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WORKING CONDITIONS AND DISABILITIES IN FRENCH WORKERS: A CAREER-LONG RETROSPECTIVE STUDY

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Abstract: This study aims to estimate the causal impact of detrimental working conditions on disabilities in France. Using a rebuilt retrospective lifelong panel and defining indicators for physical and psychosocial strains, we implement a mixed econometric strategy relying on difference-in-differences and matching methods to take into account for selection biases as well as unobserved heterogeneity. For men and women, deleterious effects of both types of working conditions on disability after exposure are found, with varying patterns of impacts according to the nature and magnitude of the strains. These results provide insights into the debate on legal retirement age postponement and justify not only policies being enacted early in individuals' careers in order to prevent subsequent mid-career health repercussions, but also schemes that are more focused on psychosocial risk factors.

Key words: Working conditions; Disability; Matching; Difference in differences; France

JEL classifications: J81; I14; C32

INTRODUCTION

While organizational innovation and emergence of the service sector should have freed employees from the most demanding physical constraints, the quality of working life seems to be declining in Europe (Greenan *et al.*, 2014). The French case, characterized by a high degree of physical strain but also a low level of autonomy at work, appears to be particularly troublesome. In France, the issue of work arduousness has been widely debated for nearly twenty years. Since 2015, people exposed to physically demanding working conditions may benefit from an early retirement, up to two years before the legal age. However, adverse health effects of exposure to psychosocial risks have not yet met a legislative response.

This differentiated approach to retirement rights may be justified by an exogenous deterioration in health (meaning independent of the individual effort such as care and preventive care access and health behaviours) and directly attributable to work drudgery. To support such an approach, we must then formulate two assumptions. On the one hand, individuals in arduous job did not deliberately choose to do so, due to either information asymmetry or lack of professional prospects. On the other hand, we must figure out that exposure to professional risks does indeed lead to a meaningful health depreciation, compared to people without (or with less) exposure but similar other characteristics.

The relationship between work and health status has already received considerable attention in epidemiology, sociology, management, psychology and ergonomics. Economics offers theoretical analytics frames as well. The differences in wages between equally productive individuals could be explained by differences in work arduousness. Therefore, workers with poorer working conditions could be overpaid in a perfect market (Rosen 1974). As health capital and wealth stock are supposed to be substitutable in this framework, workers could be willing to sacrifice a part of their health capital in return for an income surplus (Muurinen and

Le Grand 1985). We do not retain this hypothesis and assume that working conditions are a constraint (not a choice) faced by workers, but possibly partly resulting from selection effects.

This research area has yet received less attention in empirical economics (and this is particularly the case, especially considering heavy health repercussions of exposures to detrimental working conditions), due to at least two methodological challenges. First, this relationship refers to endogeneity biases such as reverse causality, endogenous selection and unobserved heterogeneity (Barnay 2016). Second, measuring and properly identifying the diversity and intensity of exposures do not appear as a simple task due to data limitations.

Though, from a public policy point of view, the issue of working conditions and their potential effects on health status becomes crucial, for instance in maintaining the financial equilibrium of the pension system and health insurance (especially, when a public disability insurance is provided for unhealthy seniors, which is the case for France). Prolonged exposure to arduous working conditions may indeed prevent the most vulnerable from reaching the legal retirement age and lead to suffering from chronic diseases early. After establishing connections between working conditions and chronic diseases in a previous study (Defebvre 2018), we now wish to question this relationship by considering a stronger and potential definitive alteration of health: the prevalence of disabilities.

In this paper, we examine the role of physical and psychosocial working conditions on the declaration of disabilities. We contribute to the literature in three ways. First, we address methodological issues caused by selection biases and unobserved heterogeneity using a difference-in-differences methodology combined with matching methods. Our second contribution arises from establishing and analysing the role of progressive and differentiated types of exposures and account for potentially delayed effects on health. Our last original contribution deals with the specificity of the outcome, focusing on the most severe health condition. The literature indeed struggles to distinguish between two competing hypotheses concerning the origin of disabilities: the direct and instantaneous cause of the accident, or the

long process of deterioration of health status linked to exposures to health-damaging activities, ultimately leading to disabilities.

The paper first presents an overview of the economic literature (Section 1), the general framework of this study (Section 2), the data (Section 3) and empirical methodology (Section 4). Then, the results are presented, along with a discussion (Section 5 and Section 6).

1. Literature

1.1. Effects of work strains on health status

The role of work strains on general health status is clearly established in the economic literature (Barnay 2016; Fletcher, Sindelar, and Yamaguchi 2011). However, if the role of physical or environmental burdens on health has traditionally been demonstrated (Case and Deaton 2003; Choo and Denny 2006; Debrand and Lengagne 2008; Robone, Jones, and Rice 2011), psychosocial risk factors have received a smaller attention in economics studies. A physically demanding job is broadly known to be correlated with self-rated health (Case and Deaton 2003; Choo and Denny 2006). Panel data studies confirm these findings by focusing on different items such as job satisfaction (Fischer and Sousa-Poza 2009) or work environment (Datta Gupta and Kristensen 2008). For instance, Ose (2005) points out that a heavy workload result in ill health and greater absenteeism. Atypical work hours and general job satisfaction influence on both self-assessed health and well-being (Robone, Jones, and Rice 2011). However, none of these studies specifically examines the effect of working conditions on the occurrence of disability.

Psychosocial risk factors are traditionally related to a psychological area (Johnson *et al.* 1989; Karasek 1979; Theorell and Karasek 1996). This research topic has been studied more recently in the empirical economics literature (Askenazy and Caroli 2010; Cohidon *et al.* 2010; Cottini and Lucifora 2013; Kuper and Marmot 2003; Laaksonen *et al.* 2006). *Job strain* situation refers to a mix between high demands and low levels of control. This constraint is highly related to coronary heart diseases (Kuper and Marmot 2003) and cardiovascular diseases, when associated

to social isolation (Johnson *et al.* 1989). Mental health is also potentially impaired by such exposures. Being exposed to weak social support and lack of pride at work (Bildt and Michélsen 2002) or being in contact with the public (Cohidon *et al.* 2010) may be related to a worse mental health condition. Using three waves of European data on 15 countries, Cottini and Lucifora (2013) demonstrate that job demands affects mental health.

Frequency, intensity, duration and simultaneity of exposures are key elements in understanding the negative effect of occupational stress on health (Michie and Williams 2003). Karasek's and Siegrist's models offer a perfect frame to study the results of combined exposures to several, simultaneous work stressors (job strain and iso-strain). The study of Fletcher, Sindelar, and Yamaguchi (2011) focuses on the role of cumulative physical and environmental exposures over five years (from 1993 to 1997) after controlling for initial health status and health-related selection. By aggregating several physical and environmental working conditions, they find clear impacts of these indicators on both men and women, with variations depending on demographic subgroups. We also consider exposures to both physical and psychosocial risk factors and we take into account (simultaneous) exposures that occur throughout the whole career.

1.2. Methodological issues

Selection effects and endogeneity problems affect this relationship and may lead to spurious estimates. First of all, facing painful working conditions is not a random phenomenon (Cottini and Lucifora 2013). Initially, healthier individuals may tend to prefer (self-selection) or to be selected (discrimination) for more physical demanding jobs (Barnay *et al.* 2015). This could lead to downwards biases related to healthy worker effect. This last skew is reinforced by considering working conditions thresholds (being subjected to high levels of exposure implies on the one hand remaining in employment for a long time and on the other hand being physically or psychologically able to cope with it). Second, we assume that workers with lesser health capital may have fewer opportunities in the labour market and thus be restricted to the toughest

jobs, in which case an upward bias may result. However, the relationship between job selection and initial health is not so obvious regarding psychologically demanding jobs. Psychosocial risks at work indeed affect the French population more homogeneously, regardless of education level or gender, than exposure to physical working conditions (Barnay and Defebvre 2018).

Therefore, unobserved individual and temporal heterogeneities that are unaccounted for may also result in biased estimations (Lindeboom and Kerkhofs 2009). Individual preferences and risk aversion behaviours as well as shocks, crises or other time-related events can cast doubt on the exogeneity hypothesis of working conditions (Bassanini and Caroli 2015).

Few papers have actually succeeded in handling these biases due to a lack of panel data that includes detailed information on both work and health status over longer periods. Notably, Cottini and Lucifora (2013) implemented an instrumental variable strategy on repeated cross-sectional data while relying on variations across countries in terms of workplace health and safety regulation, doing so in order to identify the causal effect of detrimental working conditions on mental health. In most cases, the difficulty in finding accurate and reliable instruments for working conditions leads to the question of selection, and unobserved heterogeneity is either treated differently or avoided altogether when working on cross-sectional data.

1.3. Disability

Disability is not univocal and relies on physical, mental, or cognitive impairments arising from congenital disorders, accidents, diseases, or the ageing process. This physical, mental, cognitive, or developmental condition can impair, interfere with, or limit the individual ability to get involved in certain tasks or actions, or participate in daily activities. The literature largely agrees on the adverse influence of disability on labour market outcomes, either at the extensive margin (Mussida and Sciulli 2016; Silva and Vall-Castelló 2017; Wubulihasimu, Brouwer, and van Baal 2015; Barnay *et al.* 2015) or at intensive one (Müller and Boes 2020). In addition, an

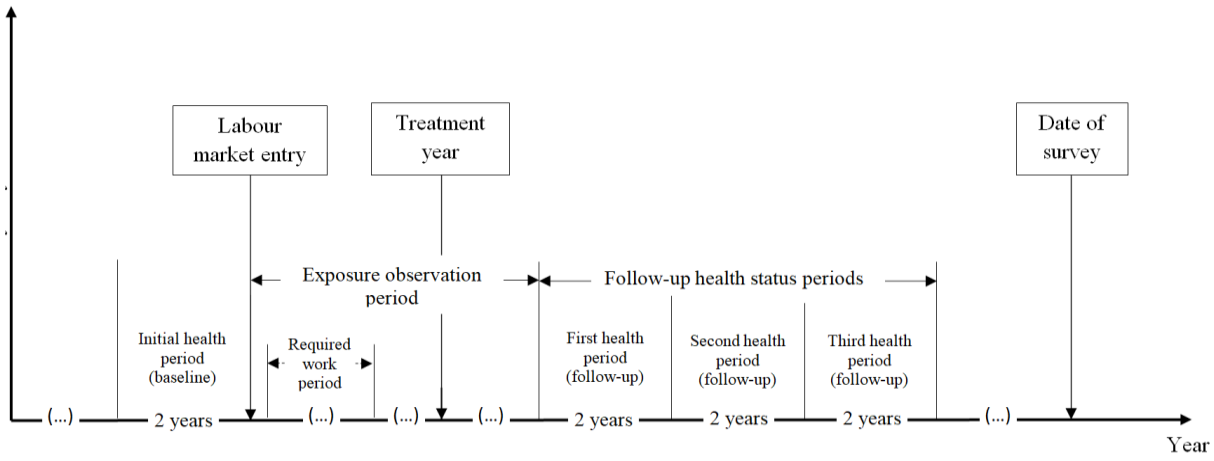
extensive body of works studies the impact of disability insurance programs on the labour supply behaviour of people with disabilities (Campolieti and Riddell 2012; Staubli 2011). However, to our knowledge, no empirical study based on longitudinal data has examined the pathogenic role of work (based on past working conditions) on the occurrence of disabilities.

We assume that this relationship may transit from different channels and at different time spans. We could first come up with a short-term hypothesis: the deterioration of working conditions would make individuals more vulnerable to work-related accidents (Ose 2005) and sickness absences (Michie and Williams 2003), directly leading to an increase in the onset of disabilities. Next, disability may result from a long process, as defined by the World Health Organization (1980, 2001), that depicts progression from diseases to functional disabilities (International Classification of Impairments, Disabilities, and Handicaps, 1980). In this second case, a potential adverse effect could appear following long and intense exposures. It is most likely that this second hypothesis is more robust than the first.

2. General framework

We estimate the influence of varying levels of exposure to detrimental working conditions in disabilities, relying on a general framework described in Defebvre (2018). In doing so, we perform a difference-in-differences framework which considers a *disability baseline period*, *i.e.*, corresponding to the initial number of disabilities before exposures to work strains, and a *follow-up period* occurring after a degree of exposure has been reached (*the treatment*).

Figure 1: Configuration of working conditions and disabilities periods



Source: *Authors.*

Thus, we define four disability periods (Figure 1). The baseline period consists of the two years before labour market entry. Following labour market entry, three two-year disability follow-up periods are reconstructed, representing short- to mid-term post-treatment health conditions.

The analysis of exposure to working conditions requires considering a relatively homogeneous population with regard to the length of the working year, potential exposure and then treatment date (Llena-Nozal, Lindeboom, and Portrait 2004). Therefore, we observe working conditions within a dedicated period (starting from labour market entry year). In order to be treated, one must reach the treatment threshold within this observation period. The other individuals are considered controls.

Table I: Thresholds description

Threshold Parameter	t_1	t_2	t_3	t_4	t_5	t_6	t_7	t_8	t_9
Treatment thresholds									
Single exposure threshold	4	6	8	10	12	14	16	18	20
Poly-exposure threshold	2	3	4	5	6	7	8	9	10
Periods definition									
Working conditions observation period	6	9	12	15	18	21	24	27	30
Minimum duration at work	2	3	4	5	6	7	8	9	10

Indications: *in years.*
Reading: *For the seventh threshold (t_7), an individual must reach 16 years of single exposure or 8 years of poly-exposure within the 24 years following labour market entry to be considered treated. Also, he/she must have worked at least 8 years within this period to be retained in the sample. His/her health status will be assessed by the mean number of yearly disabilities at baseline (the 2 years before labour market entry), and three more times (follow-up periods) after the end of the working conditions observation period.*

Source: *Authors.*

We design nine progressive exposure levels (denoted t_N). The cumulative effects between strains are considered through two types of yearly exposure: single exposure and poly-exposure (at least two simultaneous strains). Then, the duration of exposure is accounted for by introducing varying minimum durations of exposure (thresholds). However, changing the treatment thresholds will, as a consequence, lead to other necessary changes in the framework, notably to the duration of the working conditions observation period and to the minimum duration at work within it (see second half of Table I). More details about the choices made for these parameters can be found in Appendix 1. Note that only thresholds t_5 to t_9 are presented in the rest of the paper (for simplification purposes), because previous thresholds reveal no significant effect on disabilities from exposure to detrimental working conditions.

3. Data

3.1. The *Santé et Itinéraire Professionnel* (Sip) survey

We use data coming from the French Health and Professional Route survey (*Santé et Itinéraire Professionnel* – Sip). It has been designed jointly by the statistical departments of two French ministries in charge of Health[1] and Labour[2]. The panel is composed of two waves (2006 and 2010). Two questionnaires are proposed: the first one is administered directly by an interviewer and investigates individual characteristics, health and employment statuses. It also contains a life grid, which allows reconstructing biographies of individuals' lives: childhood, education, health, career and working conditions, as well as major life events. The second one is self-administered and focuses on more sensitive information such as health-related risky behaviours (weight, alcohol and tobacco consumption). Overall, more than 13,000 individuals were

[1] *Directorate for Research, Studies, Assessment and Statistics (Drees) – Ministry of Health.*
[2] *Directorate for Research, Studies and Statistics (Dares) – Ministry of Labour.*

interviewed in 2006 and 11,000 in 2010, making this panel survey representative of the French population[3].

We make specific use of the biographic dimension of the 2006 survey by reconstructing workers' career and health events yearly[4]. We are therefore able to know each individual's employment status, working conditions and disabilities every year from their childhood to the date of the survey (2006). As far as work strains are concerned, the survey provides information about ten indicators of exposure. The intensity of exposure to these work strains is also known. Individuals' health statuses are assessed by their declaration of disabilities, for which the onset and end dates are available.

In this study, we work with this reconstructed longitudinal retrospective dataset comprising more than 8,500 individuals, including their career and health-related data from childhood to the year of the survey (see Appendix 1).

3.2. Disability and work strains

In the Sip Survey, individuals can declare disabilities and their potential links to changes in their professional situations. Disabilities are identified in various ways in the Sip questionnaire along with the retrospective calendar, and are self-reported regardless of whether they are explicitly related to professional events or not. For instance, the respondent may self-report whether a disability occurred during childhood or prevented the completion of education or job training. When describing professional paths, the respondent might declare whether a disability was disruptive. For a complete employment period (1-5 years), individuals were asked if a disability resulted in a loss of employment, caused impairments or important changes in working conditions. For the current job, individuals were only asked if a disability resulted in loss of employment. For unemployment spells, individuals were asked if a disability resulted in the end of job search. For a period of non-employment, individuals were asked if a disability

[3] *For a technical note on attrition management and data calibration in the Sip survey, see* De Riccardis (2012).
[4] *It is not possible to know what happened between 2006 and 2010, making the latter wave unusable in this study.*

caused or extended it. In the health part of the survey, respondents who had already disclosed a life disturbance were asked if a disability occurred and whether other periods of disability had been experienced. In addition, we are able to know if the disability is officially recognized (i.e. disability officially recognized by the institution coping with the vocational rehabilitation of disabled workers, or health problems having resulted in a disability confirmed by the statutory health insurance). Finally, we can compute the date of the disability onset and its duration, and the Sip Survey also provides with the origin of the disability (disease, accident, ageing…).

Regarding detrimental working conditions, ten individual annual indicators are used to assess the exposure to detrimental work strains. We split them into two groups. The first one represents the physical load of work and includes night work, repetitive work, physical load and exposure to toxic materials. The second one refers to the psychosocial risk factors (full skill usage, working under pressure, tensions with the public, reward, conciliation between work and family life and relationships with colleagues). For each indicator, four response options are proposed: "Always", "Often", "Sometimes" or "Never" faced it during this period. Exposure is defined if he/she "Always" or "Often" declared facing these strains.

3.3. General descriptive statistics

Table II depicts the sample used in the 7th threshold, offering an adequate representation of the average of the studied population. Descriptive statistics allow us to draw some insights. First, the treated populations appear to initially be in a similar health condition than their counterparts (which is different from less severe conditions – Defebvre, 2018 find significant differences in baseline chronic diseases for instance). Second, significant effects of the physical and psychosocial treatments are observed on subsequent numbers of disabilities. However, due to the observed characteristics' heterogeneity between the treated and control groups, the differences in disabilities for each period between the two are likely to be unreliable. The most noticeable differences in gender gaps and human capital appear when considering physical constraints. Exposure to demanding physical working conditions overwhelmingly affects the

male population. In addition, pursuing higher education concerns 8% of the treated population *versus* 28% of the control group. In contrast, exposure to psychosocial working conditions is more homogenously distributed in the population and does not reflect a social gradient.

Table II: Base sample description (t_7)

Variable	Mean	Std. error	Min	Max	Physical sample			Psychosocial sample		
					Treated	Control	Diff.	Treated	Control	Diff.
Treatment										
Physical treatment	.35	*.48*	0	1	-	-	-	-	-	-
Psychosocial treatment	.36	*.48*	0	1	-	-	-	-	-	-
Disability periods										
Initial	.035	*.18*	0	2	.035	.035	-.00	.036	.035	-.00
1st period	.045	*.22*	0	4	.063	.036	-.028***	.060	.037	-.022***
2nd period	.046	*.22*	0	5	.066	.035	-.031***	.062	.037	-.025***
3rd period	.043	*.22*	0	4	.064	.032	-.032***	.060	.034	-.025***
Demography										
Entry year at work	1973	*13.17*	1941	1998	1968.41	1975.52	7.11***	1970.83	1974.28	3.45***
Men	.50	*.50*	0	1	.62	.44	-.18***	.52	.49	-.03***
Women	.50	*.50*	0	1	.38	.56	.18***	.48	.51	.03***
Age	51.19	*12.79*	42	74	54.42	49.44	-4.98***	53.12	50.09	-3.03***
No diploma	.09	*.28*	0	1	.14	.06	-.08***	.10	.08	-.02***
Inf. education	.54	*.50*	0	1	.68	.46	-.21***	.56	.53	-.03***
Bachelor	.15	*.36*	0	1	.09	.18	.09***	.14	.16	.02**
Sup. education	.21	*.41*	0	1	.08	.28	.21***	.19	.22	.04***
Childhood										
Problems with relatives	.38	*.48*	0	1	.43	.35	-.07***	.41	.36	-.06***
Violence	.08	*.26*	0	1	.09	.07	-.03***	.10	.06	-.04***
Severe health problems	.08	*.28*	0	1	.09	.08	-.01**	.09	.08	-.02***
Physical post-exposure										
None	.76	*.42*	0	1	.45	.93	.36***	.65	.83	.17***
Low	.14	*.32*	0	1	.24	.05	-.19***	.16	.09	-.07***
High	.12	*.32*	0	1	.31	.02	-.29***	.19	.08	-.11***
Psycho. post-exposure										
None	.75	*.43*	0	1	.61	.83	.21***	.50	.90	.40***
Low	.13	*.34*	0	1	.20	.09	-.10***	.24	.07	-.17***
High	.11	*.32*	0	1	.19	.08	-.11***	.26	.03	-.23***
Tobacco consumption										
Initial disability period	.15	*.36*	0	1	.12	.17	.05***	.15	.15	-.01
1st disability period	.24	*.43*	0	1	.27	.22	-.05***	.26	.23	-.02**
2nd disability period	.23	*.42*	0	1	.26	.22	-.04***	.25	.23	-.02**
3rd disability period	.23	*.42*	0	1	.25	.21	-.04***	.23	.22	-.02*

Interpretation: ****: difference significant at the 1% level, **: difference significant at the 5% level, *: difference significant at the 10% level. Standard errors in italics. The average number of handicaps in the whole sample at the first follow-up period is* 0.045*. In the physically treated population, this number is* 0.063 *(which is significantly higher than for the control group, i.e.* 0.36 *at the 1% level).*
Field: *Population aged 42-74 in 2006 and present from i_1 to i_9. 7th iteration. Unmatched sample.*
Source: *Health and Professional Route survey (Sip), wave 2006.*

4. Empirical analysis

4.1. Econometric strategy

The empirical framework of the difference-in-differences methodology is given by Equation 1 (Angrist and Pischke 2009). It is described in more details in Defebvre 2018:

$$E(Y_i|T_i = 1) - E(Y_i|T_i = 0) \\ = E(Y_{1i} - Y_{0i}|T_i = 1) + [E(Y_{0i}|T_i = 1) - E(Y_{0i}|T_i = 0)] \quad (1)$$

$[E(Y_{0i}|T_i = 1) - E(Y_{0i}|T_i = 0)]$ equals 0 when the conditional independence assumption is verified, *ie.*, $\{Y_{0i}, Y_{1i}\} \perp T_i$.

The estimation of the difference-in-differences relies on the fixed-effects, heteroskedasticity-robust Within panel data estimator estimating Equation (2), which explains the mean number of disabilities (Y_{it}):

$$Y_{it} = \beta_0 + \beta_1 \mathbf{1}_{(t+1)} + \beta_2 \mathbf{1}_{(T_i=1)} + \beta_3 \mathbf{1}_{(t+1)} \times \mathbf{1}_{(T_i=1)} + \beta_4 C'_{it} + \gamma_i + \gamma_t + \varepsilon_{it} \quad (2)$$

$\mathbf{1}_{(t+1)}$, $\mathbf{1}_{(T_i=1)}$ and $\mathbf{1}_{(t+1)} \times \mathbf{1}_{(T_i=1)}$ (variable of interest) are the constituents of the Difference in differences and C'_{it} is a vector of covariates. γ_i and γ_t represent the individual and temporal unobserved heterogeneities and ε_{it} the error term.

4.2. Matching variables and controls

In order to satisfy the conditional independence assumption, we perform a matching method called Coarsened Exact Matching method (CEM – Blackwell *et al.* 2010). Matching pre-treatment variables are chosen so that they are relevant in terms of health status and position in the labour market, in addition to helping cope with the (self-)selection bias. Individuals are matched according to their: year of entry into the labour market (in order to get rid of temporal heterogeneity related to generation/conjuncture effects); gender (Devaux *et al.* 2008; Shmueli 2003); education level (four levels: no education, primary or secondary, equivalent to bachelor

degree and superior); health status during the childhood (heavy health problems and handicaps) to have a better assessment of their initial health status and to cope with endogenous sorting in the labour market; and important events during childhood, aggregated into two dummy variables (on the one hand, heavy health problems of relatives, death of a relative, separation from one or more parent; on the other hand, violence suffered from relatives and violence at school or in the neighbourhood), as it is pretty clear that such childhood events may impact early outcomes in terms of health status (Case *et al.* 2005; Lindeboom *et al.* 2002).

We also control the results by post-treatment exposures (taking the value 0 at baseline and 1, 2 or 3 depending on if the individual has been exposed, respectively, hardly, a little or a lot to detrimental work strains during this post-treatment period). Health habits are also controlled for daily smoking (binary).

5. Main results

The results for matched difference-in-differences models for the five thresholds are provided in Table III below. These results, relying on matched samples, take care of the selection biases generated by endogenous sorting in the labour market and observed heterogeneity, as well as unobserved individual fixed and time-varying heterogeneities as a result of using difference-in-differences frameworks.

Table III: Matched difference-in-differences results (t_5 to t_9)

Treatment / Sex	PHYSICAL TREATMENT Diff.-in-Diff. Coeff.	Std. Err.	N (treat./tot.)	% matched (treat./contr.)	PSYCHOSOCIAL TREATMENT Diff.-in-Diff. Coeff.	Std. Err.	N (treat./tot.)	% matched (treat./contr.)
t_5: being exposed to at least 12 years of single exposures or 6 years of multiple exposures								
Men								
1st period	.021*	*.011*			.007	*.010*		
2nd period	.025**	*.011*	4241/8490		.010	*.010*	3727/8587	
3rd period	.027**	*.012*		95% / 94%	.013	*.011*		95% / 97%
Women								
1st period	.010	*.014*			.010	*.011*		
2nd period	.014	*.015*	2674/8243		.016	*.011*	3421/8329	
3rd period	.015	*.015*			.017	*.011*		
t_6: being exposed to at least 14 years of single exposures or 7 years of multiple exposures								
Men								
1st period	.022	*.015*			.022**	*.011*		
2nd period	.026**	*.013*	3963/8092		.028**	*.011*	3382/8241	
3rd period	.028**	*.014*		95% / 93 %	.041***	*.012*		95% / 96%
Women								
1st period	.018	*.014*			.010	*.010*		
2nd period	.019	*.012*	2498/8124		.016	*.011*	3065/7976	
3rd period	.019	*.013*			.018	*.012*		
t_7: being exposed to at least 16 years of single exposures or 8 years of multiple exposures								
Men								
1st period	.026	*.016*			.026**	*.012*		
2nd period	.029**	*.014*	3679/7800		.029**	*.013*	3077/7906	
3rd period	.029**	*.015*		95% / 93%	.044***	*.013*		95% / 96%
Women								
1st period	.018	*.014*			.013	*.011*		
2nd period	.023*	*.014*	2170/7495		.018	*.013*	2756/7643	
3rd period	.024*	*.015*			.019	*.012*		
t_8: being exposed to at least 18 years of single exposures or 9 years of multiple exposures								
Men								
1st period	.027*	*.016*			.026**	*.012*		
2nd period	.031**	*.014*	3421/7600		.029**	*.013*	2794/7771	
3rd period	.032**	*.015*		96% / 91%	.044***	*.013*		95% / 95%
Women								
1st period	.023*	*.014*			.013	*.011*		
2nd period	.024*	*.015*	1964/7355		.018	*.013*	2475/7502	
3rd period	.026*	*.014*			.019	*.012*		
t_9: being exposed to at least 20 years of single exposures or 10 years of multiple exposures								
Men								
1st period	.032**	*.013*			.042***	*.014*		
2nd period	.032***	*.012*	3151/7520		.044***	*.014*	2514/7724	
3rd period	.034***	*.011*		96% / 89%	.044***	*.015*		96% / 93%
Women								
1st period	.025*	*.013*			.021*	*.011*		
2nd period	.026*	*.015*	1742/7293		.025**	*.012*	2221/7453	
3rd period	.028**	*.014*			.027**	*.012*		

Interpretation: ****: significant at the 1% level, **: significant at the 5% level, *: significant at the 10% level. Standard errors in italics. The diff.-in-diff. column shows the results for the second differences (i.e., the difference between follow-up and baseline differences). The N column gives the sample sizes for, respectively, the treated and total populations. The last column denotes the percentage of the initial sample that found a match for, respectively, the treated and control groups.*

Field: *Population aged 42-74 in 2006 and present from t_1 to t_9. Matched (weighted) sample.*

Source: *Health and Professional Route survey (Sip), wave 2006.*

It should be noted that around 95% of the initial sample is preserved after matching in physical and psychosocial samples. No statistically significant difference between treated and control groups exists on observable characteristics nor on the baseline numbers of disability after matching, indicating that the method was quite successful in reducing ex-ante structural differences.

We find that men facing detrimental physical working conditions report significantly higher number of disabilities, whatever the strain threshold. For instance, men exposed to at least 12 years of single exposures or 6 years of multiple exposures report up to $.027$ more disability than the control group after exposure. This difference in growing larger, the most exposed the individuals. In women, the effect of physical exposures on their declaration of disability seems to appear later (after being exposed to at least 16 years of single exposures or 8 years of multiple exposures), and to be slightly lower in magnitude. The picture is quite similar when it comes to psychosocial exposures: men tend to face detrimental impacts on their declaration of disabilities rather early, with a growing effect as exposure levels increase. In women, only the last threshold (at least 20 years of single exposures or 10 years of multiple exposures) seems relevant.

In terms of magnitude of impact, prolonged and potentially simultaneous exposures to detrimental working conditions go so far as to double the declared number of disabilities in the most treated individuals, in comparison to pre-treatment amounts (around $.035$ disability in average). Considering our methodology, these strong increases should be attributable solely to exposures.

These results tend to go in line and reinforce the hypothesis that exposures to work strains can and do result in a long health-degradation process going towards functional limitations, and ultimately disability. This is thus in line with the hypothesis of the WHO, especially considering the rather loose definition of a disability in the Sip survey. Yet, they cannot reject the fact that being exposed longer to poor work environments may also result in an increase in the probability to experience accidents, themselves leading to disabilities.

6. Discussion and conclusion

In this study, we use French retrospective panel data to highlight links that physical and psychosocial working conditions have with disabilities in exposed males and females. Workers facing gradually increasing strains in terms of duration or simultaneity of exposure are more frequently coping with rising number of disabilities. Using combined difference-in-differences and matching methods, the empirical strategy helps to handle both (self-)selection in the labour market based on health status and other observable characteristics as well as unobserved individual and temporal heterogeneity. We find results that are in line with the hypothesis that exposures to work strains lead to an increase in disability onset, following the assumption that the origin of disabilities lies in a long-term degradation process of health status. This core insight is particularly relevant in the male population.

Postponing the onset of disability is a public health issue in order to preserve quality of life and increase healthy life expectancy. Painful physical but also psychological working conditions appear to be a speed-up factor of the onset of disability in the population over 50. Investing in health at work would therefore make it possible to delay disability onset and therefore the entry into care systems, such as disability insurance, long-term illnesses and also compensation systems for loss of autonomy. In addition, mental health becomes a major issue owing to the development of new technologies, management methods, activity controls as well as contacts with the public. Some European countries have already implemented specific policies to deal with these new threats of work. Our results strengthen this message.

However, the paper suffers from some limitations. First, working with retrospective panel data and long periods of time leads to estimates being at risk of suffering from declaration biases. Despite the inability to perfectly address this bias, matching on entry year into the labour market and on education should help in reducing recall heterogeneity. Simple occupational information notably also tends to be recalled rather accurately, even over longer periods (Berney and Blane 1997). Second, potential biases remain in the estimations. Second, we are likely to

underestimate the effects, because at the time of exposure, individuals are rather young in our study *(ie*., more resilient to exposures). Third, part of the selection process into a certain level of exposure possibly remains. Considering that the sample is matched with human and health capitals' features and because we consider only homogenous individuals present in the survey for at least 38 years, we should have rather similar individuals in terms of resilience to detrimental working conditions, *i.e.*, with similar initial abilities to sustain a certain level of severity of exposure. Part of the heterogeneity of the results between men and women can still be explained by declarative social heterogeneity regarding their working and health conditions as well as qualitative differences in their exposures, both elements which cannot really be accounted for using such declarative data. Finally, we use a wide, self-declarative definition of disabilities as an indicator for health status. This indicator does not allow for direct comparisons with the literature.

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APPENDIX 1: DETAILED DESCRIPTION OF THE PARAMETERS

The nine thresholds are designed according to increasing levels of exposures to detrimental working conditions: a 2-year step for single exposures from one threshold to another. Poly-exposure durations are half that of single ones, based on the requirements of the 2015 French law requiring that past professional exposures to detrimental working conditions be taken into account in pension calculations (in which simultaneous strains count twice as much as single exposures – Sirugue *et al.* 2015). The durations of the observation periods for working conditions are set arbitrarily to allow some time for reaching the treatment thresholds: it represents three halves of the maximum duration of exposure needed to be treated, *i.e.*, three halves of the single exposure threshold). The minimum duration at work during the observation period is set as the minimum exposure threshold to be treated, *i.e.*, it equals the poly-exposure threshold. The length of observation periods for disabilities is set to two years in order to avoid choosing overly specific singletons while preserving sample sizes.

The estimations are performed on these nine thresholds using the same sample of individuals: I keep only individuals existing in all nine of them for comparison purposes. The sample is thus based on the most demanding threshold, t_9. This means that, in this setup, individuals must be observed for a minimal duration of 38 years (2 years before labour market entry for baseline health status, plus 30 years of observation – including a minimum of 10 years in the labour market – and 6 years of follow-up health status periods – see Figure 1).