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## **Physical occupational exposures during working life and quality of life after labour market exit: results from the GAZEL study**

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## **Physical occupational exposures during working life and quality of life after labour market exit: results from the GAZEL study**

**Objective:** To investigate variations in quality of life at older ages we take a life course perspective to analyse long-term effects of physical working conditions upon quality of life after retirement. In doing so, we study to what extent these associations are explained by individuals' health at older ages.

**Method:** We use administrative data and self-administered questionnaire responses from the French GAZEL cohort. Quality of life was assessed with CASP-19 in 2009 and related to three types of physical working conditions during previous working life: (1) ergonomic strain, (2) physical danger and (3) exposures to chemicals. Health was assessed in 2007 with the SF-36 Health Survey. Multiple regressions were calculated in retired men only, controlling for important confounders including social position.

**Results:** In contrast to men, few women were exposed to strenuous and dangerous working conditions in this cohort and were not included in subsequent analyses. Negative effects on retired men's quality of life were found for the physical occupational exposures of ergonomic strain and physical danger, but not for chemical exposures. Effects were attenuated after the introduction of physical and mental health to the models, indicating an indirect effect of physical working conditions upon quality of life via health.

**Conclusion:** Adverse physical working conditions have long-term consequences for health and quality of life at older ages. Improvements to physical working conditions may improve individuals' quality of life over the long term.

**Keywords:** quality of life, life course, physical work environment, health, CASP-19.

## **Introduction**

The period following labour market exit has been associated with an improvement in well-being as individuals are freed from the demands of working life (Westerlund et al., 2010). However, while a period of personal flourishing which can accompany retirement has been described as the Third Age (Laslett, 1991), retirement can also bring risks of social marginalisation and impoverishment (Townsend, 1981). It is possible that exposures to hazards at earlier stages of the life course, such as social, financial and health hazards during working life, may increase individuals' chances of experiencing dependency rather than agency in later life. While the importance of life course circumstances for health in later life has been demonstrated (for reviews see: Blane, Netuveli, & Stone, 2007; Kuh & Shlomo, 2004), only a minority of studies have investigated life course influences on quality of life in early old age by explicitly focusing on a measure of quality of life that is not reducible to physical and mental health alone (Hyde, Wiggins, Higgs, & Blane, 2003; Netuveli, Wiggins, Hildon, Montgomery, & Blane, 2006).

In this vein, a small but growing literature highlights the importance of early adulthood and mid-life stages in explaining quality of life at older ages. Findings within the life course tradition suggest that previous conditions influence quality of life at older ages indirectly by influencing an individual's current situation; in this way, conditions during working life shape an individual's circumstances in later life as suggested by the pathway model in life course epidemiology (Blane et al., 2007; Blane, 2006). For instance, among older men in the Boyd-Orr cohort, socio-economic disadvantage during working life was associated with worse quality of life via current health and material circumstances, suggesting that earlier disadvantage tended to set men on a path to difficult current circumstances (Blane, Higgs, Hyde, & Wiggins, 2004). Similarly, in a

study using the British Household Panel Survey, having had children at younger ages was related to lower quality of life among participants aged over 51 years, a relationship again largely accounted for by current socio-economic and health disadvantages (Read & Grundy, 2011). A small retrospective survey in the British county of Northamptonshire indicated that aspects of previous employment might influence retirees' quality of life via their effects on the quality of retirement (Lowis, Edwards, & Singlehurst, 2010). These results indicate the importance of taking a life course perspective in order to understand quality of life at older ages and suggest the importance of earlier working conditions.

Dangerous and strenuous working conditions influence health through a variety of pathways. Safety hazards may influence subsequent health through the long-term impact of injuries while health hazards may result in occupational illness (Levy, Wegman, Baron, & Sokas, 2011, p. 5). Biomechanical health hazards or ergonomic strain cause long-term and painful musculoskeletal disorders (Descatha et al., 2011; Leclerc, Tubach, Landre, & Ozguler, 2003; Plouvier, Leclerc, Chastang, Bonenfant, & Goldberg, 2009; Plouvier, Renahy, Chastang, Bonenfant, & Leclerc, 2008), while chemical health hazards are likely to influence later health as a result of causing cancer or disabling and often irreversible respiratory illness (Ahasic & Christiani, 2011, p. 398; Berr et al., 2010; Imbernon et al., 1995; Lundberg, Hemmingsson, & Hogstedt, 2007, p. 13; Martin, Imbernon, Goldberg, Chevalier, & Bonenfant, 2000). However, it is not known to what extent the health effects of earlier working conditions affect individuals' chances of enjoying good quality of life following retirement.

In this contribution, we focus on the long-term effects of physical working conditions upon quality of life at older ages, using prospective and retrospective data from the French GAZEL study. In addition, we study how far these conditions exert

long-term effects on quality of life via their influences on health in later life. In doing so, two well-evidenced associations are considered and studied in a life course framework: first, studies showing that health is an important determinant of quality of life at older ages (Netuveli et al., 2006; Wiggins, Higgs, Hyde, & Blane, 2004); second, studies in which physical working conditions have been associated with health (for reviews see: Bambra, 2011, chap. 3; Clougherty, Souza, & Cullen, 2010).

Two further aspects must be considered here. First, we use the CASP-19 scale of quality of life which is specifically designed to measure quality of life in early old age. As older people live longer and healthier lives, it is no longer appropriate to reduce quality of life in older people to their experience of their health. In this way, the CASP-19 measure of quality of life has been developed by drawing on the literature of ageing and the Third Age (Gilleard, 1996; Laslett, 1991), identifying human needs (Doyal & Gough, 1991) particularly relevant in early old age (control, autonomy, self-realization, and pleasure (Hyde, Wiggins, Higgs, & Blane, 2003; see Methods for conceptual details). Consequently, this study with its measure of quality of life relates to the literature of the Third Age. Second, the GAZEL cohort provides detailed information on physical working conditions throughout working life which have been obtained from administrative sources and annually self-administered questionnaires (see measurement for details), enabling a prospective study design to be used. In addition, information on employees' career histories is available for the GAZEL participants, enabling appropriate adjustment for social position which otherwise might confound the effects of physical working conditions upon quality of life (e.g. lower social position in jobs with high physical demands).

Two research questions will be examined: (1) Can variations in quality of life in early old age be predicted from physical occupational exposures during working life?

We predict that more strenuous and dangerous working conditions over the life course will be associated with lower quality of life following labour market exit. (2) How much is the decline in quality of life related to strenuous and dangerous earlier working conditions due to a decline in health? Since exposure to higher levels of physical occupational exposures has been associated with worse health after retirement and poorer health is a predictor of worse quality of life, we predict that health will mediate the relationships between physical working conditions and subsequent quality of life.

## **Methods**

### *Data*

The research questions were explored using the GAZEL occupational cohort of persons employed by the French national gas and electricity company (EDF-GDF). GAZEL participants tended to be hired in their twenties and work for the company until they retired between the ages of 50 and 60 years. Although the GAZEL cohort represents a specific employment sector, the study population was recruited from urban and rural areas throughout France, represents a wide range of occupations and has a socioeconomic structure that compares well to the French population (for a detailed cohort profile, see: Goldberg et al., 2007). Annual questionnaires and administrative records were used to measure physical occupational exposures. At study onset, in 1989, 20 625 employees were recruited. By January 2009, 1318 people had died. In our analyses, we were interested in physical occupational exposures and their long-term effects on quality of life after labour market exit. Therefore, we restricted the sample to men and women who were retired in 2009 (excluding a further 985 individuals). We further excluded 81 employees who had worked fewer than 15 years at EDF-GDF by the start of 2009 because they might have received substantial and unrecorded physical

occupational exposures from employment elsewhere. Finally, individuals with missing data on quality of life, health or retrospective ergonomic strain (7400 people) were excluded to result in a complete case sample of 10 841 participants (8498 men and 2343 women). Attrition rates were higher among those who were in poorer health in 1989, reported more ergonomic constraints in 1989 and 1990 and had experienced workplace accidents.

## ***Measures***

### *Quality of life*

Quality of life was assessed in the self-completion questionnaires with the CASP-19 instrument. It has been specifically designed for early old age, and is widely used in international ageing surveys (Hyde et al., 2003; Netuveli et al., 2006). The CASP-19 measure is intended to be distinct of individual or contextual factors that influence quality of life, such as health or material circumstances, and does not focus on respondents' self-evaluation of quality of life. Rather, a theoretically informed approach based on the satisfaction of certain human needs has been taken (Doyal & Gough, 1991), emphasizing the more active and reflective dimensions of human nature (Wiggins et al., 2004). Each of the 19 four-point Likert-scaled items in the CASP-19 measure draws from one of four domains: control (C), autonomy (A), self-realization (S), and pleasure (P). A summary measure of the 19 items is used to assess quality of life in this study; the total sum score ranges from 0 to 57, with higher scores indicating a higher overall quality of life. In our sample the value for the internal consistency of the CASP-19 scale (Cronbach's alpha) was 0.88, the mean CASP-19 score was 43.22 and the standard deviation 7.69. Technical details about the CASP-19 scale and results of validation



procedures are provided elsewhere (Blane et al., 2004; Hyde et al., 2003; Wiggins, Netuveli, Hyde, Higgs, & Blane, 2008).

### *Physical working conditions*

In the analyses we distinguished three different types of physical working conditions: (1) ergonomic strain, (2) physical danger and (3) exposures to chemicals.

(1) Ergonomic strain: Ergonomic strain was measured with two indicators: i) a retrospective ergonomic strain score from the 2007 self-completion questionnaire and ii) a prospective score of ergonomic strain measured in 1989 and 1990.

i) Retrospective ergonomic strain score: In the 2007 questionnaire participants were asked to indicate the start and end years of periods in which they were exposed to any of the following constraints at work: regularly carrying or moving heavy loads, regularly bending forward or twisting the back or trunk, driving a vehicle for two or more hours a day (including commuting to and from work), working on their knees, going up or down more than ten flights of stairs a day, climbing onto ladders or step-ladders, working with the hands above the head, carrying loads on the shoulder and using vibrating tools. We created a summed score of career-long exposure by adding the number of different constraints participants were subjected to in each year, and adding together these annual totals to create a summed score of career-long ergonomic exposures. Individuals were grouped into three categories (“no exposure”: unexposed; “moderate exposure”: exposure level at or below the median for those exposed; “high exposure”: exposure level above the median for those exposed).

ii) Ergonomic strain score (1989/1990): In the 1989 and 1990 questionnaires participants were asked whether their current work included any of five types of activities: spending a long time on their feet; spending a long time in another tiring

posture; long, frequent or rapid journeys in a vehicle; carrying or moving heavy loads; or being subjected to shaking or vibrations. Following Melchior et al. (2005), affirmative responses to each item were summed into a score of total ergonomic strain for each year ranging from 0 to 5. To minimise the influence of temporary activities and thereby reduce measurement error, the scores for 1989 and 1990 were averaged to produce a 1989/1990 score of ergonomic strain.

(2) Physical danger: Physical danger was measured with two indicators: perception of physical hazards in 1989 and 1990 and accident records.

Perception of physical hazards: In the 1989 and 1990 questionnaires, participants indicated whether they thought they were exposed to any of a range of the following seven physical risks in the course of their work: breathing in gas, serious falls, minor falls, being injured by a machine, heat burns, chemical burns, or having a road accident. Affirmative responses to each item were summed to produce total scores of physical hazards in 1989 and 1990. In order to reduce the influence of short-term risks, as well as fluctuations in risk assessments, the scores for 1989 and 1990 were averaged to produce a 0–7 score indicating exposure to physical hazards for the period 1989/1990.

Accident records: Medically certified sickness absence data from administrative records were used to calculate total numbers of episodes of absences for each participant due to accidents at work (recorded as: *accident de travail*) between 1978 and 2009. The distribution of accidents was non-normal so a three-group categorical variable was created: a first group containing participants who did not have any accident episodes recorded (no exposure); the remainder were divided into two groups according to whether they had one accident (moderate exposure), or more than one accident (high exposure).

(3) Exposure to chemicals: To measure exposure to chemicals we used information from the MATEX job-exposure matrix which indicated, for each employee, their estimated annual exposures to harmful chemicals (Imbernon et al., 1996; Imbernon, Goldberg, & Guénel, 1991). Company occupational physicians regrouped jobs into 403 different occupations and indicated likely exposure levels to each of 30 potential carcinogens. Details about individuals' occupational histories from company records were used to attribute exposures to each employee. Information from the job-exposure matrix is available from 1956 until 1998, when levels of chemical exposure fell to low levels among participants in the GAZEL cohort. We added together the number of different chemicals to which individuals were exposed in each year and then added these annual totals together to create an index of accumulated chemical exposures over the whole career. Next, individuals were regrouped into three categories ("no exposure": unexposed, "moderate exposure": exposure level at or below the median for those exposed, "high exposure": exposure level above the median for those exposed).

#### *Health functioning*

Mental and physical component summary scores from the French standard version of the Short Form 36 Health Survey (SF-36) were used to measure health functioning in 2007 (Lepège, Ecosse, Coste, Pouchot, & Perneger, 2001; Ware Jr & Sherbourne, 1992). The SF-36 questionnaire is an internationally validated measure of health functioning composed of 36 questions about physical and mental functioning which are grouped into eight subscales depicting different health domains. The internal consistency of the single domains proved satisfactory in our sample (Cronbach's alphas vary between 0.80 and 0.84) and two summary scores were derived, a mental component summary score (SF-36 MCS) and a physical component summary score (SF-36 PCS), both ranging from 0–100 with higher scores indicating better health. The

psychometric properties of the French SF-36 and the construction of the two scores are fully described elsewhere (Leplège et al., 2001).

#### *Additional variables*

We included a number of socio-demographic variables as controls in the multivariate analyses. Age and age-squared were included because quality of life is known to have a non-linear relationship with age (Zaninotto, Falaschetti, & Sacker, 2009). To minimize the risk that any observed association between physical working conditions and quality of life was due to respondents' social position, two complementary measures of social position have been used in the multiple analyses: social class and occupational grade (both measured in 1989).

Social class was measured using the European Socio-economic Classification (ESeC) (Rose & Harrison, 2007). It categorizes individuals according to particular aspects of the work setting and the labour market situation. More specifically, occupations are grouped according to the degree of specificity of human assets they require and of the difficulty managers face in monitoring the quality and quantity of work produced (Rose, Harrison, & Pevalin, 2009, pp. 10–14). To classify respondents into ESeC, we used the four-digit French national social class classification available in GAZEL and the conversion table developed by Louis-André Vallet and Christel Colin at the French National Institute of Statistics and Economic Studies (Brousse, Monso, & Wolff, 2007, pp. 87–95). Because all the GAZEL participants were employed, only seven of the existing 10 ESeC classes were available for our study. These are: ESeC1 (Large employers, higher grade professionals, administrative and managerial occupations); ESeC2 (Lower grade professional, administrative and managerial occupations and higher grade technicians and supervisory occupations); ESeC3 (Intermediate occupations); ESeC6 (Lower supervisory and lower technician

occupations); ESeC7 (Lower sales, services and clerical occupations); ESeC8 (Lower technical occupations); and ESeC9 (Routine occupations).

The second measure, occupational grade, is an internal company classification. It classifies all occupations on a continuous scale, ranging from 1 to 52, with higher values being associated with higher salary and higher status within the company. These complementary measures, social class and occupational grade, have been used as controls because each focuses on different aspects of social position: social class on the nature of employment relationships, and occupational grade on an occupation's salary, position with the company hierarchy and prestige within the organization.

### *Statistical analysis*

The analyses were carried out in Stata 12.1 (StataCorp, 2011a); men and women were analyzed separately. First, descriptive analyses were used to explore sample characteristics (Table 1 **Erreur ! Source du renvoi introuvable.**). Second, we studied correlations between all variables under study for men only, given the low frequencies of strenuous and dangerous physical working conditions among women (Table 2).

We examined mean quality of life scores for each of the three categorical indicators of occupational exposures (retrospective ergonomic constraints, accumulated accidents and accumulated chemical exposures) in order to illustrate the crude associations between physical working conditions and quality of life in men (Figure 1).

Next, to test our two research questions, we estimated ordinary least squares (OLS) linear regression models to predict quality of life in 2009 for men (Table 3). In Table 3 we present unstandardized regression coefficients together with standard errors and levels of significance, as well as one measure of model fit (coefficient of determination "R<sup>2</sup>" as a measure of "explained variance"). Two nested models were estimated for each of the five occupational exposures. First, the effects of adverse

physical working conditions were calculated, adjusted for age and the two measures of occupational position (Model 1). These models allow the effect of each occupational exposure to be tested separately (research question 1). Next, in Model 2, mental and physical health functioning was added to the models. By comparing the coefficients of the models, we examined the degree to which associations between physical working conditions and quality of life were mediated by health (research question 2).

To address a possible bias due to sample attrition and item non-response, multiple imputations were carried out as a test of robustness (Allison 2002). The imputations were performed in Stata 12.1 using chained equations with augmentation where necessary (StataCorp, 2011b). To create the multiply imputed datasets, in addition to the covariates, variables were included that have previously been shown to predict attrition (Goldberg, Chastang, Zins, Niedhammer, & Leclerc, 2006) and that predict likely values for missing variables. For each model, 10 imputations were carried out each preceded by 10 iterations. The multiply imputed results are not presented in detail.

## **Results**

### *Descriptive findings*

Before examining the main research questions, we will briefly describe the sample as presented in Table 1. In 2009, when quality of life was measured, men's mean age was two years older than women's. Mean employment grade was higher for men than women and men were more likely to hold management and professional positions and supervisory blue-collar roles. In contrast, women tended to occupy white-collar posts; very few women held blue collar roles. Regarding our exposures of interest, men had been exposed to more strenuous and dangerous working conditions than women,

particularly for exposure to ergonomic strain and harmful chemicals where high levels of exposures were nearly non-existent for women. Male participants had better physical and mental health and reported better quality of life.

### ***Bivariate associations***

Table 2 displays all the correlation coefficients between the main variables. These analyses are restricted to men, because very few women had been exposed to adverse physical working conditions. In summary, the occupational exposures were positively correlated with each other, including the retrospective and prospective indicators of ergonomic strain, which provides some support for the reliability of the self-reported measures. Turning to the associations between social position and physical working conditions, higher grade and higher social class (the highest ESeC classes 1, 2, and 3 are non-manual) are associated with lower levels of exposures in men. Physical working conditions were weakly negatively correlated with physical and mental health functioning in men. There were positive correlations between physical and mental health functioning and quality of life. All types of physical working conditions were weakly negatively correlated with quality of life at older ages.

Figure 1 displays mean CASP-19 scores and 95% confidence intervals for the three categorical indicators of working conditions under study (retrospective ergonomic constraints, accumulated accidents and accumulated chemical exposure). In each case, the most exposed men reported lowest levels of quality of life, while quality of life was highest among those with no exposure. The differences are statistically significant at  $p < 0.001$  (ANOVA). For the accumulated accidents measure of physical danger the difference in mean scores between the no exposure and high exposure groups is almost two CASP-19 points.

Do these associations persist after adjustment for important confounders? And how far does physical and mental health mediate these associations? These questions were answered in the two sets of models presented in Table 3, in which Model 1 controls for important confounders and Model 2 additionally includes health.

### ***Multivariate findings***

The findings of the multivariate analyses support the relationship between CASP-19 and occupational exposures which was suggested by the bivariate analyses. With the exception of chemical exposures, the associations between the physical occupational exposures and quality of life are statistically significant after controlling for social position in Model 1 (Table 3). In Model 2, after inclusion of physical and mental health measures, model fit improves and the associations between each physical occupational exposure and quality of life attenuate or reverse. This suggests that the associations between physical occupational exposures and quality of life are accounted for once physical and mental health measures are included in the model.

The results of additional analyses using the multiply imputed data sets described in the methods section did not differ substantially from those displayed in Table 3 (results not shown). The magnitude and statistical significance of coefficients were similar for each measure of occupational exposure, as well as the findings suggesting a mediating role for health.

### **Discussion**

This paper uses data from the GAZEL cohort to study the long-term effects of physical working conditions on quality of life after labour market exit and finds that exposure to negative physical working conditions across the working life course is associated with worse quality of life in early old age. We study to what extent health in later life



accounts for the observed association, since working conditions are known to influence health in later life (Bodin et al., 2012; Descatha et al., 2011; Niedhammer, Chastang, David, & Kelleher, 2008), and health in turn is associated with quality of life (Farquhar, 1995; Webb, Blane, McMunn, & Netuveli, 2011; Zaninotto et al., 2009). To assess physical working conditions, we used administrative data combined with information from self-completion questionnaires and divided the exposure into three types: (1) ergonomic strain, (2) physical danger and (3) exposures to harmful chemicals. The CASP-19 questionnaire was used to indicate quality of life. To measure health in early old age we used mental and physical component scores from the SF-36 questionnaire.

The main findings can be summarized as follows: First, few women were exposed to adverse working conditions and those who were generally received low levels of exposure. In contrast, levels of physical occupational exposures were higher for men and consistent associations with quality of life were found for both measures of ergonomic strain and of physical danger, but not for chemical exposures. The associations of ergonomic strain and physical danger with quality of life remained statistically significant after adjustments for possible confounders including employment grade, social class and age of the study participants. It is possible that negative results for chemical exposures might be due to loss to follow-up due to death (Martin et al., 2000). Previous work in the Gazel cohort has shown long-term effects of solvents on cognition at high levels of exposure (Berr et al., 2010; Sabbath et al., 2012); perhaps a lack of association with quality of life in the current study was a result of using a nonspecific measure of lifetime chemical exposure. In summary, these results underline the importance of previous physical working conditions for quality of life in early old age.

Our second main finding draws attention to the mediating effect of health functioning in later life upon the relationship between physical working conditions and quality of life. For men, the associations of exposure to physical danger and ergonomic strain in the workplace with quality of life were attenuated after introduction of measures of physical and mental health functioning into the models. Corresponding to previous studies finding adverse effects of physical working conditions on later health (e.g., National Institute for Occupational Safety and Health 1997; Punnett and Wegman 2004), this result suggests that the association between working conditions and quality of life is partially mediated by health.

Additional aspects of working conditions and further mechanisms may help explain the associations with mental health. For instance, poorer mental health functioning in later life could have resulted from poorer physical health or from other characteristics of the working environment such as high levels of work stress (Wahrendorf et al., 2012).

We found negative impacts of physical occupational exposures regardless of whether a measure of ergonomic strain from a two-year period in 1989/1990 or retrospective measures of career exposures to ergonomic strain were used. This could be because the level of exposure to ergonomic strain in 1989/1990 is a good indicator of career-long ergonomic strain, perhaps because employees tended to have similar sorts of career trajectories.

To our knowledge this is the first prospective study examining long-term influences of physical working conditions upon quality of life in early old age. Our findings add to the existing literature of the determinants of quality of life in older ages, first, by pointing to the importance of previous physical working conditions for later quality of life, and second, by highlighting the possible mediating role of health. These

results extend earlier findings of long-term effects of conditions in previous life stages on quality of life (Blane et al., 2004) by studying the interrelations between previous working conditions, health in later life and quality of life after labour exit within a life course framework.

### ***Strengths and limitations***

The study design of the GAZEL cohort, in particular its large study sample and low attrition rates, is a particular strength of the study (Zins, Leclerc, & Goldberg, 2009). Uniquely, the GAZEL cohort provides detailed information on three different types of occupational physical exposures, based on administrative data and on self-reports and covering a long time-frame. Similarly, quality of life and health were measured by the full original versions of two theoretically grounded and internationally established questionnaires (Hyde et al., 2003; Leplège et al., 2001) and two complementary measures of social position were included as important confounders. However, several limitations of this study must be discussed.

First, despite a population that is socially and geographically diverse (Goldberg et al., 2007), conclusions from analyses of the GAZEL cohort data must be drawn carefully, since important segments of the population (e.g. unemployed people and self-employed workers) are absent. Furthermore, working conditions of the GAZEL cohort are considered to be generally better than those in the French population, given that participants held stable posts in a nationalised company. These might lead the impact of physical working conditions upon quality of life to be underestimated in this study. The influences of dangerous and strenuous working conditions could be greater in a less well protected population.

Second, only one quarter of the respondents in our study were female, and the majority of women employed at GDF/EDF held white-collar posts. Consequently, few

women were exposed to strenuous and dangerous working conditions and the relationship between physical occupational exposures during working life and quality of life following retirement could therefore not be explored amongst women here.

Third, by restricting the sample to people who had already left the labour market in 2009, some selection bias could have affected our findings, given that poor health might be one reason for labour market exit, and thus respondents in poor health may be overrepresented. However, sensitivity analyses which included men who were still working in 2009 gave similar results.

Fourth, although most data on occupational exposures were obtained from administrative records or from baseline in 1989, sample attrition had occurred by the time quality of life was recorded in 2009 and it may be possible that a systematic nonresponse bias occurred because people with more health problems were more likely to stop participating in the study (Goldberg et al., 2006). Similarly, people in good health may be more likely to give information on their quality of life. However, the robustness of these results has been tested by carrying out multiple imputations in which variables known to predict attrition were included and the findings were replicated.

Lastly, some readers may be concerned that the measures of health (SF-36) and quality of life (CASP-19) used in this analysis overlap, because SF-36 is sometimes used to measure health-related quality of life. We would argue that the measures are conceptually distinct, as CASP-19 explicitly focuses on aspects of quality of life that are not reducible to physical and mental health. Further research could use other health measures to confirm the results.

In this contribution we focussed on associations between physical working conditions and quality of life after labour market exit and the explanation of this association by health. In doing so, other important potential determinants of quality of

life were not included in the analyses. For instance, our findings clearly indicate that social position is associated with quality of life after labour market exit. Although our multivariate analyses control for social position and independent effect of physical working conditions could be observed in our final model, other factors associated with low social position (e.g. psychosocial work stress, health behaviours) could be investigated in subsequent studies. Similarly, analyses could examine whether the impact of physical occupational exposures varies according to the individual's social position or the timing of the exposure, or whether effects of chemical exposures can be found by differentiating exposures by type of chemicals or duration of exposure.

### ***Conclusion***

In conclusion, this study has shown that long-term exposure to ergonomic strain and physical hazards influence quality of life after labour market exit through their impact upon mental and physical health. After taking account of the effects of social class and occupational grade, findings suggest that physical work exposures during the life course have long-range effects upon subsequent quality of life. Improvements to working conditions to reduce exposure to strenuous and dangerous activities could increase quality of life as well as health over the long term.

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