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# Individual changes in working and health conditions: A longitudinal study of 8,000 employees between 2010 and 2017 in France

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## **Abstract**

**BACKGROUND:** The diverse and complex variations in the possible forms of health-work interactions are constantly reconfigured over the course of a person's career. **OBJECTIVES:** The aims of our study were: 1) assess the scope of the individual changes in working conditions; 2) examine conjoint changes in working conditions; 3) examine the links between these changes and back pain and fatigue. **METHODS:** Analyses were conducted using data from the French observatory Evrest. **RESULTS:** The frequency of the studied constraints was often similar at two dates (T1 and T2), but significantly higher for repetitive movements, working additional hours and interruptions which disrupt the work. The variations in physical constraints, intensity of work and lack of agency scores between the two timepoints are two-by-two positively correlated. Finally, respondents in the higher tertiles for any of these working condition scores at T2 had a higher probability of back pain or fatigue, compared to individuals in the lower tertiles at both timepoints. Being in a higher tertile at both dates corresponded to the highest odds-ratios for health complaints. **CONCLUSIONS:** Our findings support treating this diversity of seniority in a profession and past experience at the same time as major decisions on production are made, rather than dealing with it as an afterthought. From a "sustainability" perspective, workers' capacity to work, individual specificities, self-preservation mechanisms and mobilization need to be placed front and center of the management of production targets, work resources and careers.

**Keywords**

physical constraints, intensity of work, lack of agency

## **I. Introduction**

Investigating individual changes in working conditions over a period of several years, and the links between these changes and the individuals' state of health at the end of the period, is an interesting area of research for a number of reasons.

The first of these are the still very high levels of constraints and hazards in work, found across all industrialized countries, and in particular in Europe [1]. A reduction in these constraints and hazards, achieved through technological developments and a more qualified workforce, has often been evoked but has yet to take place, mainly due to the intensification of work [2].

The second reason is the importance of taking into account the longitudinal aspects of the relationships between work and health in a medium and long-term perspective, with the aim of developing sustainable work systems [3–5]. Work shapes health throughout people's lives, with both immediate and delayed impacts, through the work activities and conditions which mobilize the individual's physical and psychological resources. At the same time, health, and changes in health, determine what is possible or impossible for the individual in terms of activity: capacity to work [6,7]; remaining or not in a given professional situation; and even remaining or not in employment [8]. The diverse and complex variations in the possible forms of health-work interactions are constantly reconfigured over the course of a person's career.

Our perspective here is that there is a wide diversity of individual stories contained within the overall trends and relationships viewed as a whole. Work conditions do not change at the same time, in the same way, and to the same extent for each individual. Furthermore, for each individual, any given event in their professional life, for example a change in employer or a technical innovation, can improve some aspects of their work and cause a deterioration in others [9].

As regards the impacts on health, it can be considered that these career path characteristics play a role both in terms of the length of exposure to a given risk factor, and in terms of the

changes experienced. This is suggested by the results of differential mortality analyses linked to changes in socio-professional category [10]. It is also supported by the findings of longitudinal studies focusing on changes in work conditions [9]. However, very few studies of this nature have been conducted and they often only investigate one aspect of work conditions and health [11–13].

Our intention here is to examine these individual changes (or absence of change) from a broad perspective, with three aims: 1) assess the scope of these individual changes in working conditions by putting a figure on them: examining the extent to which, within a general trend, the same employees are more or less exposed than others, at different dates, to various types of physical or psycho-social constraints in their work; 2) find out if, in most cases, for individuals, these changes occur as a block, i.e. several aspects improve, remain stable or deteriorate simultaneously, or if there are frequent reconfigurations i.e. improvements in one area combined with deteriorations in another; 3) examine the link between these systems of individual changes and health, as perceived at the end of the study period; in this article health will be characterized by the prevalence of two disorders which are particularly widespread in the working population: back pain and fatigue.

This analysis was conducted using data from a French inter-professional work and health observatory. The variations for each individual (close to 8,000 in total) were studied by comparing data for each individual obtained at two dates at least four years apart within the period between 2010 and 2017.

## **II. Methods**

The longitudinal database used for this study is extracted from the database of the EVREST observatory for the period 2010 to 2017.

### *II.1. The EVREST observatory*

The French observatory EVREST (*ÉVolutions et RElations en Santé au Travail* – Evolutions and Relationships in Health at Work) conducts a pluriannual collection of data via questionnaires. It has been co-designed by occupational physicians and researchers to analyze and monitor the different aspects of employees' work and health [14,15]. Since 2008, the EVREST survey consults all employees born in October in years ending in an even number (over the period considered here), working in France, regardless of what type of employment contract they work under and their employment status. Employees who have been in their job for less than two months cannot adequately answer the questions asked and are therefore excluded from the survey.

The questionnaire is proposed to employees by volunteer occupational health teams (physicians and nurses) at the first consultation with occupational health services after hiring (if this takes place more than two months after hiring) and at each subsequent scheduled occupational health visit. In France, up until 2017, all employees were required to attend an occupational health visit every year or every two years, depending on the employee's level of exposure to risk. The data are collected via a short questionnaire (one double-sided page). The questions concern working conditions, training, lifestyle and state of health. A hash function is used to pseudonymize the personal data from the questionnaires which are then identified by an alphanumeric key which makes it possible to link the questionnaires completed by any given employee at different dates. Then, the longitudinal EVREST database is used to carry out cross-sectional and longitudinal statistical explorations about different aspects of employees' work and health, and links between them. For the present

study, databases for two consecutive years were constituted, retaining when required only one questionnaire per employee for each two-year period (the most recent).

The EVREST observatory survey was authorized by the CNIL (*Commission nationale de l'informatique et des libertés* - National Commission on Information Technology and Freedoms) authorization N°906290V1. Prior to participation, employees were informed of their rights in writing.

## *II.2. The database*

The database was constituted from four EVREST databases for the years 2010-2011, 2012-2013, 2014-2015 and 2016-2017, containing a total of 99,990 questionnaires completed by 77,135 employees. All the questionnaires were collected by 1,680 occupational health teams (with a median of 36 questionnaires per team over the period). The longitudinal database was constituted by retaining the employees seen at least twice during the study period, in two non-consecutive two-year periods: if the first questionnaire was completed in 2010-2011, the second had to be in the 2014-2015 or 2016-2017 databases; if the first questionnaire was completed in 2012-2013, the second had to be in the 2016-2017 database. When there was more than one way of respecting this rule the preferred option was that offering the longest lapse of time between the two questionnaires. In the end, the longitudinal database was composed of two questionnaires for 7,868 employees: 3,170 from the databases 2010-2011 and 2014-2015, i.e. 40.3%; 2,418 from the databases 2010-2011 and 2016-2017, i.e. 30.7%; and 2,280 from the databases 2012-2013 and 2016-2017, i.e. 29.0%. The median time lapse between two questionnaires was 4.3 years (interquartile range [3.6-5.2]).

It should be noted that for the purposes of this study, tradespeople, the agricultural sector and State civil servants were excluded from the analysis, as they were not sufficiently represented in the database for this period.

## *II.3. Variables studied*

The individual characteristics of the employees taken into account were: sex, age (five categories), socio-professional category (four categories), and sector of activity (eight categories).

Three main groups of potentially harmful work characteristics were studied: physical constraints, intensity of work and lack of agency. For each of these groups of characteristics, scores were generated at each timepoint, for each employee, based on the information in the questionnaires completed.

The physical constraints score was based on the employees' answers to three questions about the characteristics of their work: awkward postures, effort and carrying heavy loads, and repetitive movements. The possible answers to these questions were: "No, never" "Yes, sometimes" and "Yes, often" which were assigned scores of 0, 1 and 3, respectively. The scores for these three questions were added together to obtain a final physical constraints score ranging from 0 to 9. These scores were then divided at the closest possible point to the tertile to obtain three approximately equal physical constraints groups identified as "lower" (scores 0 and 1), "intermediate" (scores 2 and 3) and "higher" (scores from 4 to 9).

The intensity of work score groups together the employees' answers to five questions: "due to the workload, works beyond their normal working hours", "due to the workload, skips or cuts meals short, does not take a break", "due to the workload, completes an operation quickly which ideally requires more attention", and a combination of "frequently has to stop doing one task to do another unexpected task" and "if yes, these interruptions disrupt the work". The possible answers to the first three questions were: "No, never", "Mostly no", "Mostly yes" and "Yes, all the time" which were assigned a score of 0, 1, 3 and 4, respectively. A positive answer to the last two questions (binary response) scored 3, whilst a negative answer to either of the questions was given a score of 0. The four scores were added together to obtain a final intensity of work score ranging from 0 to 15. This score was then divided at the closest possible point to the tertile to obtain three intensity of work groups: "lower" (scores 0 to 2), "intermediate" (scores 3 to 5) and "higher" (scores from 6 to 15).



The score for lack of agency groups together the employees' responses to five statements: "your work provides opportunities to learn new things", "your work is varied", "you can choose how you do things yourself", "you have enough possibilities to obtain help and cooperation" and "your work is recognized by your professional entourage". The possible responses to these statements were: "No, not at all", "Mostly no", "Mostly yes" and "Yes, absolutely" which were assigned a score of 4, 3, 1 and 0 respectively. The scores for these five statements were added together to obtain a final lack of agency score ranging from 0 to 20. This score was then divided at the closest possible point to the tertile to obtain three lack of agency groups: "lower" (scores 0 to 3), "intermediate" (scores 4 to 6) and "higher" (scores from 7 to 20).

Two perceived health characteristics were studied: complaints of back pain and fatigue, providing an insight into the employees' physical and mental health.

#### *II.4. Statistical analysis*

For each of the four databases, weightings were estimated for each questionnaire [16], based on the probability for each employee of having been surveyed, and calibrated using the CALMAR method. Dans ce calcul, the French working population in 2014 (the midway point for the study period) has been taken as the reference population. All the statistics produced as part of this study used these estimated weightings.

Chi-square tests (Rao-Scott) were carried out to compare the main individual, work and health characteristics of the employees in the longitudinal sample to those of the employees surveyed between 2010 and 2013.

In order to assess the extent of the individual changes in work conditions, two levels of analyze were used: 1) the distribution of individual responses in the first (T1) and the second survey (T2) for each of the working conditions taken into account in the 3 scores has been described; 2) evolutions of the tertile distributions for each constraint score between T1 and T2 have been studied.

Two-by-two Pearson's correlation coefficients were estimated in order to determine if the changes in each of these areas which characterize work occur as a "block" (several aspects improve or deteriorate simultaneously) or as "reconfigurations" (improvements in one area combined with deteriorations in another). In addition, box-plot of the distribution of each evolution of score (T2-T1) has been studied according to the evolution of the other scores.

Finally, in order to examine the links between d'une part the individual evolutions in these three areas characterizing work and d'autre part health, logistic regression models were built for the health issues reported at T2 i.e. back pain and fatigue. The changes (or not) between the two dates in the tertiles for all three areas were used as the explanatory variables in these models. Each of the models was adjusted for sex and age. These models were also built separately for men and women, in order to ascertain whether the links observed vary according to gender. Finally, sensitivity analyses were carried out, this time only taking into consideration employees who did not have the health problem in question at the time of their first survey.

Analyses were done with SAS V9.4 and R V4.0.3 softwares.

### **III. Results**

In relation to the whole population surveyed under Evrest between 2010 and 2017, the individuals included in the longitudinal analysis present a number of particularities (Appendix A). The sample composed of these individuals is a much smaller population and proportionally contains less young and older people, more people working in "intermediate occupations", and slightly less people working in lower occupations and managers. It should also be noted that the individuals in the longitudinal sample have slightly better working conditions, with the exception of time constraints, and that besides there is a very small difference with the whole population concerning the health issues considered in this article (fatigue and back pain).

### *III.1. Scope of individual changes in working conditions*

Cross-referencing the answers to the questions on working conditions at the two timepoints reveals that within the general trend the employees who are exposed to the risks are not systematically the same at T1 as at T2 (Figure 1). The table margins show similar overall proportions at both timepoints, but the percentage of individuals having experienced a change varies between 14% and 26% (sum of the two cells outside of the main diagonal), selon les caractéristiques de travail étudiées.

The three scores generated from these working conditions variables show the same types of changes between T1 and T2 (Figures 2A, 2B, 2C). The majority of individuals remain in the same tertile: par exemple, pour les physical constraints (2A), respectivement 24.8% de l'échantillon demeure dans le lower aux deux dates, 11.5% dans l'intermediate et 23.4% dans le higher. Cependant, there is also movement between tertiles, usually between neighboring tertiles (entre lower et intermediate, ou entre intermediate et higher), but sometimes from one extreme to the other (entre lower et higher). Regarding physical constraints, a similar number of individuals move towards a less favorable situation as those who move towards a more favorable situation: 7.4% de l'échantillon s'est déplacé du 1er au 2ème tertile ; 8.9% du 2ème au 3ème, et 3.2% du 1er au 3ème ; pour chacun de ces types de déplacement, les mouvements en sens inverse sont dans des proportions voisines de celles-ci. Le constat est un peu différent s'agissant de the intensity of work and lack of agency: slightly more individuals experience a deterioration in their situation compared to those whose situation improves.

### *III.2. Conjoint changes in working conditions*

These three scores already revealed some two-by-two correlations at T1:  $r=0.006$  ( $p=0.60$ ) between "physical constraints" and "intensity",  $r=0.05$  ( $p<10^{-4}$ ) between "intensity" and "lack of agency" and  $r=0.24$  ( $p<10^{-4}$ ) between "lack of agency" and "physical constraints". They also show positive two-by-two correlations for the changes between T1 and T2 ( $r=0.13$

( $p < 10^{-4}$ ) between “physical constraints” and “intensity”,  $r = 0.13$  ( $p < 10^{-4}$ ) between “intensity” and “lack of agency” and  $r = 0.12$  ( $p < 10^{-4}$ ) between “lack of agency” and “physical constraints”). This can be seen in Figure 3, in which the variation in the mean and the lower and upper quartiles of the variation for one score in relation to the variation in another form upward curves in each case: dans le graphique 3A par exemple, on constate que la médiane et la moyenne des variations du score sur l’intensité sont spécialement élevées quand le score sur les contraintes physiques a augmenté d’au moins deux unités.

### *III.3. Links between individual changes in working conditions and health*

Analyzing the links between the pattern of changes in working conditions and back pain at T2 shows that back pain is significantly more frequent in “higher” situations at T2, whether in terms of physical constraints, intensity of work and lack of agency when this last aspect was already present at T1 (Table 1). Significant links between back pain and “intermediate” physical constraints at T2 and “higher” or “intermediate” physical constraints at T1 were also observed, as between back pain and “lower” physical constraints at T2 and “higher” physical constraints at T1. The odds-ratio values show that the longer the constraints are present the stronger the links are.

Fatigue at T2 is also significantly more frequent in “higher” situations at T2, except when physical constraints were not present at T1 (Table 2). Fatigue and “intermediate” lack of agency are also linked if the latter was already “intermediate” at T1. In terms of changes, there are also links in all areas with the passage from T1 to T2, from “higher” to “intermediate” and vice versa.

The logistic regressions built to explain the onset of health problems at T2 for individuals which did not present these problems at T1 produced very similar results.

Furthermore, the same results have been also observed when regression models were built for each of the two sub-populations composed according to gender.

#### IV. Discussion

The first aim of this study, as stated in the introduction, was to assess the scope of individual changes in working conditions in order to identify the extent to which the same employees are exposed to constraints at different times in their working lives. Figure 1 shows that for each of the constraints studied, the most common situation (1/2 to 3/4 of respondents) was no exposure at T1 or T2. The “appearance” or “disappearance”<sup>1</sup> of a constraint in the period between the two dates concerned a similar proportion of respondents, generally speaking around 1/10. The frequency at which the constraint was found at both dates was around the same order of magnitude (1/10), but was significantly higher for three specific constraints: repetitive movements, working additional hours and interruptions which disrupt the work. These results obviously depend on how the questions are formulated and the different answers proposed.

Our method of analysis was based on scores for multiple constraints and the division of the survey respondents into tertiles according to the values assigned to these scores. Ces scores ont été construits, non pas en additionnant les items de réponse de façon régulière, mais en accentuant la prise en compte des réponses « souvent », ou en marquant nettement la différence entre les réponses « plutôt oui » et « plutôt non ». Nous avons cependant vérifié que nos conclusions n’auraient pas été remises en question si l’on avait adopté un mode de calcul purement linéaire.

This method allowed us to study the relative position of each individual within the population as a whole, in relation to a group of similar constraints, rather than investigating the changes for each individual in relation to a given constraint. Three different areas were investigated. They have been called “physical constraints”, “intensity of work”, and “lack of agency”. In these three areas, the majority of respondents remained in the same tertile after an interval

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<sup>1</sup> These variations are treated herein as “appearances” or “disappearances” but it is important to remember that there were only two timepoints in our analysis. Therefore it is not possible to know what changes might have taken place during the period in-between. A larger number of measurements would of course provide more accurate results [12].

of several years: 62% for “physical constraints” (en additionnant, dans la figure 2A, les proportions de 26.8, de 11.5 et de 23.4%), 56% for “intensity of work” and 53% for “lack of agency”. Around 40% of respondents moved between contiguous tertiles (from the lower or higher tertile to the intermediate tertile and vice versa), with an equal distribution between these four possibilities. Movement between the two extremes (from the lower tertile to the higher tertile or vice versa) is much more limited: around 3 - 4% for each. It is important to remember that the median time lapse between two questionnaires was 4.3 years, with a maximum of 7 years; more “extreme” movements might well have been observed had this time lapse been longer.

The scores used to split the population into tertiles were calculated at T1 and maintained for T2. It is therefore interesting, for each group of constraints, to compare the total frequency of deteriorations (arrow pointing to the right in Figures 2A, 2B and 2C) and improvements (arrows to the left). These figures show there is no clear trend for “physical constraints” (Figure 2A). There is however a slight trend towards deterioration for “intensity of work” (Figure 2B) for which 24.4% (en additionnant les proportions de 9.3%, 10.5% and 4.6%) moved towards a higher tertile and 20.8% towards a lower tertile; and for “lack of agency” (Figure 2C) with 26.0% showing a deterioration and 21.8% an improvement. These changes can be analyzed in light of three processes: the general changes in working conditions, already mentioned at the beginning of this article, marked by a gradual increase in psychosocial risk factors, as perceived by the employees [2]; the increased difficulty in coping as the person gets older [17], as in any longitudinal study the employees are naturally older at the second timepoint; and, conversely, the different forms of withdrawal employed if, over the course of their career, the employees want and can remove themselves from the psychosocial conditions they find difficult to cope with; this third a phenomenon, revealed by demographic studies of work [18], can mitigate the trend studied here.

Our second objective was to see if there are any positive or negative correlations between the deteriorations or improvements in constraints in the different areas. With this in mind, il

est apparu que the variations in the three scores observed for each individual between the two timepoints étaient orientées dans le même sens. Firstly, positive linear correlation coefficients between these variations, taken two-by-two, were found. Then the extent to which an increase (or reduction) in score in one area was associated with a greater probability of an increase (or reduction) in another area were assessed. These results are shown in Figure 3 et montrent des corrélations plutôt positives. One possible explanation for this might be found in the assumption that the intensification of work undermines individual and collective strategies for coping with physical constraints [19]; therefore it reduces the possibilities for taking action when engaging in the work activity [20,21].

The link between the variations in these three areas is actually very weak. This is why, in order to assess our third objective of examining the health issues involved in these individual developments, the three dimensions were included side-by-side in the same multivariate analysis; thus nine possible changes (or non-changes) between tertiles retained for each dimension (as represented by the arrows in Figures 2A, 2B and 2C) are possible. Back pain and then fatigue were therefore studied as the explained variables, in models adjusted on sex and age (Tables 1 and 2).

The most evident finding from this analysis is that respondents in the higher tertiles of any one of the three dimensions at T2, had a higher probability of suffering from back pain or fatigue. The corresponding odds-ratios were almost all significant and sometimes highly significant (compared to individuals in the lower tertiles at both timepoints). This result was to be expected: the prevalence of back pain and fatigue is greater in the presence à la même date (T2) of high physical constraints [22] and/or psychosocial risk factors [23–25]. One additional finding was also expected: in all the relationships studied, being in a higher tertile at both dates corresponded to the highest odds-ratios. It can be seen either as the known effect of long-term exposure to risk factors [12,26], or as a consequence of the level of constraint: a high level of constraint can increase the probability of respondents giving a positive response over time.

Three further, less expected, observations were also noted. On the one hand, high levels of back pain in individuals in the higher tertile for physical constraints at T1 were observed, regardless of their score at T2. This no doubt relates to the long-term impacts on health of exposure to severe physical risks in the past, but also to selection processes: the individuals might have stopped doing work with significant physical constraints because they were in pain, but this does not always mean the pain disappears (or not entirely) [26]. On the other hand, a high level of pain is also found in individuals in the intermediate tertile for physical constraints at both dates: this result might indicate that protracted exposure to physical constraints over time also constitute a factor for joint wear and tear, even when these constraints are at average levels [27,28]. Finally, being in the higher tertile for intensity of work at T1 is linked to feelings of fatigue at T2: this link remains significant even for individuals who move into the intermediate tertile for intensity of work at T2; it is borderline significant for individuals who move into the lower tertile for intensity of work at T2. Here was found a similar, but less evident, relationship to that between physical constraints and pain.

## **V. Conclusion**

Our results show a wide diversity in individuals' career paths and the risk factors to which they are exposed at different stages of their professional life. They also show that it is possible, although not straightforward, to structure a description of this diversity and identify its impacts on health.

These findings can be linked to a more general interrogation which underpins our whole approach: in terms of the primary prevention of health impairments linked to a person's career path over time, in particular those which develop at an older age after long periods of exposure, is it better to pursue overall improvements or actions which target vulnerable populations? The present study suggests that these two approaches are actually complementary rather than mutual exclusive. Moreover, a third possible approach emerges



from this work: to increase opportunities for mobility whilst reducing exposure to risk factors and taking into account the diversity of previous experiences.

Our findings support treating this diversity of seniority in a profession and past experience at the same time as major decisions on production are made, rather than dealing with it as an afterthought. From a “sustainability” perspective [5] workers’ capacity to work, individual specificities, self-preservation mechanisms and mobilization need to be placed front and center of the management of production targets, work resources and careers.

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