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ORIGINAL ARTICLE

Occupational prestige trajectory and the risk of lung and head and neck cancer among men and women in France

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Abstract

Objectives This study aimed at investigating the associations between occupational prestige trajectories and lung and head and neck (HN) cancer risk and to assess to what extent smoking, alcohol drinking, and occupational exposures contribute to these associations.

Methods Using data from the ICARE case–control study (controls (2676 men/715 women), lung cancers (2019 men/558 women), HN cancers (1793 men/305 women), we defined occupational prestige trajectories using group-based modeling of longitudinal data. We conducted logistic regression models.

Results Among men, a gradient was observed from the downward "low to very low" trajectory to the stable very high trajectory. The associations were reduced when adjusting for tobacco and alcohol consumption and occupational exposures. Among women, when compared to the stable high trajectory, there was an increased cancer risk in all trajectories. The associations remained globally unchanged or even increased after adjustment for tobacco and alcohol consumption and did not change when adjusting for occupational exposures. The ORs were smaller for lung than for HN cancers in men.

Conclusions Occupational prestige trajectory is strongly associated with lung and HN cancer risk in men and women.

Keywords Occupational prestige trajectory · Alcohol · Smoking · Occupational exposures · Respiratory cancer

Introduction

Incidence of lung and head and neck (HN) (lip, mouth, pharynx, larynx) cancers is high among men and increasing among women (Lortet-Tieulent et al. 2013). In 2012, the European standardized incidence rates were, respectively, 30.9 (per 100,000 person years) for HN cancers and 74.5 for lung cancer in men, and 8.9 and 27.9 in women (Ferlay et al. 2013). Studies have consistently reported a strong association between socioeconomic status (SES) and lung and HN cancer incidence, with differences by gender and country (Faggiano et al. 1997).

SES is a multidimensional construct. Higher education is associated with a higher sensitivity to and a better understanding of prevention messages and a better ability to change his/her behavior, whereas income captures more material dimensions such as living conditions, good diet or access to health care. Occupational class, more closely linked to occupation itself, is another frequent indicator of SES. Several classifications exist for occupational class. Classifications such as the international Erikson and

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Goldthorpe's class categories (EGP) (Erikson and Goldthorpe 1992) or the French PCS classification (Desrosières and Thévenot 2002) are categorical and combine various dimensions such as the level of qualification, the employee/self-employed status, the work characteristics, the level of income or the supervisory position. Other classifications are hierarchical and allow ordering all occupations on the social ladder, either based on the combination of educational requirements and monetary payoffs, such as the International Socio-Economic Index of Occupational Status (Ganzeboom et al. 1992), or based on the popular degree of desirability of occupations, such as the Treiman's Standard International Occupational Prestige Scale (Treiman 1977).

Most studies investigating socioeconomic inequalities in respiratory cancer incidence have focused on educational level or occupational class at one point in time and did not capture changes in SES over the life time (Boing et al. 2011; Menvielle et al. 2004, 2009; Nkosi et al. 2012; Santi et al. 2013). However, a few studies, most of which were case–control studies, have investigated the association between respiratory cancer incidence and occupational class over the life time, assessed either by the longest occupational class or by trajectories between two points in time (Behrens et al. 2016; Conway et al. 2010; Marshall et al. 1999; Melchior et al. 2005; Menvielle et al. 2004; Schmeisser et al. 2010). Therefore, the available literature did not consider the development of SES over the whole working life. A hierarchical measure of occupational class available at various points in time over the working life may allow to identify specific social groups and, therefore, improve our understanding of socioeconomic inequalities in health.

Several studies have investigated the underlying mechanisms of the socioeconomic differences observed in respiratory cancer incidence trying to identify what risk factors could explain these inequalities. Smoking and alcohol drinking are the two main risk factors for these cancers and are strongly socially patterned. Whatever the SES indicator used, studies have generally reported that smoking and alcohol drinking partly accounted for these inequalities for lung cancer (Behrens et al. 2016; Menvielle et al. 2009, 2016) and HN cancer (Boing et al. 2011; Menvielle et al. 2004; Santi et al. 2013) although in some studies, the associations were strongly attenuated or not any more significant after adjustment (Conway et al. 2010; Melchior et al. 2005; Nkosi et al. 2012; Schmeisser et al. 2010). Few studies have investigated the contribution of occupational exposures to these inequalities and suggested a non-negligible role of these exposures (Behrens et al. 2016; Menvielle et al. 2004, 2010, 2016; Santi et al. 2013). Finally, most studies focused on men (Behrens et al. 2016; Marshall et al. 1999; Melchior et al. 2005; Schmeisser et al. 2010), whereas the situation is likely to differ by gender due to gender differences in the social stratification, the social context, the consumption of tobacco and alcohol, the exposure to carcinogens, and the work history.

Finally, the role of risk factors in socioeconomic inequalities in cancer risk may differ by SES indicator. In particular, the association between health behavior and SES may be stronger when SES is assessed using a prestige indicator, that relates to people's status and social standing in society, than a measure based on employment relations, that is more linked to income and wealth (Chandola 1998; Galobardes et al. 2006). Declining prestige may be associated with decreased self-esteem and psychological health and might be particularly linked to changes in health behaviors as a way to cope with this adversity.

The aim of our analysis was, separately among men and women, first to investigate the association between occupational prestige trajectories and lung and HN cancer incidence and second to assess to what extent smoking, alcohol drinking, and occupational exposures over the life time contributed to these inequalities.

Methods

Study population

The ICARE study is a multi-center population-based case–control study conducted in France from 2001 through 2007 in ten French "départements" (administrative areas) covered by a cancer register. The cases were all patients newly diagnosed during the study period with a primary, histologically confirmed malignant tumor of oral cavity, pharynx, sinonasal cavities, larynx and lung (International Classification of Diseases, 10th Revision codes C00-C14, C30-C34) and who were aged 75 or less at diagnosis. The control group was selected from the general population of the same geographical areas (*département*) by random digit dialing, with frequency matching to all cases by sex and age. Additional stratification was used to achieve a distribution by socioeconomic status among the controls comparable to that of the general population. Participation rates were 87.1% in lung cancer cases, 82.5% in HN cancer cases and 80.6% among controls. The study design has been described in details previously (Luce and Stucker 2011).

Measure of occupational trajectory, smoking, alcohol drinking, and occupational exposures

Subjects were interviewed face-to-face by trained interviewers, using a standardized questionnaire including detailed information about socio-demographic characteristics, lifetime tobacco and alcohol consumption (type, period of consumption, frequency of consumption and quantities consumed for each period), and lifetime occupational history (covering all jobs held for at least 1 month and periods of inactivity). For each job period, occupation and industrial activity were coded blind to the case–control status using, respectively, the International Standard Classification of Occupations 1968 (ISCO) (International Labour 1968) and the French Nomenclature of Activities (NAF).

Using each participant's work history, we defined life-course occupational prestige trajectory, using the Treiman's Standard International Occupational Prestige Scale (SIOPS), an internationally comparable scoring system. The score ranges from 14 for unskilled agricultural workers to 78 for physicians and some other occupations with higher education like university teachers. A SIOPS score was assigned to each job period based on the ISCO-code using the Ganzeboom conversion tool (Ganzeboom and Treiman 1996). For periods with two or more parallel jobs, the maximum value of the scores attributed to these jobs was taken. Retirement was considered to end a subject's work history. As recommended by Treiman, intermediate phases of occupational inactivity (training, illness, unemployment) were assigned a score of 30 or the score of the previous occupation if lower than 30. A score of 30 roughly corresponds to the prestige scores of low-skilled manual jobs (such as machinist or plasterer) or low clerical work (such as mail distributor or warehouseman). Other periods of inactivity (e.g., housewife) were assigned a missing value for SIOPS. Members of the armed forces were assigned a score of 42. For each individual, we reconstructed a work history with one SIOPS score per year. People with missing SIOPS score for the whole job history were excluded from the analysis (7.2% of men and 8.0% of women). Then, we used group-based trajectory model on SIOPS repeated measures to identify distinct clusters of individuals following a similar longitudinal pattern separately for men and women. These clusters correspond to the occupational prestige trajectories analyzed in this paper. The fit of the models as well as the homogeneity within each trajectory led us to define eight trajectories in men and in women (Fig. 1). We conducted sensitivity analyses excluding people with no SIOPS score for at least 20% (3.2% of men and 23.3% of women) or 30% of their job history (2.0% of men and 15.1% of women). The higher proportion in women accounts for housewife women.

In the lung cancer analyses, lifelong cigarette smoking was captured using an index specifically developed for this disease, the cumulative smoking index (CSI). The CSI takes into account total duration of smoking, time since cessation and average number of cigarettes smoked per day and is null for never smokers. In our data, the CSI varied linearly with lung cancer risk (Papadopoulos et al. 2014). In the HN cancer analyses, lifelong tobacco consumption was measured using pack-years (restricted cubic splines separately in men and women), smoking status (never/current/former smoker), and the interaction between these variables. The average daily alcohol consumption was calculated as the number of drinks per day by adding the average lifetime daily consumption of each type of alcoholic beverage (restricted cubic splines separately in men and women).

Occupational exposure to asbestos and crystalline silica was assessed using job-exposure matrices (JEM) specifically developed for France (Févotte et al. 2011). For each combination of an ISCO and a NAF code, the JEM assigned a probability, an intensity, and a frequency of exposure. The indices were provided for different calendar periods between 1947 and 2007 to account for possible variations in exposure over time. For each subject, we derived from its entire occupational history a cumulative level of exposure to asbestos and crystalline silica obtained as the sum over all jobs of the product of the exposure intensity, probability, frequency, and duration (using mid-points of each class). Exposure to silica could not be studied in women due to the small number of subjects exposed.

Assessment of ever exposure to diesel motor exhaust (DME) was collected for each job period and based on self-report. This information was missing for about 13% of all job periods. We combined the ISCO code with the NAF code for each job period. Missing values for exposure to DME were replaced by the modal category observed in the same ISCO-NAF combination among subjects with complete data. DME exposure was assessed from the questionnaire on a case-by-case basis when the modal category included less than 60% of the subjects. The association between lung cancer and ever exposure to DME was similar when using this variable and when restricting the analysis to complete case data (Matrat et al. 2015).

In lung cancer analyses, we adjusted for occupational exposures to asbestos (restricted cubic splines for men, ever/never for women), silica (restricted cubic splines for men), and DME (ever/never). In HN cancers analyses, we adjusted for occupational exposures to asbestos (restricted cubic splines for men, ever/never for women).

Logistic regression models were conducted separately for lung and HN cancers, and for men and women. The first model was adjusted for age and residence area. The second model was adjusted additionally for smoking (lung cancer) or alcohol and tobacco consumption (HN cancer). The third model included additional adjustment for occupational exposures. For a large proportion of women, their work history includes long periods of inactivity as housewife. Therefore, among women, we conducted an additional

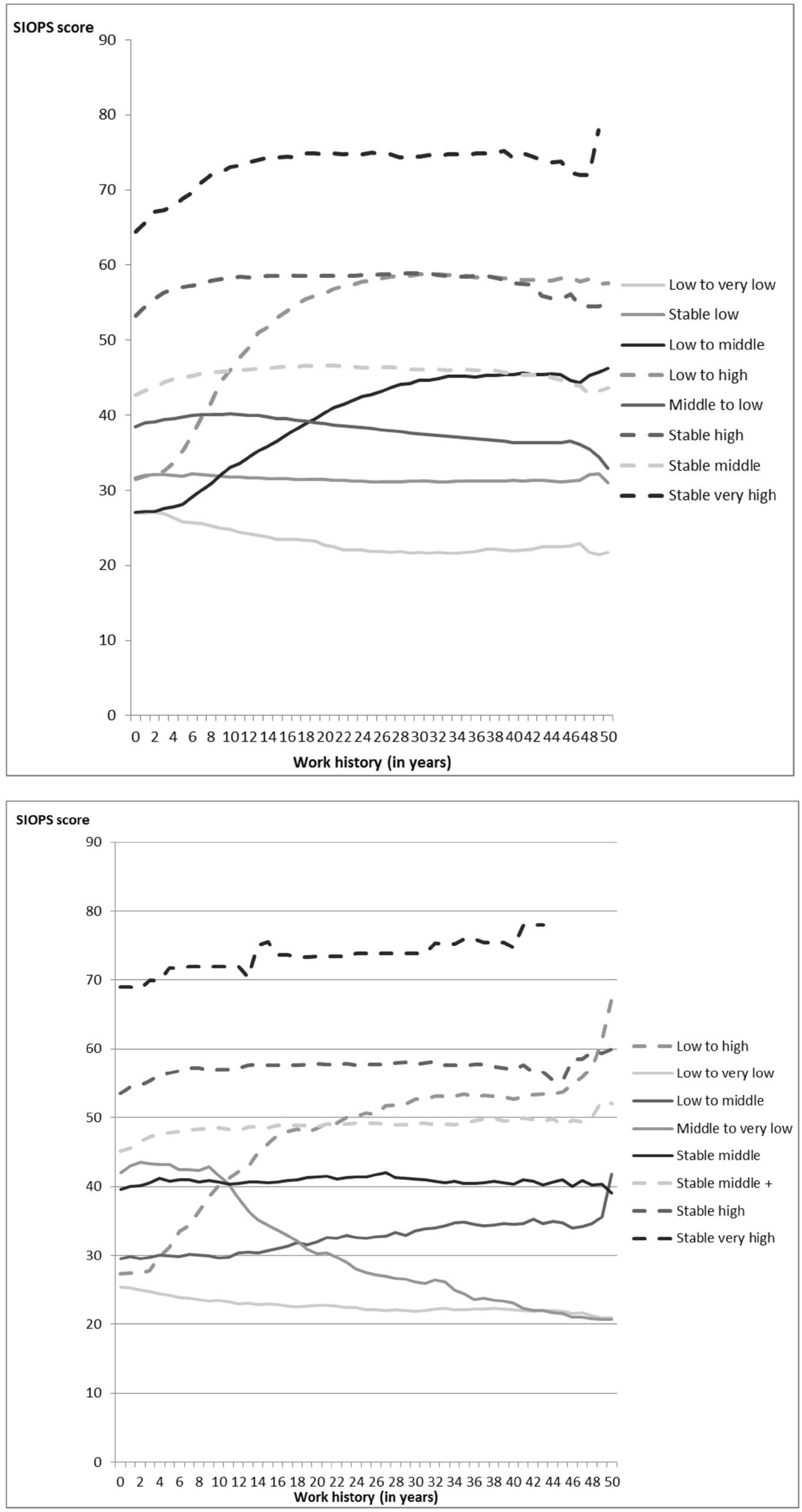

Fig. 1 Occupational prestige trajectories over the whole working life in men (upper panel) and women (lower panel). The ICARE case–control study, France, 2002–2005. *SIOPS* Standard International Occupational Prestige Scale

model adjusted for the number of years as housewife (as a continuous variable). Data with missing values on risk factors were excluded (smoking $n = 59$, alcohol $n = 77$, occupational exposures $n = 175$, periods of inactivity as housewife $n = 129$). All analyses were conducted using SAS 9.4 software (SAS Institute, Cary,NC). Overall, our analyses were based on 3391 controls (2676 men/715 women), 2577 lung cancers (2019 men/558 women), and 2098 HN cancers (1793 men/305 women).

Results

We identified eight occupational prestige trajectories in men and in women (Fig. 1). In men, there were four trajectories stable over the working life (stable low, stable middle, stable high, stable very high), two upward trajectories (very low to middle, low to high), and two slightly downward trajectories (low to very low, middle to low). In women, there were four stable trajectories (stable middle, stable middle +, stable high, stable very high), two upward trajectories (low to middle, low to high) and two downward trajectories (low to very low, middle to very low). In total, 19% of male controls and 27% of female controls experienced a downward trajectory. The respective percentages for an upward trajectory were 21 and 26%. The distribution of alcohol and tobacco consumption, the occupational exposure to asbestos, silica and DME as well as the number of years of inactivity as housewife are presented in Table 1 by gender and occupational trajectories. The risk factors were more prevalent in the more socially deprived groups. Among men, these differences were especially pronounced for alcohol consumption in HN cancer cases. Among women, the stable very high trajectory, although based on very small numbers, displayed the worst profile with high alcohol and tobacco consumption.

The results of the logistic models are presented in Tables 2 and 3.

In men, a gradient was observed amongst all occupational prestige trajectories. A decreased HN cancer risk was observed in the stable very high trajectory and an increased HN cancer risk was observed in all other trajectories when compared with the stable high trajectory. The increased risk was especially pronounced among men who experienced a low to very low or a stable low trajectory. The risk in the upward trajectories was close to the risk of the group they joined. The associations were substantially reduced when adjusting for tobacco and alcohol consumption and for occupational exposures in all trajectories except in the low to high and in the stable very high trajectories where the ORs hardly changed. The ORs were statistically significant after full adjustment in all trajectories but the low to high and the stable very high trajectory. The pattern was similar for lung cancer, although the ORs were much lower than those observed for HN cancers. When compared with the stable very high trajectory, an significantly increased lung cancer risk was observed in all trajectories but the stable very high and the low to high trajectories. The associations were reduced when adjusting for smoking and then for occupational exposures (the OR although higher than 1 became non-significant for the low to middle trajectory).

In women, when compared to the stable high trajectory, there was an increased HN cancer risk in all trajectories in particular in the stable very high trajectory. The ORs were nonetheless significant only for the low to very low, stable middle and very high trajectories. After adjustment for tobacco and alcohol consumption, the associations remained globally unchanged or even increased. The ORs hardly changed when adjusting for the number of years as housewife, except for the stable very high trajectory. Contrary to men, the ORs were only slightly lower for lung than for HN cancer, and even higher and statistically significant for the low to high trajectory. When adjusting for smoking, the ORs increased for the low to very low, stable middle and stable middle + trajectories, decreased and became non-significant for the low to high and the stable very high trajectories, and did not change for the other trajectories. For both lung and HN cancer analyses, additional adjustment for occupational exposures hardly changed the estimates.

Results from the sensitivity analyses excluding people with no SIOPS score for at least 20 or 30% of their job history led to similar conclusions (results not shown).

Discussion

Although there is now a substantial body of literature on SES and cancer risk, little is known on SES over the life time and cancer risk. Using a continuous variable for occupational prestige, we precisely modeled people's trajectories over the whole working life and identified eight groups of occupational prestige trajectories in men and in women. This classification was more discriminatory than the French categorical occupational class classification; e.g. in our data, 47% of the women were clerks most of their working life. In men, we did not identify pronounced downward trajectories. However, we observed a low and slightly downward trajectory that accounted for a non-negligible part of the population (4% of controls, 8% of lung cancers, 12% of HN cancers). This trajectory was characterized by a high consumption of alcohol. It is likely that alcohol played a role in this trajectory, probably both by impacting the first job at the bottom of the occupational

Table 1 Distribution of tobacco and alcohol consumption and occupational exposures by gender and occupational prestige trajectories among controls, lung, and head and neck cancers

Occupational prestige trajectory	*N*	Nb alcoholic drink/day[a]	Light drinkers[b]	Never smokers	Pack-years[a]	CSI[a]	Ever exposed to			Nb years as
		Mean	*N* (%)	*N* (%)	Mean	Mean	Asbestos *N* (%)	Silica *N* (%)	DME *N* (%)	housewife Mean
Controls										
Men										
Low to very low	115	4.4	42 (36.5)	33 (28.7)	21.3	1.1	67 (58.3)	30 (26.1)	38 (33.0)	–
Stable low	588	3.5	249 (42.4)	148 (25.2)	22.6	0.9	428 (72.8)	208 (35.4)	192 (32.7)	–
Middle to low	382	3.2	159 (41.6)	99 (25.9)	22.8	1	272 (71.2)	99 (25.9)	100 (26.2)	–
Low to middle	291	3.5	111 (38.1)	88 (30.2)	22.2	0.9	229 (78.7)	95 (32.7)	104 (35.7)	–
Stable middle	492	2.9	247 (50.2)	124 (25.2)	21.8	0.9	293 (59.6)	111 (22.6)	151 (30.7)	–
Low to high	272	2.6	129 (47.4)	76 (27.9)	17.9	0.8	141 (51.8)	32 (11.8)	68 (25.0)	–
Stable high	464	2.4	234 (50.4)	136 (29.3)	18.9	0.9	100 (21.6)	32 (6.9)	50 (10.8)	–
Stable very high	72	2.1	43 (59.7)	25 (34.7)	20.8	0.8	16 (22.2)	8 (11.1)	3 (4.2)	–
Women										
Low to high	46	1.3	7 (15.2)	26 (56.5)	18.5	0.9	8 (17.4)	–	2 (4.4)	2.8
Low to very low	134	0.9	38 (28.4)	104 (77.6)	19.8	1.1	36 (26.9)	–	10 (7.5)	5.1
Low to middle	138	0.7	26 (18.8)	92 (66.7)	12.3	0.8	40 (29.0)	–	13 (9.4)	3.7
Middle to very low	57	1.3	18 (31.6)	30 (52.6)	12.3	0.8	12 (21.1)	–	8 (14.0)	5.8
Stable middle	97	1.1	26 (26.8)	62 (63.9)	11.2	0.7	26 (26.8)	–	10 (10.3)	2.5
Stable middle+	120	1.1	24 (20.0)	81 (67.5)	13.6	0.9	14 (11.7)	–	7 (5.8)	2.4
Stable high	120	1.0	19 (15.8)	76 (63.3)	17.4	1	8 (6.7)	–	4 (3.3)	0.6
Stable very high	3	1.5	1 (33.3)	2 (66.7)	9.8	1.2	0 (0)	–	0 (0)	0.0
Lung cancer										
Men										
Low to very low	171	–	–	0(0)	–	1.7	119 (69.6)	56 (32.8)	51 (29.8)	–
Stable low	701	–	–	14 (2.0)	–	1.7	578 (82.5)	347 (49.5)	261 (37.2)	–
Middle to low	337	–	–	14 (4.2)	–	1.6	271 (80.4)	112 (33.2)	97 (28.8)	–
Low to middle	180	–	–	5 (2.8)	–	1.6	150 (83.3)	80 (44.4)	66 (36.7)	–
Stable middle	309	–	–	6 (1.9)	–	1.6	214 (69.3)	83 (26.9)	83 (26.9)	–
Low to high	127	–	–	3(2.4)	–	1.6	65 (51.2)	23 (18.1)	28 (22.1)	–
Stable high	164	–	–	4(2.4)	–	1.6	40 (24.4)	9 (5.5)	24 (14.6)	–
Stable very high	30	–	–	2(6.7)	–	1.5	1 (3.3)	1(3.3)	4 (13.3)	–
Women										
Low to high	39	–	–	14 (35.9)	–	1.6	5 (12.8)	–	6 (15.4)	1.9
Low to very low	111	–	–	40 (36.0)	–	1.5	26 (23.4)	–	4 (3.6)	4.2
Low to middle	96	–	–	21 (21.9)	–	1.6	33 (34.4)	–	12 (12.5)	2.8

Table 1 continued

Occupational prestige trajectory	*N*	Nb alcoholic drink/day[a]	Light drinkers[b]	Never smokers	Pack-years[a]	CSI[a]	Ever exposed to			Nb years as
		Mean	*N* (%)	*N* (%)	Mean	Mean	Asbestos *N* (%)	Silica *N* (%)	DME *N* (%)	housewife Mean
Middle to very low	46	–	–	11 (23.9)	–	1.5	8 (17.4)	–	7 (15.2)	4.2
Stable middle	102	–	–	33 (32.4)	–	1.6	25 (24.5)	–	9 (8.8)	2.3
Stable middle+	90	–	–	26 (28.9)	–	1.5	16 (17.8)	–	6 (6.7)	2.0
Stable high	65	–	–	19 (29.2)	–	1.6	4 (6.2)	–	4 (6.2)	1.2
Stable very high	9	–	–	0 (0)	–	1.6	0 (0)	–	0 (0)	0.2
Head and neck cancers										
Men										
Low to very low	207	11.3	17 (8.2)	6 (2.9)	39.9	–	152 (73.4)	–	–	–
Stable low	700	8.4	98 (14.0)	23 (3.3)	40.2	–	568 (81.1)	–	–	–
Middle to low	331	7.9	49 (14.8)	16 (4.8)	39.3	–	270 (81.6)	–	–	–
Low to middle	146	7.4	21 (14.4)	11 (7.5)	40.8	–	114 (78.1)	–	–	–
Stable middle	221	6.9	37 (16.7)	12 (5.4)	39.1	–	142 (64.3)	–	–	–
Low to high	84	6.0	15 (17.9)	4 (4.8)	39.4	–	49 (58.3)	–	–	–
Stable high	97	5.3	23 (23.7)	6 (6.2)	38.2	–	24 (24.7)	–	–	–
Stable very high	7	4.9	0 (0)	0 (0)	46.6	–	1 (14.3)	–	–	–
Women										
Low to high	15	2.3	4 (26.7)	8 (53.3)	24.8	–	5 (33.3)	–	–	4.9
Low to very low	68	3.6	13 (19.1)	20 (29.4)	36.1	–	15 (22.1)	–	–	4.5
Low to middle	61	3.7	7 (11.5)	10 (16.4)	33.2	–	11 (18.0)	–	–	4.0
Middle to very low	28	3.6	5 (17.9)	6 (21.4)	27.8	–	10 (35.7)	–	–	6.4
Stable middle	49	4.2	8 (16.3)	11 (22.5)	34.2	–	7 (14.3)	–	–	2.4
Stable middle+	47	2.1	6 (12.8)	19 (40.4)	38.3	–	7 (14.9)	–	–	2.1
Stable high	32	2.7	3 (9.4)	4 (12.5)	26.3	–	3 (9.4)	–	–	1.0
Stable very high	5	3.7	0 (0)	0 (0)	31.7	–	1 (20.0)	–	–	0.0

The ICARE case–control study, France, 2002–2005

N number of subjects, *CSI* Comprehensive Smoking Index, *DME* Diesel Motor Exhaust, *Nb* number

[a]Among people who ever smoked or drank

[b]Light drinkers: 0 drink/day in women, [0–2] drinks/day in men; —Not included in the analyses

Table 2 Odds ratios (OR) and 95% confidence intervals (CI) associated with occupational prestige trajectories for lung and head and neck cancers risk among men

Occupational prestige trajectory	Lung cancer			Head and neck cancers		
	OR[a] (95% CI)	OR[b] (95% CI)	OR[c] (95% CI)	OR[a] (95% CI)	OR[b] (95% CI)	OR[c] (95% CI)
Low to very low	4.55 (3.37–6.15)	3.05 (2.13–4.38)	2.66 (1.85–3.84)	8.10 (5.88–11.2)	4.52 (3.09–6.62)	4.25 (2.89–6.24)
Stable low	3.52 (2.85–4.36)	2.67 (2.07–3.46)	2.13 (1.62–2.81)	5.52 (4.31–7.08)	3.58 (2.67–4.79)	3.22 (2.38–4.37)
Middle to low	2.57 (2.04–3.25)	2.16 (1.63–2.87)	1.88 (1.40–2.52)	4.10 (3.14–5.35)	2.86 (2.08–3.92)	2.62 (1.89–3.63)
Low to middle	1.68 (1.29–2.18)	1.55 (1.13–2.13)	1.29 (0.93–1.79)	2.18 (1.62–2.95)	1.73 (1.21–2.48)	1.61 (1.12–2.32)
Stable middle	1.80 (1.43–2.26)	1.52 (1.15–2.01)	1.37 (1.03–1.82)	2.13 (1.62–2.80)	1.69 (1.22–2.33)	1.57 (1.13–2.19)
Low to high	1.26 (0.95–1.67)	1.26 (0.89–1.77)	1.18 (0.84–1.66)	1.42 (1.02–1.98)	1.48 (1.00–2.19)	1.42 (0.96–2.11)
Stable high	1	1	1	1	1	1
Stable very high	1.14 (0.71–1.82)	1.24 (0.70–2.22)	1.26 (0.71–2.25)	0.49 (0.22–1.10)	0.51 (0.21–1.26)	0.51 (0.21–1.27)

Men (4695 men in the lung cancer analyses, 4469 men in the head and neck cancers analyses). The ICARE case–control study, France, 2002–2005

[a] Model adjusted for age and residence area

[b] Model 1 further adjusted for smoking (lung cancer) or tobacco and alcohol consumption (HN cancer)

[c] Model 2 further adjusted for occupational exposures (asbestos, silica and DME for lung cancer; asbestos for HN cancers)

prestige ladder and by preventing an upward trajectory over the life time.

Both in men and women, we identified a small group who experienced a stable very high occupational prestige trajectory. Among women, this extremely small group is very specific: when it is grouped with the much larger stable high trajectory and used as the reference category, no differences in respiratory cancer risk between occupational prestige trajectories appear any more. That is why we kept this small group separate in our analyses. In men this socially very privileged group displayed the best health profile and our results suggest that a socioeconomic gradient in respiratory cancers risk exists until the very top of the social ladder. In women, however, this socially very privileged group showed the highest lung and HN cancer risk, partly due to a high alcohol and tobacco consumption. We acknowledge that our estimates are based on small numbers and that no firm conclusion can be drawn. However, our results suggest that in this birth cohort, the most socially privileged women had the worst health behaviors, which may reflect their higher emancipation (Schaap et al. 2009; Waldron 1991).

Before discussing the results, some methodological issues should be discussed. The ICARE study is among the largest case–control studies worldwide on respiratory cancers, with high participation rates (82.5% among HN cancer cases, 87.1% among lung cancer cases and 80.6% among controls). Cases were recruited through a collaboration with the French network of cancer registries, which allowed a nearly complete identification of eligible cases. Controls were selected to have a socioeconomic distribution comparable to that of the general population of the same geographical area. Recall bias is a well-known weakness of case–control studies. Therefore, we paid special attention to data collection. Detailed information was collected by trained interviewers during face-to-face interviews, with a standardized questionnaire, and in a similar manner, among cases and controls.

We collected detailed information on lifetime tobacco and alcohol consumption, with information on the different types and quantity consumed for the different consumption periods. However, we did not account for differences in the type of tobacco smoked (brown or blond, use of filter) in our measure of lifelong smoking. We could identify occasional drinkers and exclude them from the 'never drinker' group. In France, in 2005, only 8.4% of individuals reported never having consumed alcohol, (Legleye 2005) a proportion close to the proportion of never drinkers among controls in the ICARE study (8.6%). In addition, in France, in 2005, around 26% of men (age standardized figure) reported being never smokers, a proportion close to our Figures (28%) (Peretti-Watel et al. 2007). However, differential reporting between cases and controls cannot be

Table 3 Odds ratios (OR) and 95% confidence intervals (CI) associated with occupational prestige trajectories for lung and head and neck cancers risk among women

	Lung cancer			Head and neck cancers		
	OR[a] (95% CI)	OR[b] (95% CI)	OR[c] (95% CI)	OR[a] (95% CI)	OR[b] (95% CI)	OR[c] (95% CI)
Model without adjustment for years of inactivity						
Occupational prestige trajectory						
Low to high	1.76 (1.03–3.01)	1.70 (0.92–3.12)	1.70 (0.93–3.13)	1.34 (0.66–2.76)	1.72 (0.74–3.99)	1.70 (0.73–3.95)
Low to very low	1.70 (1.13–2.55)	2.09 (1.51–3.33)	2.09 (1.31–3.33)	1.95 (1.18–3.21)	2.12 (1.15–3.92)	2.08 (1.12–3.86)
Low to middle	1.35 (0.89–2.02)	1.39 (0.87–2.21)	1.39 (0.87–2.24)	1.60 (0.97–2.65)	1.62 (0.87–3.00)	1.59 (0.86–2.96)
Middle to very low	1.38 (0.83–2.29)	1.39 (0.78–2.47)	1.39 (0.78–2.48)	1.72 (0.93–3.18)	1.65 (0.78–3.48)	1.61 (0.76–3.42)
Stable middle	1.93 (1.27–2.94)	2.19 (1.36–3.55)	2.20 (1.36–3.58)	1.86 (1.10–3.15)	1.82 (0.95–3.47)	1.79 (0.93–3.42)
Stable middle+	1.41 (0.93–2.13)	1.59 (0.99–2.54)	1.59 (0.99–2.55)	1.47 (0.87–2.48)	1.77 (0.94–3.34)	1.76 (0.94–3.33)
Stable high	1	1	1	1	1	1
Stable very high	5.21 (1.35–20.2)	3.54 (0.73–17.1)	3.53 (0.73–17.1)	7.49 (1.66–33.9)	7.27 (1.23–43.2)	7.21 (1.21–43.0)
Model with adjustment for years of inactivity (as a continuous variable)						
Occupational prestige trajectory						
Low to high	1.79 (1.05–3.05)	1.74 (0.95–3.19)	1.74 (0.95–3.19)	1.31 (0.64–2.70)	1.69 (0.73–3.93)	1.67 (0.72–3.89)
Low to very low	1.77 (1.17–2.67)	2.20 (1.38–3.53)	2.21 (1.38–3.55)	1.88 (1.13–3.11)	2.07 (1.11–3.84)	2.03 (1.09–3.78)
Low to middle	1.38 (0.92–2.08)	1.44 (0.90–2.29)	1.44 (0.90–2.32)	1.56 (0.94–2.59)	1.59 (0.85–2.95)	1.56 (0.84–2.91)
Middle to very low	1.45 (0.87–2.41)	1.49 (0.83–2.67)	1.49 (0.83–2.68)	1.63 (0.88–3.05)	1.59 (0.75–3.39)	1.55 (0.72–3.33)
Stable middle	1.97 (1.29–3.00)	2.26 (1.39–3.65)	2.26 (1.39–3.68)	1.83 (1.08–3.11)	1.79 (0.94–3.43)	1.77 (0.92–3.38)
Stable middle+	1.43 (0.94–2.16)	1.62 (1.01–2.60)	1.62 (1.01–2.61)	1.45 (0.86–2.45)	1.76 (0.93–3.32)	1.75 (0.93–3.30)
Stable high	1	1	1	1	1	1
Stable very high	5.17 (1.33–20.0)	3.48 (0.72–16.8)	3.48 (0.72–16.8)	7.59 (1.68–34.3)	7.32 (1.23–43.5)	7.23 (1.22–43.3)
Year of inactivity	0.99 (0.97–1.01)	0.98 (0.96–1.01)	0.98 (0.96–1.01)	1.01 (0.99–1.03)	1.01 (0.98–1.03)	1.01 (0.98–1.03)

Women (1273 women in the lung cancer analyses, 1020 women in the head and neck cancers analyses). The ICARE case–control study, France, 2002–2005

[a]Model adjusted for age and residence area

[b]Model 1 further adjusted for smoking (lung cancer) or tobacco and alcohol consumption (head and neck cancers)

[c]Model 2 further adjusted for occupational exposures (asbestos and Diesel Motor Exhaust for lung cancer; asbestos for head and neck cancers)

excluded, and we cannot rule out an underestimation of tobacco or alcohol consumption, which may differ by SES (Huerta et al. 2005). We nevertheless believe that any misreporting in lifetime tobacco or alcohol consumption is not likely to substantially affect our main conclusions.

Occupational exposures were assessed thanks to the lifetime job history. Self-reported occupational history is usually considered as reliable (Blair et al. 2007). Occupations were coded blind to the case–control status. Occupational exposure to asbestos and silica was assessed through specific JEMs developed for France. A JEM generates only non-differential misclassification which could result in an underestimation of the association between the carcinogens and cancer and an underestimation of the role of these occupational exposures in socioeconomic inequalities in respiratory cancers risk. However, previous studies have validated these JEMs (Guida et al. 2013; Lacourt et al. 2012). In addition, lifetime prevalence of asbestos exposure among our male and female controls (24.3% and 4.1%) is comparable to an estimation from 2007 based on the general French population (26.7 and 2.7% resp.) (Févotte et al. 2011). Overall, we accounted for occupational exposures to asbestos and silica in a much more precise way than in previous studies on socioeconomic inequalities in cancer risk (Behrens et al. 2016; Santi et al. 2013) due to both the detailed measure of exposures (weighted combination of intensity, duration, frequency, and probability) and the modeling of the association with cancer risk (splines). Regarding exposure to DME, we cannot exclude a recall bias. However, 26.2% of our male controls reported at least one job with DME exposure, a proportion close to that found in an Italian study (Richiardi et al. 2006).

We investigated the association between occupational prestige trajectory and lung and HN cancer risk using data from the ICARE study. Data for lung cancer have been previously included in a pooled analysis on social mobility for occupational prestige (Behrens et al. 2016). However, in the latter study, trajectories were assessed using only the first and the last or longest occupation and occupational exposures were assessed in a crude way using ever employment in a job with known lung carcinogen exposure. We observed strong associations between occupational prestige trajectory and lung and HN cancer risk. These associations were reduced when adjusting for people's education but most remained elevated (results not shown), suggesting that education and prestige have an independent effect on cancer risk and do not account for the same dimensions of people's SES (Galobardes et al. 2006).

The SIOPS classification has been developed for men and this may impact our results in women due to differences in occupational prestige between men and women for some occupations. However, prestige scores measure the classical sociological hypothesis that occupational status constitutes the single most important dimension in social interactions and this hierarchy is not likely to fundamentally differ by gender. Investigating work history in women is complexified because of inactivity periods as housewife. We chose to adjust for the duration of these episodes. Finally, we assessed occupational prestige using people's own occupation. Several studies have shown that not onlywomen's but also men's health was related to their partner's SES (Chandola 1998; Skalicka and Kunst 2008; Torssander and Erikson 2009). Therefore, our results may be different when using the occupational prestige of the household. However, the lifetime occupational history of the partner was not available in our study.

Our results confirm the substantial role of smoking and alcohol drinking in socioeconomic inequalities in respiratory cancers incidence in men. Consistently with most of the available literature (Behrens et al. 2016; Boing et al. 2011; Menvielle et al. 2004, 2009, 2016; Santi et al. 2013), we observed that these risk factors only partly accounted for these inequalities. We cannot rule out residual confounding by smoking and alcohol drinking. This would occur in all groups, but may be larger among men with a low occupational prestige due to longer and heavier consumptions. However, it is unlikely that residual confounding accounts for all remaining inequalities.

Our analyses stress the importance of work-related factors in socioeconomic inequalities in respiratory cancer incidence. Interestingly, we observe a stronger gradient relating occupational prestige to occupational exposures than to health behaviors in men. We may have underestimated the contribution of occupational exposures as we did not account for all carcinogens because of no data availability. For lung cancer, we adjusted for the three carcinogens with the highest number of attributable lung cancer cases (Brown et al. 2012), but could not include several known or suspected carcinogens for HN cancers (e.g., strong acid mists, wood dust or formaldehyde). This may explain why the decrease in socioeconomic inequalities after adjustment for occupational exposures was more pronounced for lung than HN cancers and residual confounding may be larger for HN cancers.

In women, although smoking and alcohol drinking contributed to socioeconomic inequalities in respiratory cancer incidence, the situation is more complex. Our results suggested that the women with the highest occupational prestige had the highest tobacco consumption: when compared with women with a stable high occupational prestige trajectory, adjustment for smoking decreased the risk of lung cancer for the stable very high trajectory and did not change or even increased the risk in the other groups. This is consistent with the literature that shows that France has now reached the last stage of the smoking epidemic: tobacco consumption is now among the highest SES women only in the oldest age group, i.e., among women born before 1955, close to our population (mean age of 60.4 in controls and 57.5 in cases) (Bricard et al. 2016). Although residual confounding due to misreporting of alcohol and tobacco consumption is likely to occur in women as in men, it is less clear to assess how this would have impacted the results because of the lack of gradient between SES and smoking. We observed a negligible contribution of occupational exposures to socioeconomic inequalities in respiratory cancers incidence. This reflects the low prevalence of these exposures in female occupations, at least for the high levels of exposure.

Finally, other risk factors such as poor diet (Lagiou et al. 2009; Skuladottir et al. 2004) or physical inactivity (Steindorf et al. 2006) may account for part of the remaining inequalities (Malon et al. 2010; Menai et al. 2015). There is also an increasing body of literature suggesting that exposure to infections may account for part of the worst health in low SES groups, either through a higher and/or an earlier exposure during the lifecourse and/or a higher vulnerability (Dowd et al. 2009). Although it has been very little investigated, this is likely to be more important for HN (through human papillomavirus infection) than for lung cancer (D'Souza et al. 2007; Rotnaglova et al. 2011), and this could explain part of the remaining inequalities in HN cancer risk. Factors associated with SES during childhood (including infections) may also explain part of the remaining inequalities (Kelly-Irving et al. 2013), especially in groups with low occupational prestige at the beginning of their carrier, as the first occupation is more closely linked to childhood SES. This may in particular account for the differences observed between men in the stable high and low to high occupational prestige trajectories for HN cancers risk. Future studies are needed to investigate these issues.

We investigated the role of occupational prestige trajectories on respiratory cancers risk in men and women in France. Our results confirmed the existence of large socioeconomic inequalities both in men and women, but they also highlighted specific patterns that were not observed with other SES indicators. Our study, therefore, underlines the importance of using various measures of SES to fully understand the complex mechanisms at stake in socioeconomic inequalities in health.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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