile-de-France) and by the French data protection authority
156 (CNIL: 908198).

157 ***COFI study design***

158 Patients were included provided they fulfilled the 2000 ATS/ERS consensus criteria for IPF, which
159 were slightly amended. First, basal and subpleural honeycombing on high resolution computed
160 tomography (HRCT) was required for patients not submitted to surgical lung biopsy (SLB), in keeping
161 with the definition of usual interstitial pneumonia (UIP) pattern of the 2011[10] and 2018[11]
162 updated consensus for IPF diagnosis. Second, SLB was mandatory for patients under 50 years of age.
163 Only incident cases with a diagnosis \leq 9 months were eligible. IPF diagnosis was prospectively
164 adjudicated for each case by a centralized expert board involving several pulmonologists, a
165 radiologist and a pathologist during monthly multidisciplinary meetings. Data were collected in an
166 electronic Case Report Form (eCRF). At inclusion, demographics, smoking status, clinical information,
167 including history of comorbidities, pulmonary function tests (PFTs), and six-minute walk test (6MWT)
168 were detailed. After inclusion, patients were monitored every 3 months with spirometry, and
169 diffusing capacity for carbon monoxide (DLCO). At each visit, investigators reported every health
170 problem, including hospitalization or acute exacerbation (AE), as defined by Akira et al.[12]. Vital
171 status at 5-year follow-up and the causes of death, when applicable, were recorded. Gender Age
172 Physiology (GAP) staging was based on Ley et al.[13] and the *composite physiologic index* (CPI) was
173 calculated according to Wells et al.[14].

174 Three hundred and nine patients were recruited in COFI, 64 of whom were excluded (not
175 UIP pattern on HRCT: n=39, not UIP on SLB: n=2, recognized cause of ILD: n=13, bronchoalveolar
176 lavage (BAL) not available: n=3, BAL lymphocytes > 30%: n=5, and disease duration > 9 months: n=2).

177 ***Study population***

178 All patients enlisted in COFI were eligible, provided that their residential address was informed and
179 median city level income was available from the INSEE database. Of the 245 patients included in
180 COFI, 25 patients had no residential address in the database, 11 patients lived in small towns with no
181 available income data for such areas, and 9 patients who withdrew their consent were excluded. In
182 total, 200 patients were selected for the current study (Figure 1).

183 ***Socioeconomic status***

184 Since there was no specific socioeconomic data collected in COFI, the income of each patient was
185 estimated using the median city-level income per consumption unit (CU) provided by the INSEE[15].
186 For the biggest cities the median income per borough was available. INSEE estimates a city-based
187 median annual income per CU throughout the national territory on the basis of individual tax
188 declaration. Income per CU is a weighting system assigning a coefficient to each member of the
189 household using an equivalence scale (1 CU for the first adult in the household, 0.5 CU for each other
190 person aged 14 years or more, 0.3 CU for each child under 14 years). In France, data are not provided
191 for municipalities with less than 100 inhabitants for reasons of personal data protection and
192 statistical secrecy. In our study, incomes were imputed to patients according to their residential
193 address. We used the latest (2014) available data from INSEE [15]. The population was divided into
194 two groups depending on city-level incomes: “low income”, when values were within the first
195 quartile of the study population, under 18 170€ euros per year *versus* the remainder in the “higher
196 income” group. Along with INSEE data, we obtained the price per square meter of the patients’
197 residential address from notarial registries (i.e. official sale property prices as registered by the
198 state)[16]. Prices from 2018 sales were taken into account as they were the only available.

199 ***Environmental exposures***

200 Assuming that SES could have a prognostic impact *via* higher level of exposures, we looked at
201 occupational exposures and air pollution. Some patients included in COFI cohort had a job exposure
202 assessment by an occupational health physician. The COFI investigators were asked to fill a box in the
203 eCRF regarding patients' exposures to asbestos, crystalline silica, wood, organic, livestock, and metal
204 dust. However, hypersensitivity pneumonitis or pneumoconiosis were excluded by the COFI expert
205 board. As previously described, air pollutant levels obtained from the air quality monitoring station
206 closest to the patient's residential address were assigned to each patient[17]. Cumulative exposure
207 to each pollutant was expressed as the average concentration of the pollutant during the exposure
208 period, which was defined as the entire period from inclusion to the date of disease progression or
209 the end of the study.

210 **Statistical analysis:**

211 Results are expressed as percentages or mean \pm SD. Percentages and means in the "low income" and
212 "higher income" groups were compared using a Chi-squared test and ANOVA, as appropriate. We
213 evaluated the association of income with both overall survival and progression free survival (PFS).
214 Overall survival was defined as the time from the date of inclusion to death or transplantation. PFS
215 was defined as the time from the date of inclusion to the first occurrence of one of the following
216 events: (i) absolute decrease in forced vital capacity (FVC) $>$ 10% of predicted value (pred) or
217 absolute decrease in DLCO $>$ 15%pred compared to baseline values, after exclusion of other causes
218 of worsening, (ii) AE, (iii) transplantation, or (iv) death. The survival probability of "low income" and
219 "higher income" groups was estimated using the Kaplan-Meier method and compared by a log-rank
220 test. A Cox proportional hazards model was used for studying the survival after adjustment for
221 potential confounders. **Key IPF outcome variables known to be strongly associated with IPF mortality**
222 **in the literature, including age, sex and FVC at inclusion were chosen as adjustment parameters for**
223 **the Cox model. In order to precise the relative contribution of low income compared to geographical**
224 **origin and occupational exposure, these parameters were also integrated in the model.** Results of the
225 Cox model are reported as hazard ratio (HR) and 95% confidence interval. Data were analysed in R

226 software V3.0.1 and $p < 0.05$ was considered significant.

227

228 **Results:**

229 ***Socioeconomic characteristics of IPF patients***

230 Among the 200 IPF patients included, 154 (77%) were men, aged 68 ± 11 years. The SES of IPF patients
231 compared with the general population is presented in Table 1. The distribution of income in our IPF
232 cohort was generally comparable to that in the French population. Conversely, the distribution of IPF
233 patients' geographical ancestry was significantly different, with a low proportion of patients having
234 European origin (77% vs 95%, $p < 0.001$) (Table 1). As expected, the IPF patients' city-level income was
235 strongly correlated to the property square meter price ($r = 0.7$, $p < 0.001$).

236 ***Comparison of characteristics at inclusion between "low income" and "higher income" groups***

237 The findings are summarized in Table 2. "Low income" patients were more likely to be from a non-
238 European origin (42% vs 17%, $p < 0.006$), and to live in a cheaper residential area ($2\,337 \pm 837 \text{€} \cdot \text{m}^2$ vs 4
239 $255 \pm 3107 \text{€} / \text{m}^2$, $p < 0.001$), whereas no differences were found between groups in terms of age, sex,
240 cigarette smoking, or comorbidities (Table 2). With respect to disease severity, "low income" patients
241 were more dyspnoeic ($p = 0.049$), with a shorter distance on 6MWT at inclusion ($74.1 \% \pm 18.3\% \text{ vs}$
242 $81.5 \% \pm 21.8\%$ $p = 0.021$), whereas functional impairment, GAP stages and CPI were similar between
243 the two groups.

244 ***Comparison of outcomes between "low income" and "higher income" groups***

245 The mean duration of follow-up was 33.8 ± 22.7 months. At the end of the study, 6 (3%) patients had
246 been lost to follow-up, 32 (16%) had experienced an AE, 17 (9%) had been transplanted, and 120
247 (60%) had died. The large majority of deaths resulted from respiratory cause ($n = 94$, 78%), including
248 fibrosis progression ($n = 33$), AE ($n = 26$), pulmonary hypertension ($n = 5$), lung cancer ($n = 7$), pulmonary
249 embolism ($n = 2$), respiratory infection ($n = 16$), and acute respiratory distress syndrome ($n = 5$). The
250 proportion of AE, hospitalization, lung transplantation and deaths were equivalent in both income
251 groups. The median PFS was 15.6 months ($\text{CI}_{95\%}$: 13.0-20.4) for the entire cohort. In the "low income"
252 group, the median PFS was significantly worse (11.6 months ($\text{CI}_{95\%}$: 6.9-21.1) vs 16.0 months ($\text{CI}_{95\%}$:

253 13.1-23.8), p=0.038). Low incomes remained an independent risk factor of poor PFS after a
254 multivariate analysis adjusted for age, sex and FVC (% predicted) at inclusion, **geographical origin and**
255 **occupational exposure** with an HR of 1.81 (CI_{95%}: 1.24-2.62, p=0.001) (Figure 2) (Table 3). Considering
256 survival, **the** median survival in the “low income” group **was lower than “higher income” group, but**
257 **the difference** did not reach the level of significance (22.4 months (CI_{95%}: 19.7- 40.2) vs 36.7 months
258 (CI_{95%}: 31.5-42.5, p=0.3). **Nevertheless**, on multivariate analysis adjusted for age, sex and FVC (%
259 predicted) at inclusion, **geographical origin and occupational exposure**, low incomes were associated
260 with an increased overall mortality (HR: 1.49; CI_{95%}: 1.0006 - 2.23, p=0.049) (Table 3).

261 ***Comparison of exposures between “low income” and “higher income” groups***

262 Nineteen patients had a job exposure assessment by an occupational health physician confirming at
263 least one exposure among: asbestos (n=15), crystalline silica (n=1), wood dust (n=5), organic dust
264 (n=1), and metal dust (n=8). In 34 additional patients, one or more exposures were reported by the
265 investigator, yet without being based on a specialized evaluation (asbestos (n=15), silica (n=3), wood
266 dust (n=1), organic dust (n=11), metal dust (n=13), and livestock exposure (n=6)) (Figure 3). Because
267 of the small number of patients, the analyses combined all exposures. Patients in the “low income”
268 group were more likely than those with higher income to have been exposed at least to one
269 occupational pollutant (46% vs 20%, p<0.0001). With regard to the cumulative exposure to air
270 pollution during follow-up, the “low income” group was more frequently exposed to fine particles
271 matter ((PM)_{2.5}), the difference being almost significant (20.4 ± 3.62 vs 19.0±2.26 µg/m³, p=0.057).

272 **Discussion:**

274 As far as we know, for the first time in IPF patients our study highlights that low income (i.e.
275 estimated < 18 170€ per year) is related to poorer PFS **and overall survival**, even after adjusting for
276 **other prognostic factors, including** age, sex and FVC, **geographical origin, and occupational exposure**.
277 In addition, patients having low income are more frequently exposed to toxic inorganic particles in
278 occupational settings and tend to have higher long-term PM_{2.5} exposure.

279 Our results in IPF are consistent with the literature. In a recent American epidemiological
280 study, the difference in life expectancy between the richest and poorest people was 14.6 years for
281 men and 10.1 years for women[18]. Such inequalities are also present across Europe [19]-[20]. COPD
282 patients of the lowest socioeconomic stratum are at least twice as likely to have poor outcomes as
283 those of the highest one[2]. In addition, beyond the effects of current smoking, income disparity is a
284 strong predictor of disease progression in COPD[21]. Similarly, a worse survival is observed for
285 patients with lung cancer and low income[22]. So far, only few studies have assessed the role of SES
286 in ILDs. Gaffney et al. analysed a database consisting of all hospitalizations from a 20% sample of US
287 hospitals and failed to find any association between insurance status or low income and death.
288 However, the studied sample only represented hospitalizations, which could bias the results, since
289 disadvantaged patients may be less likely to be admitted to hospitals that offer better quality of care.
290 Moreover, IPF diagnosis was based on ICD-9 coding, with potential misclassification. Last, the model
291 used in-hospital mortality. In our study, ~~we may hypothesize that the effect of low income on overall~~
292 ~~survival, the most meaningful endpoint in IPF[23], was not significant probably because of lack of~~
293 ~~statistical power~~ **observed only in multivariate analysis**. The impact of income was more pronounced
294 in PFS, which for some authors is a relevant surrogate that takes into account several events related
295 to the IPF natural history [24].

296 There are several possible explanations for our findings on the impact of SES on IPF PFS.
297 First, having low income may inhibit the access to medical care, contributing to disease severity and
298 mortality. There is a large body of evidence in the literature supporting the existence of a negative
299 correlation between SES and lung function in the general population[25]-[26]. In IPF, Lamas et al.
300 suggested that delayed access to a tertiary care center was associated with a higher mortality, but
301 surprisingly, this was independent from lung function, education attainment, or insurance
302 coverage[27]. In the study by Gaffney et al., there was no information on lung function, but
303 hospitalized IPF patients with low SES, Medicaid coverage and without insurance were less likely to
304 receive several clinical interventions, including transplantation. A prospective cohort of sarcoidosis,

305 another fibrotic ILD, showed that low income and other barriers to healthcare access, including the
306 absence of private or Medicare health insurance, were associated with respiratory severity at
307 presentation[28]. In our study, IPF patients with low income tended to have a more severely
308 impaired lung function, worse dyspnoea and reduced 6MWT distance at inclusion, which may reflect
309 a potential delay in their diagnosis. Conversely, the proportion of transplanted patients was not
310 different according to income.

311 Second, the levels and types of exposure to air and occupational pollutants are strongly
312 linked to the SES[1]. In a previous publication, our group has raised the possibility of an association
313 between mortality and cumulative exposure to PM₁₀ and PM_{2.5} in IPF[17]. Similarly, IPF patients
314 exposed at the workplace have a worse prognosis than non-exposed[29]. Accordingly, our patients
315 with low income were more frequently exposed to occupational pollutants. They could also be
316 submitted to higher air pollution levels, with a nearly significant over-exposure to PM_{2.5}.

317 Third, SES and education are intertwined, and inadequate education about preventive
318 measures regarding health habits, comorbidities or IPF itself (e.g. vaccinations, smoking cessation,
319 control of cardiovascular risk factors) may have promoted disease progression. Yet, even though
320 these indicators were not explored in our study, the causes of death were similar between patients
321 with low or higher income, which does not fully support this hypothesis.

322 The evaluation of SES is complex because it is multidimensional and changes over time, but
323 income has been established to be the best socioeconomic marker of health disparities[1]. Given the
324 absence of individual income in COFI, we applied the method of area-based *income estimates*⁸. We
325 decided to define the first quartile of income as our group of interest, because 18 170€/year (1
326 514€/month) corresponds approximately to the gross minimum wage in France, which makes our
327 results expressive. As expected, city-level incomes were strongly correlated with real estate sale
328 prices in IPF patients. Moreover, the associations highlighted in our study between level of income,
329 geographical origin and occupational exposure are in line with previous reports on respiratory health
330 status[1].

331 This study has several strengths. It is the first to deal with SES in a well-characterized IPF population
332 of incident cases. COFI is indeed a well-designed prospective cohort, with a long follow-up. Its
333 multicentre nature throughout France ensures a representative sample of IPF population in terms of
334 SES and environmental contexts. The study also has several limitations. First of all, city-based
335 imputations of income are less precise than individual measurements. However, this method has
336 been used and validated in the literature [30][31][32]. Patient's health insurance status is an
337 important socioeconomic factor that could not be evaluated in our study. **On the other hand, given**
338 **that the low-income group had worse NYHA and 6MWT at baseline, a lead-time bias in IPF diagnosis**
339 **between groups may exist. Unfortunately, the time lag between the first symptoms and the**
340 **diagnosis was not recorded in the cohort database.** There was no systematic comprehensive
341 evaluation of patients' occupational exposure, which was left to the investigator's judgement. Some
342 potentially relevant exposures may therefore have been missed. Last, the level of education, another
343 important socioeconomic factor, was not collected in COFI. Patients included in cohorts have often
344 achieved sufficient education to understand an informed consent and accept its terms, leading to
345 potential selection biases.

346 **Conclusion:**

347 As for other chronic respiratory diseases, the income appears to be a prognostic factor of PFS in IPF.
348 Further studies using individual data on income and a holistic approach including SES, environmental
349 and occupational exposures are required. In order to improve comparability between nations and
350 across different levels of aggregation, a common definition for SES measurement would also be
351 highly fruitful.

352

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

354 **Guarantor statement:** LS takes responsibility for the content of the manuscript, including the data
355 and analysis.

356 **Author contributions:** DV was the scientific leader of the COFI cohort. All authors and COFI
357 collaborators contributed to the data collection. HN conceived and planned the study. LS performed
358 the statistical analyses. LS, HN, DV, CC, IAM wrote the manuscript. All authors read the manuscript,

359

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 475

476

477 Legend of figures

478

479 Figure 1: Study flow chart

480

481 Figure 2: Progression-free survival of IPF patients with low income versus higher income levels *

482

* Survival was calculated from the time of inclusion to physiologic progression, occurrence of acute
 483 exacerbation, lung transplantation, or death. Survival was adjusted for age, sex and forced vital
 484 capacity at inclusion (% of predicted value)

485

486 Figure 3: Occupational and environmental exposure assessment in IPF patients from the COFI 487 cohort

488

* Prior to inclusion in COFI cohort some patients had an occupational health physician consultation.

489

† The diagnosis of IPF was adjudicated during an expert multidisciplinary discussion in all patients
 490 included in COFI cohort. For those patients with an exposure, the diagnosis of hypersensitivity
 491 pneumonitis or pneumoconiosis was excluded by the expert panel based on clinical grounds, the
 492 results of precipitins, bronchoalveolar lavage and/or surgical lung biopsy.

493

494

495 Table 1: Socioeconomic characteristics of the French population and the study population of IPF 496 patients

497

Abbreviations: IPF: idiopathic pulmonary fibrosis; NA : not available.

499

*: provided by the French national institute for statistics and economic studies; †: provided by
 500 notarial registries; § : each patient could be exposed to several types of exposure.

501

502

| Socioeconomic variables | Study population n=200 | Mainland France * n= 67,0 M | p value |
|---------------------------------------------------|--------------------------------------------|-----------------------------------|---------|
| Geographic origin: n (%) | | | |
| Europe | 154 (77%) | 95.0% | <0.001 |
| Africa | 38 (19%) | 4.3% | <0.001 |
| Asia | 8(4%) | 1.4% | <0.004 |
| America, oceania | 0(0%) | 0.6 | |
| Real estate sale price (€/m²) † | | NA | |
| Minimal | 830 | | |
| First quartile | 1790 | | |
| Median | 2760 | | |
| Third quartile | 4850 | | |
| Maximal | 10 870 | | |
| City-level annual income (€/year) | | | 0.0615 |
| Minimal | 13 060 | 9 960 | |
| First quartile | 18 170 | 18 400 | |
| Median | 20 520 | 20 050 | |
| Third quartile | 23 800 | 22 270 | |
| Maximal | 42 770 | 45 900 | |
| Exposures: n (%) | n=200 | NA | |
| At least one exposure | 53 (27%) | | |
| Types of exposure | n=78 exposures in 53 patients [§] | | |
| Crystalline silica | 4 (5%) | | |
| Asbestos | 30 (38%) | | |
| Wood dust | 6 (8%) | | |
| Organic exposure | 11(14%) | | |
| Metal dust | 21 (27%) | | |
| Livestock | 6 (8%) | | |

| | Higher income (>18170€/year) | Low income (< 18170€/year) | p value |
|------------------------------------------------------------------------|---------------------------------|-------------------------------|---------|
| | n=150 | n=50 | |
| Age (years): mean ± SD | 68.2 ± 11.30 | 67.4 ± 8.48 | 0.592 |
| Males: n (%) | 115 (77%) | 39 (78%) | 1.000 |
| BMI mean ± SD | 27.6 ± 4.2 | 27.9±5.1 | 0.678 |
| Smokers: n (%) | | | 0.730 |
| Current | 10 (7%) | 5 (10%) | |
| Former | 94 (63%) | 30 (60%) | |
| Never | 46 (31%) | 15 (30%) | |
| Geographical origin: n (%) | | | 0.001 |
| Non-European | 25 (17%) | 21 (42%) | |
| European | 125 (83%) | 29 (58%) | |
| At least one occupational exposure: n (%) | 30 (20.0%) | 23 (46.0%) | 0.001 |
| Cumulative air pollution exposure (µg/m³): mean ± SD | | | |
| PM₁₀ | 25.9 ± 3.58 | 26.2 ± 3.11 | 0.619 |
| PM_{2,5} | 19.0 ± 2.96 | 20.4 ± 3.62 | 0.057 |
| O₃ | 42.0 ± 7.72 | 40.8 ± 9.48 | 0.403 |
| NO₂ | 30.7 ± 9.60 | 31.5 ± 8.11 | 0.592 |
| Real estate sale price (€/m²): mean ± SD | 4 255 ± 310 | 2 337 ± 837 | <0.001 |
| Comorbidities: n (%) † | | | |
| GER | 40 (27%) | 16 (32%) | 0.585 |
| Cardiovascular comorbidities | 53 (35%) | 19(44%) | 0.863 |
| Arterial hypertension | 69 (46%) | 22 (44%) | 0.935 |
| Diabetes | 35 (23%) | 8 (16%) | 0.371 |
| Neoplastic history | 22 (15%) | 7 (14%) | 1.000 |
| Sleep apnoea | 22 (15%) | 7 (14%) | 1.000 |
| NYHA functional class at inclusion: n (%) | | | 0.049 |
| I | 24 (16%) | 2 (4%) | |
| II | 88 (59%) | 35 (70%) | |
| III | 35 (23%) | 10 (20%) | |
| IV | 3 (2%) | 3 (6%) | |
| 6MWT at inclusion | | | |
| Distance (% predicted): mean ± SD | 81.5 ± 21.8 | 74.1 ± 18.3 | 0.021 |
| Desaturation < 88%: n (%) | 73(53%) | 21(51%) | 0.991 |
| PFTs at inclusion | | | |
| TLC (ml): mean ± SD | 4219 ± 1173 | 4153 ± 1141 | 0.725 |
| TLC (% predicted): mean ± SD | 68.3 (15 %) | 69.2 (17%) | 0.735 |
| FVC (ml): mean ± SD | 2591 ± 838 | 2444 ± 765 | 0.254 |
| FVC (% predicted): mean ± SD | 76.4 ± 19.6 | 74.1 ± 19.6 | 0.467 |
| FVC < 50 % predicted: n (%) | 13 (9%) | 4 (8%) | 1.000 |
| FEV1 (ml): mean ± SD | 2138 ± 671 | 2074 ± 621 | 0.548 |
| FEV1 (% predicted): mean ± SD | 81.1 (22%) | 80.3 (20%) | 0.813 |
| DLCO (% predicted): mean ± SD | 46.8 ± 16.3 | 46.6 ± 16.5 | 0.966 |
| DLCO < 30 % predicted: n (%) | 21 (14%) | 7 (14%) | 1.000 |
| CPI: mean ± SD | 48.3 ± 13.7 | 50.5 ± 15.6 | 0.372 |
| GAP stage at inclusion: n (%) | | | 0.561 |
| I | 61 (41%) | 19 (38%) | |
| II | 71 (47%) | 22 (44%) | |

| | | | |
|----------------------------------------------|-------------|-------------|-------|
| III | 18 (12%) | 9 (18%) | |
| Treatment at inclusion: n (%) | | | |
| Immunosuppressive treatment | 29 (19%) | 9 (18%) | 1.000 |
| Corticosteroids treatment | 48 (32%) | 18 (36%) | 0.728 |
| Antifibrotic treatment | 0 (0%) | 0 (0%) | 1.000 |
| Follow-up | | | |
| Duration of follow-up (in months): mean ± SD | 34.8 ± 21.6 | 31.0 ± 25.9 | 0.309 |
| Hospitalizations (nb of days?): mean ± SD | 1.28 ± 1.80 | 1.36 ± 2.00 | 0.802 |
| AE (nb of events?): n (%) | 24 (16%) | 8 (16%) | 1.000 |
| Death: n (%) | | | |
| Any cause | 88 (59%) | 32 (64%) | 0.617 |
| Respiratory cause | 68 (45%) | 26 (52%) | 0.513 |
| Transplantation: n (%) | | | |
| | 13 (9%) | 9(8%) | 1.000 |

505

506

507

508 **Table 2: Characteristics of IPF patients according to city-based annual income**

509

510 Abbreviations: IPF: idiopathic pulmonary fibrosis; BMI: body mass index; GER: gastro-oesophageal
511 reflux; 6MWT: six-minute walk test; PFTs: pulmonary function tests; TLC: total lung capacity; FVC:
512 forced vital capacity; FEV1: forced expiratory volume in one second; DLCO: diffusing capacity of the
513 lung for carbon monoxide; CPI: composite physiologic index; GAP: gender, age, and physiologic; AE:
514 acute exacerbation.

515 * Provided by the French national institute for statistics and economic studies; † Cardiovascular
516 comorbidities include coronary artery disease, myocardial infarction, atrioventricular block, heart
517 failure, arteritis of the lower limbs or aortic aneurysm, cerebrovascular accident, atrial fibrillation or
518 flutter.

519

520

521 **Table 3: Multivariate Cox model analyzing the relative contribution of income on survival of IPF**
522 **patients**

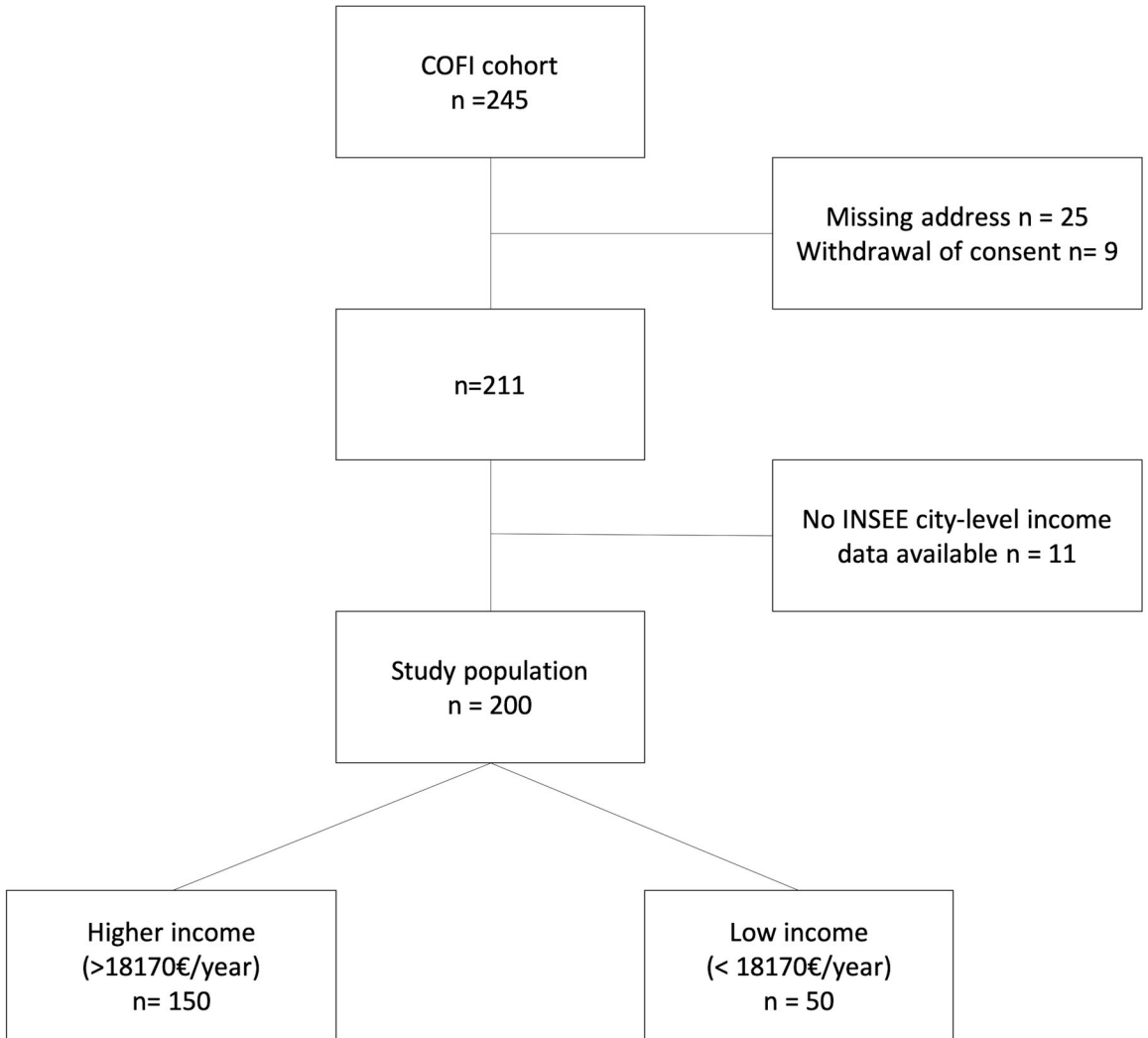
523

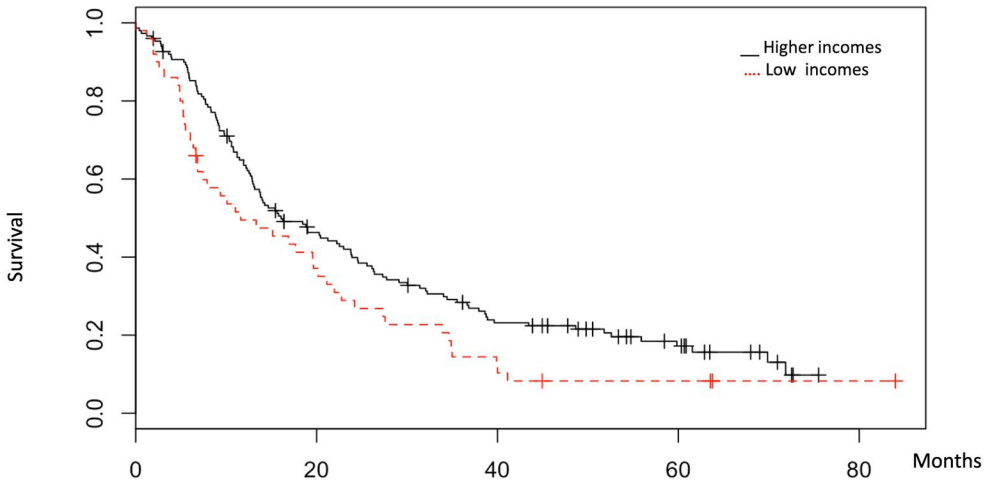
| | Progression free survival | | Overall survival | |
|------------------------|---------------------------|-------------------|----------------------|-------------------|
| | HR (CI95%) | p-value | HR (CI95%) | p-value |
| Low income | 1.81 (1.24 - 2.62) | 0.002 | 1.49 (1.0006 - 2.23) | 0.049 |
| Age | 1.01 (0.91 - 1.02) | 0.401 | 1.01 (0.99-1.03) | 0.137 |
| Males | 0.93 (0.64 - 1.33) | 0.677 | 0.75 (0.49 - 1.13) | 0.170 |
| FVC at inclusion | 0.98 (0.97 - 0.98) | < 0.001 | 0.97 (0.95 - 0.97) | < 0.001 |
| European origin | 1.95 (1.28 - 2.95) | 0.001 | 2.29 (1.43 - 3.65) | < 0.001 |
| Occupational exposure* | 1.02 (0.71 – 1.45) | 0.93 | 0.97 (0.65 – 1.43) | 0.866 |

524

525 Abbreviations: IPF: idiopathic pulmonary fibrosis, HR: hazard ration, CI: confident interval, FVC:
526 forced vital capacity.

527 *Any occupational exposure among asbestos, crystalline silica, wood, organic, livestock, or metal
528 dust.
529 P-value <0.05 was considered significant
530
531
532
533
534





Number at risk
 Higher income
 Low income

150
 50

65
 18

31
 6

14
 3

0
 1

