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### The role of individual and contextual factors in paid employment of workers with a chronic disease

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# Chapter 4

**Do chronic diseases moderate the association between psychosocial working conditions and work exit? Longitudinal results from 55,950 Dutch workers**

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## **Abstract**

### **Background**

This study aims to examine whether the presence of chronic diseases or multimorbidity moderates the associations between psychosocial working conditions and work exit through unemployment, work disability or early retirement.

### **Methods**

Data from Lifelines (n=55, 950), a prospective population-based cohort study, were enriched with monthly information on employment status from Statistics Netherlands. Working conditions were measured with the Copenhagen Psychosocial Questionnaire. Work exit was defined as unemployment, work disability and early retirement. Participants were classified as having no chronic disease, one chronic disease or multimorbidity. Cause-specific Cox proportional hazard regression models, adjusted for age, gender, education and partnership status, were used to analyse associations between working conditions and work exit. Interaction terms were used to examine moderation by chronic disease status.

### **Results**

Higher social support decreased the risk for unemployment, work disability and early retirement. Higher meaning of work decreased the risk of unemployment, and more possibilities for development decreased the risk for work disability. Chronic disease status did generally not moderate associations between working conditions and work exit. Only among workers without a chronic disease, more possibilities for development was associated with a lower risk for unemployment (HR: 0.89, 95% CI: 0.85; 0.94).

### **Conclusion**

While efforts to retain workers with chronic diseases in the labour market should continue, favourable psychosocial working conditions are important for all workers.

## Introduction

An increasing number of individuals is working with a chronic disease (1), mainly due to an increase of the statutory retirement age (2) and a steady increase in the prevalence of chronic diseases (3). Between 1992 and 2016, workers with a chronic disease extended their working lives by approximately 18 months (4). However, individuals with a chronic disease still work considerably less often than individuals without a chronic disease (5). Furthermore, chronic diseases increase the risk of work exit through unemployment and disability benefits, especially when workers have multi-morbidity (6-11).

Favourable psychosocial working conditions like high skill discretion and high social support at work have been shown to reduce the risk of work exit among healthy workers and workers with a chronic disease (11-18). According to the Job Demands-Resources model, unfavourable working conditions may lead to stress and ill health (i.e., the energetic process), while favourable working conditions or job resources may lead to increased motivation and productivity (i.e., the motivational process) (19,20). While favourable psychosocial working conditions are generally considered beneficial for all workers (19,20), they may be especially important for workers with a chronic disease. Working with a chronic disease may be challenging, as most workers with a chronic disease have to deal with both practical and health-related problems (21). This vulnerability may heighten their susceptibility to experience the energetic process, especially when their working conditions are not befitting their needs. Favourable psychosocial working conditions may help workers experience the motivational process by giving them the ability to adequately cope with their chronic disease at work, deal with uncertainty concerning their chronic disease, and by bolstering feelings of stability (22). For example, high influence at work may allow workers with a chronic disease to rearrange their schedule to navigate fluctuating physical or psychological symptoms while high social support from supervisors contributes to peace of mind and reduced anxiety (22).

Previous studies have found some indications that associations between working conditions and work exit differ between workers with and without a chronic disease (23,24). A three-year follow-up study showed that less strenuous psychosocial working conditions were associated with work exit among workers with but not without a chronic disease (23). Another two-year follow-up study found that higher autonomy was associated with working until retirement for workers with but not without a chronic disease

(24). However, most associations between working conditions and work exit were similar for workers with and without a chronic disease (23-25). This study may contribute to the existing literature in several ways. First, this study addresses workers of all ages whereas previous research mainly focused on older workers (23-25). Second, previous studies have focused on general exit from paid employment (23) or different forms of retirement (24,25). This study will focus on work exit through unemployment, work disability and early retirement separately, taking into account competing risks. Third, in contrast to previous studies categorizing workers as having or not having a chronic disease, this study will explicitly examine the role of multi-morbidity as the accumulation of health problems may pose a higher risk for work exit than having just one chronic disease. Better insight into whether chronic diseases moderate associations between specific working conditions and work exit may offer opportunities for the development of targeted interventions to retain workers with and without chronic diseases in the workforce.

The aims of this study are to examine whether the presence of a chronic disease or multi-morbidity moderates the associations between psychosocial working conditions and work exit through unemployment, work disability or early retirement.

## Methods

### Study design and sample

The study sample was derived from the Lifelines Cohort and Biobank Study (26). Lifelines is a multi-disciplinary prospective population-based cohort study using a three-generation design to examine the health and health related-behaviours of 167,729 persons living in the North of The Netherlands. It employs a broad range of investigative procedures in assessing the biomedical, socio-demographic, behavioural, physical and psychological factors which contribute to the health and disease of the general population. Participants were recruited through invitations by their general practitioner, family members or through self-registration. Recruitment and data collection have been described elsewhere (26). Lifelines was conducted according to the guidelines in the Declaration of Helsinki and the Medical Ethics Committee of the University Medical Center Groningen approved all procedures involving human subjects (ethics number: 2007/152). Written informed consent was obtained from all participants. For the present study, we restricted the analyses to participants that participated in the second

follow-up measurement (2012–2015) because working conditions were only measured at this time point (Supplementary Figure 1). We also used information from the baseline measurement (2006–2013) and the first follow-up measurement (2011–2014) to classify chronic diseases. In total, 95,310 participants participated in the second follow-up measurement but 11,477 participants were excluded due to age ineligibility, 21,551 because they were not working, and 6,332 because they were self-employed, resulting in a sample size of 55,950 participants. Lifelines data were enriched with data from Statistics Netherlands with information on main income components, social benefit pensions and gross wages derived from the Dutch tax registers and stored in the social statistical database SSB (27).

## Measures and procedures

### Chronic diseases

We used data from three measurement waves to establish whether workers had a chronic disease at the time of their second follow-up measurement. At baseline, clinical measures, self-reports, and medication use were used to classify participants as having cardiovascular disease (CVD), type 2 diabetes mellitus (T2DM), Chronic Obstructive Pulmonary Disease (COPD), rheumatoid arthritis, or depression. During the first and second follow-up measurements, self-reports were used to identify incident chronic diseases since the baseline measurement (Supplementary Table 1). These chronic diseases were included because they have a high burden in terms of disability-adjusted life years and are relatively prevalent among the working age population.(28) Classification of chronic diseases was in line with previous Lifelines studies (29). Participants were classified as having multi-morbidity when they had  $\geq 2$  of the specific chronic diseases (29).

### Work exit

Work exit was measured by using data on the gross wages and social benefit pensions from the Dutch tax register, which was available through Statistics Netherlands. Data were available on a monthly basis from the time of enrolment in Lifelines to December 2018. Work exit from the second follow-up measurement onwards was defined as exiting paid work into unemployment, receiving disability benefits, or early retirement. To be categorized as unemployed, an individual needed to have lost their job and receive unemployment or social security benefits. To be categorized as receiving disability benefits, at least half of the individual's income had to come from disability benefits. To be categorized as being early retired, individuals needed to receive

pension benefits before the statutory retirement age. In line with previous research (15,29), an individual needed to be unemployed, receiving disability benefits or be in early retirement for at least three months to be included as an event. While individuals may return to work after an unemployment spell, work disability or even early retirement, only the first event was considered. Participants could not re-enter the study population after an event.

### **Working conditions**

Working conditions were measured at the second follow-up measurement using six dimensions from an adapted version of the Copenhagen Psychosocial Questionnaire (COPSOQ II) (30). Quantitative demands were measured with the questions: “Do you get behind in your work?” and “Do you have enough time for the work that you need to do?” (Cronbach’s Alpha ( $\alpha$ ) = 0.68). Work pace was measured with the questions “Do you have to work very fast?” and “Is the work pace high throughout the workday?” ( $\alpha$ =0.81). Influence at work was measured with the questions: “Can you influence the amount of work that you have to do?” and “Do you have a high degree of influence on your work?” ( $\alpha$ =0.64). Possibilities for development was measured with the questions “Do you have the possibility to learn new things through your work?” and “Does your work require you to take the initiative?” ( $\alpha$ =0.59). Meaning of work was measured with the questions: “Do you think the work you do is important?” and “Is your work meaningful?” ( $\alpha$ =0.88). Social support was measured with the questions (separate items for colleagues and superior): “How often do you get help and support from your colleagues/superior?” and “How often are your colleagues/superior willing to listen to your work-related problems?” ( $\alpha$ =0.76). All questions were scored on an ordinal five-point scale, ranging from 1 to 5. The domain scores were estimated as the mean of scores on the questions within each domain.

### **Covariates**

Covariates included age, gender, educational level, and partnership status. Educational level was categorized into low, medium and high (29). Partnership status was dichotomized into having a partner and not having a partner (29).

### Statistical analyses

First, participant characteristics were described for the total study sample and separately for workers without a chronic disease, with one chronic disease and with multi-morbidity. Second, missing values of the independent variables were imputed using the R mice-package, imputing 20 datasets based on multiple imputation by chained equations. Imputation for the working conditions was performed on item-level and domain scores were calculated after data imputation, resulting in six mean scores.

Third, cause-specific Cox proportional hazard regression models were fitted to the  $m=20$  imputed datasets and pooled to analyse the effects of working conditions on work exit through unemployment, work disability and early retirement separately. Cox regression models take an individual's time-to-event into account. Hazard ratios (HR) and corresponding 95% confidence intervals (CIs) are presented. Individuals were censored in case of missing-data due to mortality or emigration, in case of a competing risk (i.e. economic inactivity, early retirement, work disability or unemployment), or if they reached the retirement age of 65 years. Analyses included all working conditions and were further adjusted for age, gender, educational level and partnership status. Since we do not assume that observed associations are influenced by calendar year, we do not adjust for exposure year. The proportional hazard assumption was checked by examining Schoenfeld residual plots; no indication for violation of the proportional hazards assumption was found.

In the fourth step of the analyses, the presence of moderation was tested through interaction terms between working conditions and chronic disease status (i.e. 0 versus 1 chronic disease, 0 versus multimorbidity, and an overall p-value for interaction; only the latter was reported) and considered statistically significant if  $p < 0.05$ . In case of a significant interaction, results are presented stratified by the number of chronic diseases. Otherwise, results are presented irrespective of chronic disease status.

In sensitivity analyses, we performed the analyses again without mutually adjusting the working conditions. Analyses were conducted using R version 3.6.2.



## Results

The mean age of the study population was 44.4 years (SD=9.8) (Table 1). Most participants were women (59.7%) and had a partner (87.6%). The most prevalent chronic disease was COPD (5.3%), followed by depression (5.0%). In total, 12.0% of participants left paid work; 8.3% through unemployment, 1.7% through work disability, and 2.0% through early retirement. In addition to participants experiencing an event of interest, participants were censored because of economic inactivity (n=1,924 (3.4%)), statutory retirement (n=1,592 (2.8%)) or loss to follow-up (n=279 (0.5%)). In adjusted analyses, compared to workers without a chronic disease, workers with one chronic disease or multi-morbidity had an increased risk for unemployment (HR: 1.32, 95% CI: 1.22; 1.43 and HR: 1.43, 95% CI: 1.18; 1.72) and work disability (HR: 2.38, 95% CI: 2.04; 2.77 and HR: 5.48, 95% CI: 4.22; 7.11), but not for early retirement (Table 2). The median follow-up time was 54 months (IQR: 44-66). Supplementary Table 2 shows the median follow-up times by chronic disease status and exit route.

### Work exit

Higher meaning of work (HR: 0.80, 95% CI: 0.76; 0.83) and higher social support (HR: 0.80, 95% CI: 0.77; 0.84) were associated with a lower risk for unemployment regardless chronic disease status (Table 3). Chronic disease status moderated the associations between work pace and unemployment and possibilities for development and unemployment. Higher work pace increased the risk for unemployment, albeit non-significantly, among workers with multi-morbidity (HR: 1.28, 95% CI: 1.00; 1.63), but not among workers without or workers with one chronic disease. More possibilities for development was associated with a lower risk for unemployment among workers without a chronic disease (HR: 0.89, 95% CI: 0.85; 0.94), but not among workers with one chronic disease or multi-morbidity.

**Table 1.** Characteristics of 55,950 workers participating in the Lifelines Cohort Study

|   | <b>Total sample*<br/>N=55,950</b> | <b>No chronic disease<br/>N=47,408</b> | <b>One chronic disease<br/>N=7,563</b> | <b>Multi-morbidity<br/>N=979</b> |
|---|-----------------------------------|--|--|----------------------------------|
| <b>Sociodemographic factors</b>                             |                                   |  |  |                                  |
| Age, mean (SD)<br>(range 18-<65)                            | 44.4 (9.8)                        | 43.7 (9.8)                             | 47.5 (9.1)                             | 51.1 (8.0)                       |
| Gender, %   |                                   |  |  |                                  |
| Male  | 40.3                              | 40.3                                   | 39.9                                   | 44.4                             |
| Female  | 59.7                              | 59.7                                   | 60.1                                   | 55.6                             |
| Educational level, %  |                                   |  |  |                                  |
| High  | 35.8                              | 37.5                                   | 28.0                                   | 17.6                             |
| Medium  | 42.0                              | 42.1                                   | 41.6                                   | 39.2                             |
| Low   | 22.1                              | 20.4                                   | 30.4                                   | 43.2                             |
| Partnership status, %                                       |                                   |  |  |                                  |
| Partnered   | 87.6                              | 87.9                                   | 86.0                                   | 85.6                             |
| Not partnered   | 12.4                              | 12.1                                   | 14.0                                   | 14.4                             |
| <b>Working conditions, demands (scale 1-5), mean (SD)</b>   |                                   |  |  |                                  |
| Quantitative demands  | 2.26 (0.85)                       | 2.26 (0.85)                            | 2.27 (0.87)                            | 2.19 (0.91)                      |
| Work pace   | 3.32 (0.78)                       | 3.32 (0.76)                            | 3.32 (0.82)                            | 3.29 (0.91)                      |
| <b>Working conditions, resources (scale 1-5), mean (SD)</b> |                                   |  |  |                                  |
| Possibilities for development                               | 3.58 (0.78)                       | 3.60 (0.77)                            | 3.48 (0.81)                            | 3.36 (0.84)                      |
| Meaning of work   | 4.11 (0.70)                       | 4.11 (0.70)                            | 4.08 (0.74)                            | 4.06 (0.82)                      |
| Influence at work   | 3.24 (0.85)                       | 3.25 (0.84)                            | 3.17 (0.89)                            | 3.14 (0.90)                      |
| Social support  | 3.60 (0.70)                       | 3.61 (0.70)                            | 3.53 (0.75)                            | 3.43 (0.82)                      |
| <b>Chronic conditions**</b>                                 |                                   |  |  |                                  |
| Cardiovascular disease, %                                   | 2.1                               | -                                      | 11.4                                   | 34.3                             |
| Type 2 diabetes mellitus, %                                 | 2.4                               | -                                      | 13.2                                   | 38.0                             |
| Chronic obstructive pulmonary disease, %                    | 5.3                               | -                                      | 31.8                                   | 57.0                             |
| Rheumatism, %   | 2.3                               | -                                      | 30.8                                   | 31.5                             |
| Depression, %   | 5.0                               | -                                      | 12.8                                   | 49.5                             |
| Multi-morbidity, %  | 1.7                               | -                                      | -                                      | -                                |
| <b>Work exit***</b>   |                                   |  |  |                                  |
| Unemployment, %   | 8.3                               | 7.8                                    | 10.6                                   | 11.5                             |
| Disability, %   | 1.7                               | 1.4                                    | 3.1                                    | 6.6                              |
| Early retirement, %   | 2.0                               | 1.7                                    | 3.3                                    | 4.6                              |

\* Missing values: educational level 1.6%, partnership status 0.9%, quantitative demands 4.7%, work pace 4.7%, possibilities for development 4.5%, meaning of work 4.6%, influence at work 4.6%, social support 10.2%. \*\* Based on the baseline measurement, and the first and second follow-up measurements. \*\*\* Work exit between the second follow-up measurement (2012-2015) and December 2018.

**Table 2.** Cox regression analyses for the association between chronic disease status and work exit among 55,950 workers participating in Lifelines

|                     | Unemployment             |                          | Work disabled            |                          | Early retirement         |                          |
|---------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
|                     | Unadjusted               | Adjusted*                | Unadjusted               | Adjusted*                | Unadjusted               | Adjusted*                |
|                     | Hazard ratio<br>(95% CI) | Hazard ratio<br>(95% CI) | Hazard ratio<br>(95% CI) | Hazard ratio<br>(95% CI) | Hazard ratio<br>(95% CI) | Hazard ratio<br>(95% CI) |
| No chronic disease  | ref                      | ref                      | ref                      | ref                      | ref                      | ref                      |
| One chronic disease | <b>1.41 (1.30; 1.52)</b> | <b>1.32 (1.22; 1.43)</b> | <b>2.36 (2.03; 2.74)</b> | <b>2.38 (2.04; 2.77)</b> | <b>1.98 (1.72; 2.28)</b> | <b>1.14 (0.99; 1.31)</b> |
| Multi-morbidity     | <b>1.60 (1.32; 1.93)</b> | <b>1.43 (1.18; 1.72)</b> | <b>5.29 (4.10; 6.83)</b> | <b>5.48 (4.22; 7.11)</b> | <b>2.91 (2.16; 3.93)</b> | <b>1.03 (0.76; 1.39)</b> |
| One chronic disease | ref                      | ref                      | ref                      | ref                      | ref                      | ref                      |
| Multi-morbidity     | <b>1.13 (0.91; 1.39)</b> | <b>1.12 (0.92; 1.36)</b> | <b>2.25 (1.71; 2.96)</b> | <b>2.16 (1.63; 2.86)</b> | <b>1.46 (1.06; 2.01)</b> | <b>0.94 (0.68; 1.29)</b> |

\*Associations are adjusted for age, gender, educational level and partnership status

More possibilities for development (HR: 0.88, 95% CI: 0.79; 0.99) and higher social support (HR: 0.87, 95% CI: 0.79; 0.97) were associated with a lower risk for work disability. Higher social support (HR: 0.91, 95% CI: 0.83; 0.99) was associated with a lower risk for early retirement. Chronic disease status did not moderate the associations between working conditions and work disability or early retirement.

### **Sensitivity analyses**

Analyses without mutually adjusting working conditions showed similar results (Supplementary Table 3). Compared to the main analyses, more influence at work was associated with a lower risk for unemployment and work disability, more meaning of work was associated with a decreased risk for work disability, and the interaction term between possibilities for development and unemployment was no longer significant.

## **Discussion**

In this study among 55,950 Dutch workers, we found that higher social support decreased the risk for unemployment, work disability, and early retirement. Higher meaning of work decreased the risk of unemployment, and more possibilities for development decreased the risk for work disability. Little evidence was found for a moderating effect of chronic disease status on the association between working conditions and work exit. Chronic disease status moderated the association between work pace and unemployment in such a way that workers with multi-morbidity had an increased risk of unemployment, albeit non-significantly. Furthermore, chronic disease status moderated the association between possibilities for development and unemployment in such a way that workers without a chronic disease had a decreased risk of unemployment.

The finding that chronic disease status has little influence on the associations between working conditions and work exit is in line with previous studies (23,25). Boot et al. (2014) showed that associations between physical and psychosocial work demands and work exit did not differ between workers with and without a chronic disease except for low psychosocial resources (23). Similarly, Sewdas et al. (2019) showed that, besides work-family conflict and the quality of colleague relationships, the associations between emotional demands, work pace, and quantitative demands and early retirement, did not differ between workers with and without a chronic disease (25). Findings from our and previous studies thus suggest that psychosocial

**Table 3.** Cox regression analyses for the associations between working conditions (scale 1-5) and work exit among 55,950 workers participating in Lifelines\*

|                                 | Total sample             |  | No chronic disease       |                   | One chronic disease   |  | Multi-morbidity           |  |
|---------------------------------|--------------------------|--|--------------------------|-------------------|-----------------------|--|---------------------------|--|
|                                 | Hazard ratio (95% CI)    |  | Hazard ratio (95% CI)    |                   | Hazard ratio (95% CI) |  | P-value for interaction** |  |
| <b>Unemployment Demands</b>     |                          |  |                          |                   |                       |  |                           |  |
| Quantitative demands            | 0.97 (0.93; 1.01)        |  |                          |                   |                       |  | 0.11                      |  |
| Work pace                       |                          |  | 0.98 (0.94; 1.03)        | 1.03 (0.94; 1.14) | 1.28 (1.00; 1.63)     |  | <b>0.01</b>               |  |
| <b>Resources</b>                |                          |  |                          |                   |                       |  |                           |  |
| Possibilities for development   |                          |  | <b>0.89 (0.85; 0.94)</b> | 0.96 (0.86; 1.08) | 0.82 (0.61; 1.09)     |  | <b>0.05</b>               |  |
| Meaning of work                 | <b>0.80 (0.76; 0.83)</b> |  |                          |                   |                       |  | 0.27                      |  |
| Influence at work               | 0.98 (0.94; 1.02)        |  |                          |                   |                       |  | 0.50                      |  |
| Social support                  | <b>0.80 (0.77; 0.84)</b> |  |                          |                   |                       |  | 0.13                      |  |
| <b>Work disability Demands</b>  |                          |  |                          |                   |                       |  |                           |  |
| Quantitative demands            | 1.01 (0.93; 1.11)        |  |                          |                   |                       |  | 0.23                      |  |
| Work pace                       | 1.04 (0.95; 1.15)        |  |                          |                   |                       |  | 0.83                      |  |
| <b>Resources</b>                |                          |  |                          |                   |                       |  |                           |  |
| Possibilities for development   | <b>0.88 (0.79; 0.99)</b> |  |                          |                   |                       |  | 0.71                      |  |
| Meaning of work                 | 0.94 (0.85; 1.05)        |  |                          |                   |                       |  | 0.25                      |  |
| Influence at work               | 0.93 (0.85; 1.01)        |  |                          |                   |                       |  | 0.94                      |  |
| Social support                  | <b>0.87 (0.79; 0.97)</b> |  |                          |                   |                       |  | 0.96                      |  |
| <b>Early retirement Demands</b> |                          |  |                          |                   |                       |  |                           |  |
| Quantitative demands            | 1.02 (0.94; 1.10)        |  |                          |                   |                       |  | 0.81                      |  |
| Work pace                       | 0.98 (0.90; 1.06)        |  |                          |                   |                       |  | 0.08                      |  |
| <b>Resources</b>                |                          |  |                          |                   |                       |  |                           |  |
| Possibilities for development   | 1.07 (0.97; 1.19)        |  |                          |                   |                       |  | 0.10                      |  |
| Meaning of work                 | 1.02 (0.92; 1.13)        |  |                          |                   |                       |  | 0.33                      |  |
| Influence at work               | 0.95 (0.88; 1.03)        |  |                          |                   |                       |  | 0.83                      |  |
| Social support                  | <b>0.91 (0.83; 0.99)</b> |  |                          |                   |                       |  | 0.72                      |  |

\*Associations are adjusted for age, gender, educational level, partnership status and working conditions

\*\*Overall interaction-term between the individual working conditions and chronic disease status

working conditions are generally not more important for workers with a chronic disease than for workers without a chronic disease. Workers with multi-morbidity however, may benefit from lower work pace in the prevention of unemployment. However, since workers with a chronic disease or multi-morbidity have an increased risk to exit work before statutory retirement (6-11), efforts to retain these workers should be a priority of key stakeholder such as employers and governments. Additional research is needed to examine whether other factors like health behavior (29) and employer policies and practices to manage and prevent unemployment and work disability (31) are more important for the prevention of work exit of workers with chronic diseases.

For all workers, higher social support was a protective factor for unemployment, work disability and early retirement, whereas higher meaning of work was a protective factor for unemployment, and higher possibilities for development for work disability. Social support is an important job resource and has previously been shown to decrease the risk of work exit, especially via unemployment (11,13). Somewhat surprisingly, quantitative demands were not associated with work exit. This finding differs from studies showing that especially among workers with health problems, lower demands reduce the risk of work exit into work disability(32) while high demands lower the risk of unemployment (13,33). Measurement differences regarding quantitative demands in our study (i.e. two items) and previous studies (i.e. four items) might explain these differences (13,32).

A strength of the current study is the use of a large representative group of workers from the Lifelines Cohort Study (34). The large sample size enabled analyses on work exit through unemployment, work disability and early retirement. Second, psychosocial working conditions were measured with a validated version of the COPSOQ II (30), the classification of the selected chronic diseases was based on a combination of self-reports, clinical measures and medication use, and work exit was determined with monthly register data. These measurements limit the risk for information bias, especially regarding the outcome and moderator.

A limitation is that, despite our initial large sample size, we were not able to perform disease specific analyses. For example, influence at work may be especially important for workers with depression while physical demands may be more important for workers with rheumatoid arthritis.

In addition, we have focused on a selection of chronic diseases thereby potentially underestimating the prevalence, and moderating effect, of chronic diseases and multimorbidity among the working population. Furthermore, while depression and feelings of depression are often chronic either in terms of recurrent or persistent depression, it is not by definition a chronic disease (35). Furthermore, the rather low Cronbach's Alphas for the working conditions quantitative demands, influence at work, and possibilities for development suggest that these domains were not measured optimally. We also had no information about physical work demands, while physical work demands are related to work exit (33), especially when having a chronic disease (23).

This study may have some important implications for future research. This study focused on the first event and individuals may return to work after an unemployment spell, work disability or even early retirement. Future studies could incorporate re-entering employment to create a more dynamic presentation of workers' reality. In addition, workers with a chronic disease or multi-morbidity may have selected themselves into jobs with less-demanding psychosocial working conditions or rate their working conditions as more demanding compared to workers without a chronic disease. To counter these potential problems, future studies with longer follow-up times may need to focus on the moderating role of incident chronic diseases.

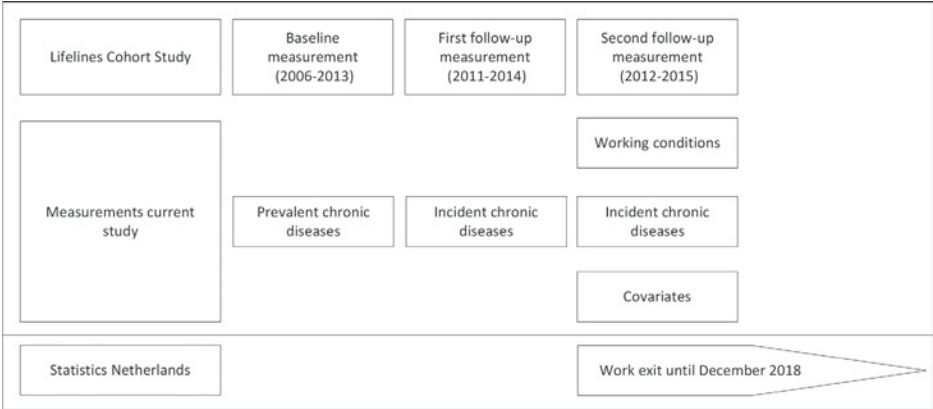
To conclude, favourable working conditions are important for workers' employment status regardless of their chronic disease status. Efforts to obtain and maintain favourable psychosocial working conditions should target all workers. Nevertheless, additional focus on work pace may benefit workers with multi-morbidity.

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**Supplementary Figure 1.** Overview of the collected data across the measurement waves

Supplementary Table 1. Classification of chronic diseases by measurement wave

| Chronic disease                              | Baseline measurement within Lifelines   | First and second follow-up measurements within Lifelines  |
|--|---|---|
| Cardiovascular disease (CVD)                 | Participants were classified as having CVD if they (1) reported having experienced heart failure and used any type of medication related to their heart failure use (ATC-code C03A, C03B, C03C, C03E, C03X, C03D, C07, C08); (2) reported having vascular disease (i.e., heart attack, stroke, aortic aneurysm, balloon angioplasty, or a bypass surgery) in combination with medication use (ATC-code B01AA, B01AC06, B01AC08, B01ACO4), (3) reported having a pacemaker or heart transplant, (4) had atrial fibrillation (AF) assessed by electrocardiography (Welch Allyn®) or self-report in combination with medication use (ATC-code B01AA), or (5) had a CHADSVASc < 2 and used medication (ATC-code B01AA). The CHADSVASc-score is used to measure the risk of stroke and AF, based on information on risk factors, i.e. history of congestive heart failure, hypertension, age, diabetes, vascular disease, and sex. | “Did the health problems listed below start since the last time you filled in the Lifelines questionnaire?”<br><br>(at least 1/3 of the diseases indicated below)<br>- Heart infarction<br>- Heart failure<br>- Intermittent claudication |
| Chronic Obstructive Pulmonary Disease (COPD) | Participants were classified as having COPD (1) if the ratio of FEV1 (forced expiratory volume) to FVC (forced vital capacity) (FEV1/FVC) < 0.70 or when there was a reduced vital capacity < 80% predicted, and (2) based on self-report and use of COPD medication (ATC-code R03AC, R03CC, R03AK, R03BA, R03BB, R03BC01, R03BC03, R03DA04, or R03DC). Individuals were only classified as having COPD if they were above the age of 40, as the onset of COPD generally occurs in midlife.   | “Did the health problems listed below start since the last time you filled in the Lifelines questionnaire?”<br><br>- COPD, lung emphysema or chronic bronchitis   |
| Depression                                   | Participants were classified as having depression if (1) they had a current depressive disorder, or (2) if they had a dysthymic disorder and used antidepressants (ATC-code N06A). Classification was based on the Mini International Neuropsychiatric Interview.   | “Did the health problems listed below start since the last time you filled in the Lifelines questionnaire?”<br><br>- Depression   |

| Chronic disease          | Baseline measurement within Lifelines   | First and second follow-up measurements within Lifelines  |
|--------------------------|---|---|
| Type 2 Diabetes Mellitus | T2DM classification was based on fasting plasma glucose levels ( $\geq 7.0$ mmol/L) or non-fasting plasma glucose levels ( $\geq 11.0$ mmol/L), glycated hemoglobin (HbA1c) $\geq 6.5\%$ (48 mmol/mol), self-report (including a question referring to having type 1 or type 2 diabetes), and reported medication use (ATC-code A10A/A10B). | “Did the health problems listed below start since the last time you filled in the Lifelines questionnaire?”<br>- Diabetes             |
| Rheumatoid arthritis     | Rheumatoid arthritis was based on self-report of RA or self-reported symptoms of stiffness or pain in hands/feet in combination with medication use (ATC-code M01AE, M01AB, M01, LO4AB, or LO4AA24, LO1XC02, LO1BA01).  | “Did the health problems listed below start since the last time you filled in the Lifelines questionnaire?”<br>- Rheumatoid arthritis |

**Supplementary Table 2.** Median (IQR) months of follow-up by chronic disease status and exit route

|                     | No work exit |  | Unemployment |  | Work disability |  | Early retirement |  |
|---------------------|--------------|--|--------------|--|-----------------|--|------------------|--|
|                     | Median (IQR) |  | Median (IQR) |  | Median (IQR)    |  | Median (IQR)     |  |
| No chronic disease  | 55 (48-67)   |  | 19 (9-33)    |  | 23 (13-40)      |  | 29 (15-42)       |  |
| One chronic disease | 55 (48-68)   |  | 19 (9-33)    |  | 24 (12-40)      |  | 24 (13-44)       |  |
| Multimorbidity      | 56 (45-67)   |  | 29 (9-35)    |  | 23 (13-40)      |  | 25 (14-38)       |  |

**Supplementary Table 3.** Cox regression analyses for the associations between working conditions (scale 1–5) and work exit among 55,950 workers participating in Lifelines\*

|                                 | Total sample             |  | No chronic disease       |  | One chronic disease      |  | Multi-morbidity          |                              |
|---------------------------------|--------------------------|--|--------------------------|--|--------------------------|--|--------------------------|------------------------------|
|                                 | Hazard ratio<br>(95% CI) |  | Hazard ratio<br>(95% CI) |  | Hazard ratio<br>(95% CI) |  | Hazard ratio<br>(95% CI) | P-value for<br>interaction** |
| <b>Unemployment Demands</b>     |                          |  |                          |  |                          |  |                          |                              |
| Quantitative demands            | 0.98 (0.95; 1.02)        |  |                          |  |                          |  |                          | 0.09                         |
| Work pace                       |                          |  | 0.96 (0.92; 1.00)        |  | 1.01 (0.92; 1.10)        |  | <b>1.29 (1.03; 1.61)</b> | <b>0.02</b>                  |
| <b>Resources</b>                |                          |  |                          |  |                          |  |                          | 0.06                         |
| Possibilities for development   | <b>0.77 (0.74; 0.80)</b> |  |                          |  |                          |  |                          | 0.31                         |
| Meaning of work                 | <b>0.73 (0.70; 0.75)</b> |  |                          |  |                          |  |                          | 0.41                         |
| Influence at work               | <b>0.90 (0.87; 0.93)</b> |  |                          |  |                          |  |                          | 0.16                         |
| Social support                  | <b>0.74 (0.71; 0.77)</b> |  |                          |  |                          |  |                          |                              |
| <b>Work disability Demands</b>  |                          |  |                          |  |                          |  |                          |                              |
| Quantitative demands            | 1.03 (0.95; 1.12)        |  |                          |  |                          |  |                          | 0.20                         |
| Work pace                       | 1.04 (0.96; 1.14)        |  |                          |  |                          |  |                          | 0.82                         |
| <b>Resources</b>                |                          |  |                          |  |                          |  |                          | 0.71                         |
| Possibilities for development   | <b>0.82 (0.75; 0.90)</b> |  |                          |  |                          |  |                          | 0.25                         |
| Meaning of work                 | <b>0.86 (0.79; 0.95)</b> |  |                          |  |                          |  |                          | 0.95                         |
| Influence at work               | <b>0.87 (0.81; 0.95)</b> |  |                          |  |                          |  |                          | 0.96                         |
| Social support                  | <b>0.82 (0.75; 0.90)</b> |  |                          |  |                          |  |                          |                              |
| <b>Early retirement Demands</b> |                          |  |                          |  |                          |  |                          |                              |
| Quantitative demands            | 1.04 (0.96; 1.11)        |  |                          |  |                          |  |                          | 0.79                         |
| Work pace                       | 1.01 (0.93; 1.09)        |  |                          |  |                          |  |                          | 0.07                         |
| <b>Resources</b>                |                          |  |                          |  |                          |  |                          | 0.10                         |
| Possibilities for development   | 1.03 (0.95; 1.13)        |  |                          |  |                          |  |                          | 0.32                         |
| Meaning of work                 | 1.01 (0.92; 1.11)        |  |                          |  |                          |  |                          | 0.82                         |
| Influence at work               | 0.96 (0.90; 1.03)        |  |                          |  |                          |  |                          | 0.74                         |
| Social support                  | <b>0.91 (0.84; 0.99)</b> |  |                          |  |                          |  |                          |                              |

\*Associations are adjusted for age, gender, educational level, and partnership status

\*\* Overall interaction-term between the individual working conditions and chronic disease status



