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# Mortality gradient across the labour market core–periphery structure: a 13-year mortality follow-up study in north-eastern France

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## Abstract

**Purpose** This study explores mortality related to temporary employment, about which very little is known to date. **Methods** In 1996, a health survey was carried out in the French region of Lorraine, and all members of 8,000 randomly chosen households were followed up for mortality over a 13-year period. Mortality of subjects in relation to their employment situation at baseline was analysed using a Cox survival regression.

**Results** In comparison with permanent workers, for unemployed men, we found age and occupation-adjusted hazard ratios (HR) of 4.1 for all-causes of death and 3.9 for non-violent causes, and for male temporary workers a HR of 2.2 for both all-causes and non-violent causes of death. Bad health, tobacco smoking and alcohol misuse explained 17 % of the excess risk for the unemployed and 41 % of that for temporary workers.

**Conclusion** The observation of large mortality inequalities across the labour market core–periphery structure has important policy implications, particularly in terms of prevention focused on unhealthy behaviours among male unemployed and temporary workers.

**Keywords** Mortality · Inequalities · Unemployment · Temporary work · Precarious work · Flexibility · Health behaviours

## Introduction

The flexible labour market is typically segmented: the centre or core comprises individuals employed on a permanent basis or with no fixed term, and it is surrounded by a band of individuals in various kinds of restricted-term employment. In past decades, there has been a re-composition of the work force, with a steady development of the peripheral segments to the detriment of the core of secure employments. In both Europe and the USA, the number of individuals in temporary employment is now exceeding the number of unemployed, and the different forms of flexible jobs have much in common with unemployment in terms of social and economic disadvantages (Benach et al. 2002; Virtanen et al. 2005).

The excess morbidity and mortality among men and women having experienced unemployment has been extensively described in the literature (Bartley et al. 1999; Roelfs et al. 2011). However, there is no agreement on the consequences of flexible work on health, since available studies are not conclusive. The experience of job insecurity has been associated with psychological morbidity but not with physical morbidity (Quesnel-Vallée et al. 2010; Virtanen et al. 2003, 2005; Waenerlund et al. 2011), and, apart from studies in Finland (Kivimäki et al. 2003; Nätti et al. 2009), there is little evidence of an association between job insecurity and premature mortality.

Yet there are several pathways through which temporary work might have adverse health consequences. Temporary workers are more exposed than permanent ones to work

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strain and physical hardship (painful and tiring positions, intense noise and repetitive movements) and to hazardous work conditions, because they often have limited on-the-job training and may feel more constrained by their insecure position to complain about working conditions and risks (Benach et al. 2000, 2002). In addition, studies from different countries suggest that they are more prone to tobacco smoking and alcohol abuse (De Cuyper et al. 2008; Jung et al. 2013; Kivimäki et al. 2003; Legleye et al. 2011). Given their general pattern of social and material deprivation, temporary workers are also less likely to be properly treated (Iezzoni and O'Day 2006; van Beljouwe et al. 2010), and therefore, special attention should be given to their healthcare needs.

Selection processes may, however, distort the picture in unpredictable ways. The “healthy worker effect” to which temporary workers are subject at selection into employment is one candidate, and this pattern is compounded by poor health hindering transition from temporary employment to permanent employment and favouring transition from temporary employment to unemployment (Bardasi and Francesconi 2004; De Cuyper et al. 2009; Virtanen et al. 2002, 2006). Lastly, poor health may lead to disability, which in turn may accelerate exit from the labour market and transition to inactivity.

The purpose of this study was to investigate mortality inequalities in relation to the structure of the labour force from core to periphery. Our data originate from the Lorraine region in north-eastern France, which has been particularly exposed to labour market hardship during the past decades. In France, the unemployment rate has fluctuated around 10 % since the mid-1980s, and limited-term contracts have constantly been on the rise, reaching 12.6 % of salaried workers in 2009 (INSEE 2011). The Lorraine region, a leading industrial region after the Second World War, has undergone massive de-industrialization and tertiarization over the last 50 years, with a significant growth of unemployment and temporary employment (Thirion and Schmitt 2010). Currently, Lorraine is particularly disadvantaged in terms of unemployment and poverty compared to the other French regions.

This study uses a unique epidemiological mortality follow-up survey, the Lorhandicap health survey, which was implemented in Lorraine in 1996 and comprised 8,000 randomly chosen households, of which all members were carefully followed up for mortality over a 13-year period, i.e. until 2008. Our research questions were as follows: (1) Is the mortality of temporary workers higher than that of workers with permanent employment, and how does it compare with that of the unemployed, adjusting for age and occupational group? (2) Are the mortality differences, if any, explained by health status and health-related behaviours at baseline?

## Materials and methods

### Procedure

Several studies based on the Lorhandicap survey data have already been published (Baumann et al. 2007; Chau et al. 2009; Lemogne et al. 2012). The initial sample consisted of subjects aged 15 years or more living in 1996 in 8,000 randomly selected households in the Lorraine region of north-eastern France (2.3 million inhabitants), representing 1/100 of the population. The investigation was approved by the Commission Nationale de l'Informatique et des Libertés (national review board), and a written informed consent was obtained from the respondents.

### Measures

All measures were collected using the survey questionnaire administered at the start of the study in 1996. Occupation was chosen as an indicator of adult socioeconomic status, and employment situation was categorized into permanent employment (paid employment with unlimited duration, i.e. civil servants, workers with indefinite-term contracts and self-employed), temporary employment (project employees, workers “on-call” and workers from temporary labour agencies) and unemployment. Subjects who were not in the labour force at study baseline were excluded (retirees, students, at-home mothers and other non-working people not looking for employment).

Five occupational categories were considered, following the International Classification of Occupation (ISCO) (Kivimäki et al. 2003): professionals/managers (reference category), associate professionals/technicians, service workers/clerks, manual workers and others. We used self-reported health, with a categorization into good (“very good” and “good”), average (“average”), and poor or bad (grouping “mediocre” and “bad”). Behavioural factors included smoking status (smoker, ex-smoker or non-smoker), and “alcohol misuse” which was measured using the French version of the Cut/Annoyed/Guilty/Eye-opener (CAGE) questionnaire (Beresford et al. 1990) and defined by at least two positive responses to four items: consumption considered excessive by the subject, consumption considered excessive by people around the subject, subject wishes to reduce consumption and consumption on waking.

### Follow-up

The cohort was followed up for mortality from 1st July 1996 to 31st December 2008 (12.5 years). The vital status of all subjects was ascertained from the national computerized database listing all deceased subjects in France from 1978, by contacting the registry offices of the birth places

for people born in France and by contacting the registry office for foreign-born French citizens (Ministry of Foreign Affairs). Causes of death were coded by the French national cause-of-death registry (INSERM) using the current revisions of the International Classification of Diseases. Violent mortality corresponds to codes E800.0-E999 (8th or 9th revision) or V01.0-Y89.9 (10th revision) and comprises suicides, homicides and accidental deaths. Non-violent deaths comprise all other deaths.

### Statistical analysis

The study aimed to explore the 13-year (1996–2008) subsequent mortality of subjects who were temporary workers at baseline and to compare it to that of unemployed and permanent workers. The duration of follow-up for each subject was from 1 July 1996 to either the date of death or 31 December 2008 for those still alive at the end of follow-up. Cox regression models were used to examine the associations of employment status with all-cause mortality, non-violent mortality and violent mortality.

To assess the roles played by self-reported health and behavioural risk factors in all-cause mortality, three Cox regression models were performed: a basic model (model 1) including age and occupation; then self-reported health was added to model 1 (model 2); and finally, behavioural risk factors were added to model 2 (model 3). The contributions of self-reported health and those of behavioural risk factors were estimated by the changes in the HRs, derived from the formulas:  $(HR_{\text{model 1}} - HR_{\text{model 2}})/(HR_{\text{model 1}} - 1)$  and  $(HR_{\text{model 1}} - HR_{\text{model 3}})/(HR_{\text{model 1}} - 1)$ , respectively. The proportional hazard assumption was evaluated from Schoenfeld residuals for the global model and for each covariate. The statistical analyses were performed using STATA software (Stata, College Station, TX, USA).

### Sample

Of the 8,000 households included in the sample, dispatches to 193 (2 %) were lost (due to addressing error or death). Of the 7,807 households contacted, 3,460 (44.3 %) participated (all eligible members of the family took part in 86 % of these). In total, 6,234 subjects filled in a questionnaire, including 34 failing to provide gender or age data, leaving a population of 6,200 subjects. The composition of the initial sample was found to be close to that of the census population (“Appendix”).

During mortality follow-up, 157 subjects (2.5 %) were lost and excluded, resulting in a study population of 6,043 participants. Only the subjects who were either working or unemployed and aged between 30 and 64 years at baseline (1st July 1996) were retained for this study, i.e. 2,500

subjects, 1,402 men and 1,098 women. In total, 95 deaths (66 men and 29 women) occurred.

### Results

The subjects experiencing temporary employment had lower occupational categories, poorer self-reported health, greater exposure to behavioural risk factors (for men) and higher general and cause-specific mortality than permanent workers, but a somewhat more favourable profile than the unemployed (Table 1). Hazard ratios for mortality from all-causes, adjusted for age and occupation, differed between men and women, and a significantly elevated hazard ratio was found for temporary male workers (2.2 times higher risk,  $p < 0.05$ ), and, as expected, for unemployed males (4.1 times higher risk,  $p < 0.001$ ), compared to permanent workers (Table 2). With regard to non-violent mortality, the analyses highlighted a significant disadvantage among men for both temporary workers and unemployed (2.2 times higher risk,  $p < 0.05$  and 3.9 times higher risk  $p < 0.01$ , respectively). After subdividing non-violent mortality into mortality from cancers and mortality from cardiovascular diseases, the gap remained pronounced and significant for cardiovascular mortality (3.6 and 5.5 times higher risk,  $p < 0.05$ , respectively), while the estimates for cancer mortality, although elevated (2.3 and 2.9), did not reach significance ( $p < 0.10$ ). For violent mortality, no significant hazard ratio was found for temporary workers, while the estimates were elevated for unemployed men (7.2, close to significance,  $p < 0.10$ ) and significantly elevated for unemployed women (11.2,  $p < 0.05$ ).

Using nested models, we found that after inclusion of health in a first stage, and health-related behaviours in a second stage, the excess risks of death found for men were substantially reduced by 35 and 41 % for temporary workers and by 20 and 17 % for unemployed, remaining significant only for the latter (3.6,  $p < 0.01$ ) (Table 3). Further analyses failed to demonstrate a major role of these factors in explaining mortality from cardiovascular diseases for either the temporary workers or the unemployed. Conversely, the elevated (but non-significant) estimates for cancer mortality were substantially reduced after adjustment for both temporary workers and the unemployed.

### Discussion

The mortality of non-permanent employees has received very little attention to date, and the differences that we have uncovered are impressive, with increasing levels when shifting from permanent employment at baseline to

**Table 1** Sample description: distribution percentages for the explanatory variables in the different employment groups (age 30–64 years)

	Men				Women			
	Permanent workers	Temporary workers	Unemployed	Pearson chi <sup>2</sup> or Fisher test ( <i>p</i> value)	Permanent workers	Temporary workers	Unemployed	Pearson chi <sup>2</sup> or Fisher test ( <i>p</i> value)
Total number of individuals	1,231	130	41		858	166	74	
Number of person—years until 2008	15,295	1,569	459		10,728	2,072	907	
Sociodemographic characteristics								
Age (years)								
Mean (SD)	42.0 (7.9)	42.9 (9.1)	46.4 (10.0)	0.0021	42.0 (8.0)	43.6 (10.7)	44.8 (9.4)	0.0045
Range	30–64	30–62	30–64		30–64	30–64	30–63	
Occupation				<0.001				<0.001
Managers	22	17	20		17	12	4	
Intermediate professionals, technicians	21	15	15		9	4	1	
Service workers, clerks	19	22	5		57	51	54	
Manual workers	34	32	46		11	10	26	
Others	4	14	15		7	23	15	
Risk factors								
Health-related behaviours								
Smoking				0.056				0.781
Non-smoker	28	21	12		48	49	42	
Ex-smoker	36	43	44		26	25	26	
Smoker	36	36	44		26	25	32	
Alcohol abuse	13	22	15	0.027	4	4	5	0.797
Health profile (self-reported health)								
Good	65	51	49	<0.001	66	60	53	0.009
Average	30	35	34		29	33	34	
Poor or bad	4	14	17		5	7	14	
Mortality (crude death rate per 1,000 person—years)								
From all-causes	3.0	7.6	17.4		1.8	2.4	5.5	
Non-violent deaths	2.6	7.0	15.3		1.6	2.4	3.3	
Cancers	1.5	3.8	6.5		1.1	1.0	3.3	
Cardiovascular diseases	0.5	2.5	4.4		0.2	0.5	0	
Other causes	0.6	1.3	4.4		0.3	0.9	0	
Violent deaths	0.4	0.6	2.2		0.2	0	2.2	

temporary employment (2.2 times higher risk) and to unemployment (4.1 times higher risk). Temporary employment and unemployment are in most cases transient situations in employment trajectories, and a study covering the 1990s indicates that two-thirds of the temporary workers reached permanent employment within 3 years (Junod 2006). Our findings are all the more striking, as changes during the course of follow-up are bound to dilute differences across groups.

The large mortality inequalities associated with the situation at baseline are likely to reflect both direct and indirect selection into precarious employment and long-term influence of the socioeconomic disadvantage attached to that position on health. In France, it has been demonstrated that the destabilization of workers into flexible employment was not generalized but rather concentrated on the less stable segment of the population (Petit 2006). In support of this hypothesis, in this study, we have found

**Table 2** Association between employment status and mortality by cause: age and occupation-adjusted hazard ratios (HRs and 95 % confidence intervals)

	Men			Women		
	Permanent workers	Temporary workers	Unemployed	Permanent workers	Temporary workers	Unemployed
Number of subjects	1,231	130	41	858	166	74
Number of person—years	15,295	1,569	459	10,728	2,072	907
Mortality from all-causes	1.00	<b>2.21*</b> (1.16–4.24)	<b>4.09***</b> (1.85–9.01)	1.00	1.28 (0.45–3.62)	2.69 (0.97–7.43)
Non-violent mortality	1.00	<b>2.22*</b> (1.12–4.40)	<b>3.87**</b> (1.66–9.03)	1.00	1.33 (0.46–3.88)	1.80 (0.51–6.32)
Cancers	1.00	2.25 (0.90–5.65)	2.89 (0.82–10.18)	1.00	0.88 (0.18–4.21)	2.79 (0.76–10.30)
Cardiovascular diseases	1.00	<b>3.56*</b> (1.02–12.44)	<b>5.46*</b> (1.07–27.84)	1.00	2.72 (0.21–34.95)	0
Violent mortality	1.00	1.84 (0.22–15.44)	7.20 (0.82–63.34)	1.00	0	<b>11.16*</b> (1.48–84.37)

Significant estimates are in bold: \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$

**Table 3** Association between employment status and mortality for men: additional adjustment for health, tobacco and alcohol: hazard ratios (HRs and 95 % confidence intervals, reference category: permanent workers)

Model	Temporary workers (130 men, 1,569 person—years)		Unemployed (41 men, 459 person—years)	
	HR (95 % CI)	% reduction in HR <sup>a</sup>	HR (95 % CI)	% reduction in HR <sup>a</sup>
<i>Mortality from all-causes</i>				
Adjusted for age and occupation	<b>2.21*</b> (1.16–4.24)	100	<b>4.09***</b> (1.85–9.01)	100
Adjusted for age, occupation and health	1.79 (0.91–3.54)	35	<b>3.46**</b> (1.53–7.84)	20
Adjusted for age, occupation, health, tobacco and alcohol	1.71 (0.86–3.40)	41	<b>3.56**</b> (1.59–7.95)	17
<i>Non-violent mortality</i>				
Adjusted for age and occupation	<b>2.22*</b> (1.12–4.40)	100	<b>3.87***</b> (1.66–9.03)	100
Adjusted for age, occupation and health	1.76 (0.86–3.62)	38	<b>3.22**</b> (1.34–7.75)	23
Adjusted for age, occupation, health, tobacco and alcohol	1.69 (0.82–3.49)	43	<b>3.34**</b> (1.40–7.94)	18
<i>Cancers</i>				
Adjusted for age and occupation <sup>b</sup>	2.25 (0.90–5.65)	100	2.89 (0.82–10.18)	100
Adjusted for age, occupation and health	1.79 (0.68–4.72)	37	2.38 (0.65–8.75)	27
Adjusted for age, occupation, health, tobacco and alcohol	1.78 (0.67–4.74)	38	2.44 (0.67–8.85)	24
<i>Cardiovascular diseases</i>				
Adjusted for age and occupation	<b>3.56*</b> (1.02–12.44)	100	<b>5.46*</b> (1.07–27.84)	100
Adjusted for age, occupation and health	3.43 (0.94–12.56)	5	<b>5.39*</b> (1.04–27.94)	2
Adjusted for age, occupation, health, tobacco and alcohol	3.46 (0.95–12.67)	4	<b>5.54*</b> (1.08–28.51)	0

Significant estimates are in bold: \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$

<sup>a</sup> Reduction (%) in HR computed with the following formula:  $100 \times (\text{HR}_{\text{age-occupation-adjusted}} - \text{HR}_{\text{extended model}}) / (\text{HR}_{\text{age-occupation-adjusted}} - 1)$

<sup>b</sup> The age–occupation-adjusted HRs for temporary workers, and unemployed were close to significance ( $p < 0.10$ )

that, within each occupational category, unemployed and the temporary workers are less educated than permanent workers. For instance, the proportion of male manual workers with primary education only is 38 % among those with indefinite-term contracts, 51 % among those with fixed-term contracts and 61 % among the unemployed. This is in line with the segmentation theory, which states that there are differences in terms of skills between workers in the “core” and the “periphery” of the labour market (Gordon et al. 1982). A compositional difference of this

type is a kind of indirect selection, which certainly contributes to the mortality disadvantage in the peripheral segments of the labour force.

In the literature, there is to our knowledge only one study, from Finland (Kivimäki et al. 2003), that has investigated mortality among temporary workers, over a 10-year observation period. In that study, the same type of gradient across the labour market core–periphery structure was found, and mortality was found to be 1.2–1.6 times higher among male and female temporary employees

compared with permanent employees. More recently, a second analysis of the Finnish data showed that temporary workers were not a homogeneous group and that the mortality disadvantage was limited to those feeling that the insecure situation was unsatisfactory, and to those holding the job on an involuntary basis (Nätti et al. 2009). Indeed, temporary jobs are not all necessarily disadvantaged, and some may even be advantageous when they enable better control over the working time or are used as a stepping stone into permanent employment.

In a recent review and meta-analysis of unemployment and mortality (Roelfs et al. 2011), the mean hazard ratio for mortality was 1.63 among HRs adjusted for age and additional covariates. For the unemployed, we observed a larger gap (fourfold higher risk), but this should be related to the nature of the reference group, which in our study represents the core of the work force. Given the heterogeneity within the employed group, the traditional approach of using all employed as a reference, regardless of their type of employment, is bound to attenuate the association between unemployment and mortality.

In terms of causes of death, external causes, and particularly suicide, are at the forefront in the literature on unemployment and mortality (Mäki and Martikainen 2010). In the Finnish study (Kivimäki et al. 2003), temporary employment was associated among both men and women, with increased deaths from external causes and from alcohol-related causes and, in men only, from smoking-related cancers. Recently, Lundin et al. (2010) reported an increased risk of mortality for unemployed men from both natural and external causes. In line with these findings, among men we observed an association between temporary employment and unemployment at start of the study with non-violent mortality. Our hazard ratios for violent mortality were also very high among the unemployed, but, given the small number of deaths, significance was reached for women, but was borderline for men ( $p < 0.10$ ).

For male temporary workers, we find evidence for a role of health, and, to a lesser extent, of tobacco and alcohol at baseline as explanatory factors for the excess mortality, more so for cancers than for cardiovascular diseases. This difference might be due to the fact that cardiovascular diseases are very much influenced by dietary habits, on which no information was collected in the survey. The role played by poor health in the disadvantage of temporary workers provides some support for the reverse causation (or selection) hypothesis, i.e. that the individuals with poor health are less likely to find a permanent job. On the other hand, the role of reverse causation needs to be mitigated, as health in this group of temporary workers may have been altered by cumulative exposures to hazardous working conditions, occupational injury or occupational diseases. In

support of this interpretation, further analysis of the study data showed that the prevalence of self-reported functional limitations for daily living activities at baseline was 20 % for permanent employment, 33 % for temporary employment and 41 % for unemployment among men ( $p < 0.001$ ) and 14, 21 and 23 %, respectively, among women ( $p < 0.001$ ).

For male unemployed, we find a lower contribution of poor health and behavioural factors than for male temporary workers (fully adjusted HR 3.6,  $p < 0.01$ , 17 % reduction in HR). This may suggest that the post-unemployment pathway plays a significant role for the unemployed. According to the “coping hypothesis”, individuals cope with the stress associated with unemployment by changing their health behaviours in unhealthy ways (Hammarstrom and Janlert 1994). This change is already visible in our data. Further to this, some studies have demonstrated that the experience of joblessness has long-term effects on income [the “unemployment scar” (Aru-lampalam 2001)]. A “scar” of this type could contribute to less favourable pathways, particularly because “unemployment spells do not happen at random, but tend to take place as part of a generally disadvantaged life course” (Bartley and Ferrie 2010).

The health effects of different types of employment situations may differ by gender, and the idea that loss of employment may have less of a negative influence for women has been supported, with the argument that women are more able to cope because they take on roles as mothers and housewives. We found no significant mortality inequalities among women, although the hazard ratios associated with female unemployment were quite elevated. First, certain types of temporary jobs may have positive aspects for women whenever they need to invest more of their time and energy in family life. This might be changing, since women’s traditional social roles are evolving, with working status becoming an increasingly important component of women’s identity (Bambra 2010). Second, while women are more likely to belong to the more peripheral temporary workforce, they are less involved than men in manual jobs, which are the most exposed to occupational health risks. It is also worth noting that there were no significant differences across employment situations in terms of smoking and alcohol misuse among women and that the differences for poor health were much smaller than among men (Table 2). This finding is consistent with the greater contribution of unhealthy behaviours to the excess mortality of male temporary workers and definitely calls for targeted prevention approaches on these issues.

Before turning to policy implications, it is important to stress the study limitations. First, the response rate was rather moderate (about 44 %). However, this response rate

is similar to those of other studies using postal self-administered questionnaires in France (Goldberg et al. 2001). Furthermore, the distributions for gender, age, education, marital status, occupation, unemployment and occupational injury in the initial sample were close to those of the census population (“Appendix”).

Second, given the small number of observations in the exposure groups (unemployed and temporarily employed), our study did not possess sufficient statistical power and used wide confidence intervals for the estimations. The main issue in this case is type II error rather than type I error, and therefore, the significant findings that we report are all the more unlikely to arise by chance. Another reassuring point is that our hazard ratio estimates for the unemployed agree with those found in a five-year mortality follow-up of the French longitudinal samples derived from the 1975, 1982 and 1990 censuses (3.9 for men and 1.9 for women in (Mesrine 2000)), compared to 4.1 and 2.7 (non-significant) in our study.

Third, our analyses are based on subjects’ employment situation, health and behaviours at the start of the study, and we do not have retrospective information, nor do we have updates during the follow-up period. Not knowing to what extent poor health and unfavourable health behaviours are the cause or the consequence of remaining or becoming a temporary worker or unemployed, we cannot give credit to a causality relation and have therefore emphasized both causation and reverse causation (selection) hypotheses in the discussion. Given the sample size and the issues outlined above, our findings definitely need to be replicated and confirmed.

## Conclusion

The issue of precarious employment and health is progressively gaining more visibility in the public health arena, but the empirical evidence is scant. Based on a unique mortality follow-up in a region of France subjected to economic hardship, our study uncovers large mortality inequalities and provides evidence for a new form of mortality inequality across the core-periphery structure of the labour market. The evolution of the Lorraine region during the past decades, from a prosperous industrial region to one of the most socioeconomically disadvantaged regions in the country, could partly explain the role of health behaviours as coping mechanisms for the population. Our findings have important policy implications, particularly in terms of prevention focused on unhealthy behaviours among male temporary workers and the unemployed.

Furthermore, job insecurity today is bound to lead to wider health consequences than in the economic recessions of the 1980s, given the progressive weakening of the

protection of citizens against labour market risks by the welfare state in many countries (DeNavas-Walt et al. 2011; Observatoire des inégalités 2011). It follows that fuller consideration of the new forms of health inequalities in the flexible labour market landscape is required (Benach and Muntaner 2007).

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

## Appendix

See Table 4.

**Table 4** Comparison between the study sample and the general population (Lorraine region of the north-eastern France, Census 1999) (%)

	Study sample	General population
Number of subjects	6,200	1,893,826
Women	52.4	51.6
Age (years)		
15–19	6.0	8.6
20–24	8.0	7.9
25–29	10.1	8.6
30–49	36.9	36.0
50–59	12.4	13.4
60–74	20.4	17.2
75 or over	6.2	8.3
Educational level		
University	16.9	22.0
High/middle school	48.0	42.3
Primary school	35.1	35.7
Marital status		
Married and single <sup>a</sup>	88.7	86.0
Separated/divorced	4.4	5.6
Widowed	6.9	8.4
Retirees	25.0	20.6
Working population		
Number of subjects	2,882	888,470
Job category		



**Table 4** continued

	Study sample	General population
Managers, professionals and associate professionals <sup>b</sup>	32.0	32.2
Farmers, craftsmen, tradesmen, heads of firm	5.6	7.0
Service workers/clerks	23.7	28.7
Manual workers	38.7	32.1
Unemployed among economically active people <sup>c</sup>	11.9	11.8
Annual prevalence of occupational injury with sick leave <sup>d</sup>	4.6	4.0 <sup>d</sup>

Standardized mortality ratio (for 1996–2008 period): 0.91 vs. France, 0.86 vs. Lorraine region

Source: Institut National d'Etudes Démographiques, 1999. France métropolitaine-Enquête annuelle de recensement 1999

<sup>a</sup> We cannot separate married and single due to differences between our study (living as couple/married and single) and the Lorraine census (married and unmarried)

<sup>b</sup> We cannot separate these subgroups due to differences between our study and the Lorraine census

<sup>c</sup> Non-included in the 2,882 subjects

<sup>d</sup> Concerns the general compensation system, which includes about the two-thirds of the working population in the Lorraine region (the prevalence was similar for France)

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