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MR RUBÉN LÓPEZ-BUENO (Orcid ID : 0000-0002-7865-3429)

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RUBÉN LÓPEZ-BUENO[1,2], EMIL SUNDSTRUP[2], JONAS VINSTRUP[2, 6], JOSÉ A. CASAJÚS[3,4,5] & LARS L. ANDERSEN[2,6]

[1]Department of Physical Medicine and Nursing, University of Zaragoza, Zaragoza, Spain, [2]National Research Centre for the Working Environment, Copenhagen, Denmark, [3]Faculty of Health Sciences, University of Zaragoza, Zaragoza, Spain, [4]GENUD (Growth, Exercise, Nutrition and Development) Research Group, University of Zaragoza, Zaragoza, Spain, [5]Biomedical Research Networking Centre about Nutrition and Obesity Physiopathology (CIBER-OBN), Madrid, Spain, [6]Department of Health Science and Technology, Aalborg University, Aalborg, Denmark

Correspondence: Rubén López Bueno, Department of Physical Medicine and Nursing, University of Zaragoza, no number Domingo Miral, Zaragoza, 50009, Spain.

E-mail: rlopezbu@unizar.es

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Abstract

Objectives: This study examined the association of leisure-time physical activity (LTPA) with the risk of long-term sickness absence (LTSA). **Methods:** A total of 10427 subjects from the general working population in Denmark answered questions about physical activity habits, health and work environment in the 2010 Danish Work Environment Cohort Study (DWECS). Data on LTSA (≥6 consecutive weeks during 2-year follow-up) were obtained from the Danish Register for Evaluation of Marginalization (DREAM). Cox regression analysis censored for competing events and adjusted for potential confounders (age, sex, BMI, smoking habits, depression, cancer, back diseases, previous LTSA, occupational social class, and psychosocial work environment) estimated the association between the predictor (LTPA) and the outcome variable (LTSA). During the 2-year follow-up period, 9.2% of the studied population experienced LTSA. **Results:** In the general working population, moderate LTPA was not associated with LTSA (HR = 0.89, 95% CI: 0.72 - 1.09), while high LTPA showed a tendency (HR = 0.77, 95% CI: 0.59 - 1.01). In subgroup analyses, women below the age of 45 years with high LTPA showed a significantly lower risk of LTSA when compared with their low LTPA counterparts (HR = 0.44, 95% CI: 0.25 - 0.78). **Conclusion:** The results suggest that high levels of physical activity during leisure is associated with a lowered risk of LTSA, especially among younger women.

Keywords: *sickness absence, epidemiology, exercise, prospective studies, workplace, physical activity, absenteeism, sick leave*

1. Introduction

There is high-quality evidence that regular physical activity reduces the risk of major chronic diseases.[1] Low physical activity levels have been associated with mortality, several types of cancer, type II diabetes, cardiovascular diseases, and poor mental health.[2–4]

Despite this, physical activity trends in European countries have remained stable for years, and approximately 60% of the adult population are never or rarely doing exercise.[5] Further, cardiorespiratory fitness within high- and upper-middle-income countries has decreased by 7.7% over the last five decades.[6]

However, physical inactivity affects not only personal health but also has high societal costs: In European countries, there is an annual cost of 80 billion euros derived from medical care and treatments, functional limitations, disability as well as a loss of dependence and productivity due to physical inactivity.[7]

A large portion of the costs derived from sickness absence is usually assumed by the governments, in which long-term sickness absence (LTSA) accounts for the major part of the expenditure. The average annual raise of sickness benefit per inhabitant in the European Union (EU) was 2.5% during the period 2008-2013, with similar values found in the Nordic countries.[8]

Sickness absence is a reliable measurement to assess the health of the workers, as it has previously been associated with both disability pensioning and mortality.[9,10] Therefore, intervening to prevent sickness absence may also, in the long term, decrease rates of disability pension. According to the Nordic Social Statistical Committee (NOSOSCO), there are different patterns of sickness absence for each of the Nordic countries. Thus, Norway and Sweden have the highest levels of LTSA, whereas Denmark and Finland are more prompted to have higher levels of short term sickness absence.[11] Knowledge of risk factors related to sickness absence are eagerly requested, and can potentially lead to more effective preventative solutions.

Because physical inactivity at the workplace is a growing problem in European countries (i.e. less proportion of active jobs and more proportion of sedentary jobs),[7] several workplaces have implemented different policies and practices as preventive measures, including the promotion of physical activity at and outside the workplace. On the other hand, blue-collar workers were reporting demanding physical jobs that showed an increased risk of LTSA.[12] Thus, the type of physical activity being promoted should be health-enhancing, i.e. have sufficient specify, intensity, frequency and volume to increase physical fitness and strength.

When physical exercise has been directed towards treating specific pain or injuries in the workplace, good results have previously been reported.[13,14] In particular, leisure-time physical activity (LTPA) has been inversely associated with the risk of stroke and all-cause mortality in adults.[3,15] Even some psychosocial hazards, such as perceived stress, depression, and burnout, have been inversely associated with high levels of physical activity.[16] Therefore, as all cardiovascular diseases, musculoskeletal and mental disorders, three of the main causes behind LTSA,[17] have shown benefits from physical activity, we hypothesised to find an inverse association between LTSA and LTPA among this population of Danish workers.

The primary aim of this study was to examine the association of different levels of LTPA with subsequent LTSA (≥ 6 weeks) among the general working population.

2. Methods

2.1. Study design

The current study is based on a prospective cohort design and examines possible associations between different levels of LTPA and LTSA in a general population of Danish workers. Data on physical activity were extracted from the Danish Work Environment Cohort Study (DWECS) whereas data sickness absences were obtained from the Danish Register for Evaluation of Marginalization (DREAM).

2.2. Participants and setting

A total cohort of 10427 active general Danish employees from the 2010 DWECS was randomly sampled from the Central Register of Denmark for this study. The provided information about the characteristics of the population, health, and psychosocial work factors was obtained through a survey included in the 5-annual DWECS rounds.[18] As not all the participants completed all the survey questions, the total number of subjects included in each analysis varies depending on the employed variables.

2.3. Ethical approval

The present study was informed to and registered with the Danish Data Protection Agency (journal number: 2007-54-0059). Due to Danish law, questionnaire-based and registered-based studies need neither approval from an ethical committee nor informed consent from the study subjects. All data were de-identified and anonymously analysed.

2.4. Predictor variable

Measures on LTPA were obtained through the following question used in prior research:[17] "How much time have you spent on each of the following leisure-time activities during the last year (including commuting to and from work)?" (i) "Walking, biking or other low-intensity exercises, where you do not get short of breath and do not begin to sweat (e.g., Sunday walks or low-intensity gardening)?"; (ii) "Exercise training, heavy gardening, or higher intensity walking/biking, where you sweat and get short of breath?"; and (iii) "Strenuous exercise training or competitive sports?". Possible answers for each sub-question were: > 4, 2 – 4, < 2 hours/week or "I do not perform this activity". Low physical activity was described as performing < 4 hours of low-intensity physical activity per week and not performing moderate-intensity and high-intensity activities at all. Moderate physical activity was described as performing > 4 hours of low-intensity physical activity per week or moderate or high-intensity for < 4 hours/week. High physical activity was described as performing a moderate or high activity for > 4 hours/week or a combination of moderate and high activity for 2 – 4 hours/week.

2.5. Outcome variable

Data on LTSA were obtained from DREAM and linked to the DWECS through the unique personal identification number given to the Danish citizens at birth. DREAM incorporates information on transfer payments such as a sickness absence compensation, early retirement benefits, unemployment benefits, and disability pension, among other personal information on all Danish residents.

Because employers get financial compensation for employees´ sickness absence costs after 30 days of sick leave, LTSA was defined as registered sickness absence for at least 30 calendar days (i.e. six weeks in the register). Previous studies have documented the high validity and reliability of the DREAM register.[10]

2.6. Control variables

Based on previous research,[17,19–23] this study included the following potential confounders: age, gender, and variables related to lifestyle, health, occupational social class (i.e. job group), and psychosocial work environment. Regarding lifestyle, body mass index (BMI) derived from self-reported height and weight (i.e. weight in kilograms divided by height in squared meters) and participants were classified according to World Health Organization (WHO) guidelines[24] ("underweight, < 18.5 kg m^{-2}", "normal, 18.5 – 24.9 kg m^{-2}", "overweight, 25.0 – 29.9 kg m^{-2}", and "obese, ≥ 30.0 kg m^{-2}"), and smoking status ("yes", "ex-smoker", and "no") were included. Concerning health, several of the chronic diseases behind most of the LTSA were included:[17] cancer ("yes" and "no, never"), depression ("yes" and "no, never"), back disorders ("yes" and

"no, never"), and previous long term sickness absence (≥1 episode of LTSA during the previous two years prior to baseline). Occupational social class was estimated through a Danish register managed by Statistics Denmark, including information on job groups. A total of 86 job groups comprising a wide-range of job roles (i.e. from blue and white-collar workers to self-employees) were represented in this research. The psychosocial work environment was measured by four dimensions from the Copenhagen Psychosocial Questionnaire,[25] including influence at work, emotional demands, support from colleagues and support from superiors. Each of these dimensions was assessed with a 0 - 100-point scale.

2.7. Statistical analysis

Employing the PROC PHREG procedure in SAS version 9.4 (SAS Institute, Cary, NC, USA), a Cox proportional hazard model was implemented for modelling the risk of LTSA (≥ 6 weeks) during the 2-year follow-up period as a function of LTPA. Using the standard Cox-regression for LTSA, we assessed the hazard of an LTSA event by a competing risk procedure. When any of the study subjects had an onset of LTSA within the 2-year follow-up period (i.e. from 2010 to 2012), the survival times were referred to as events of interest and non-censored, whereas respondents were censored in case of permanent drop out of the labour market based on the DREAM register (i.e., statutory or early retirement, disability pension, immigration or death). Also, the study subjects were censored at the end of the 2-year follow-up. Based on previous studies underscoring the importance of age and gender to design health promotion strategies,[26,27] we divided participants into different subgroups regarding age and gender. A data-driven approach was used to categorise the study sample into below or above 45 years of age (i.e. 45 years represented the median age of the study sample). This cut-off point was selected to ensure sufficient statistical power when comparing groups regarding age. Results are reported as hazard ratios (HRs) with 95% confidence intervals (95% CI), and the estimation method was the maximum likelihood.

3. Results

Table 1 shows the descriptive statistics for the study variables. Of the 10427 participants (54.3% women), 960 (9.2%) had an LTSA onset during the 2-year follow-up. The participant's mean age was 43.5 ± 11.7 years.

Table 2 shows prospective associations between LTPA and LTSA among a general working population). For the entire group, high LTPA reduces more the risk of LTSA than moderate LTPA in all the implemented models when referencing to those with low LTPA. Moderate and high LTPA significantly decreases the risk for LTSA by 18% (HR = 0.82, 95% CI: 0.68 - 0.97) and 28% (HR = 0.72, 95% CI: 0.57 - 0.91) respectively (model 1).

The results observed in table 3, with additional adjustment for smoking habits and BMI (model 2), show an increased risk estimates for both moderate (HR = 0.87, 95% CI: 0.72 - 1.05) and high LTPA (HR = 0.80, 95% CI: 0.62 – 1.02). Adjusting for these variables attenuates LTPA influence on LTSA, after which LTSA risk reduction loses statistical significance for moderate LTPA. In model 3, additionally adjusted for job group and psychosocial work environment, moderate LTPA continues increasing LTSA risk (HR = 0.89, 95% CI: 0.73 - 1.09) whereas high LTPA presents a LTSA risk reduction (HR = 0.76, 95% CI: 0.58 - 1.00). The final model (model 4), also adjusted for chronic disease and previous LTSA, observes no substantial LTSA risk estimation changes for both moderate LTPA (HR = 0.89, 95% CI: 0.73 - 1.09) and high LTPA (HR = 0.77, 95% CI: 0.59 - 1.01).

Table 3 also shows prospective associations between LTPA and LTSA stratified by age and/or gender, in which risk of LTSA differs by age and sex stratum. Only high LTPA exposure remains significant after fully adjustment (model 4) when meeting the conditions of being < 45 years old (HR = 0.62, 95% CI: 0.41 - 0.96), a woman (HR = 0.72, 95% CI: 0.49 - 1.00) and especially, being a woman < 45 years old (HR = 0.44, 95% CI: 0.25 - 0.78).

4. Discussion

Findings from the present study in a large cohort from the Danish general workforce showed that high LTPA reduced LTSA risk by a borderline significant 23%, even when adjusted for a broad set of potential confounders. Moderate LTPA also showed to reduce risk of LTSA but in less percentage than high LTPA. In women, a significant reduction of LTSA risk was observed for those aged less than 45 years performing high LTPA.

The results of the present study support the role of LTPA as a protective factor for LTSA. A study by Holtermann et al.[26] observed LTPA reduce the risk for LTSA (≥ 3 consecutive weeks) among another cohort of Danish general workers. Similarly to our study, both moderate and high LTPA reduced LTSA risk; although, it was high LTPA which significantly reduced more LTSA after full adjustment. In a similar line, another study by Lahti et al.[21] found significant inverse associations between LTPA and both short-term sickness absence (≤ 14 days) as well as LTPA (≥ 14 days) among Finish employees performing vigorous LTPA; that inverse association was not found for moderate-intensity LTPA.

A large body of literature has shown the effects of LTPA over general adult´s health worldwide in a dose-response manner, reducing the risk of suffering a wide-range of chronic diseases[29] and all-cause as well as case-specific mortality.[30] Further, even when adjusted for sedentary time, another critical risk factor for both chronic disease and mortality,[31] physical activity showed to be a reliable predictor of all-cause

mortality.[32] Thus, those LTPA protective properties might contribute to diminishing the risk of LTSA, since that has been highly associated with chronic conditions[33] and early mortality[9] Because aerobic capacity (i.e. maximal oxygen consumption), as well as muscular strength, have been inversely associated with respectively cardiovascular disease morbidity[34] and all-cause mortality among adults,[34,35] the LTSA risk might decrease when performing either endurance or strength training during leisure. Therefore, encouraging workers to move more as a general notion, regardless of the type of physical activity, might contribute to reducing LTSA levels in a general population of workers. In opposition, intensity (i.e. degree of physical effort) has been observed to be a critical issue, since vigorous-intensity LTPA has shown higher inverse associations with general sickness absence than moderate-intensity LTPA.[36]

Regarding control variables, BMI and smoking habit were the main contributors to mitigate the influence of LTPA over risk reduction of LTSA in this study. It might be explained by the fact that both obesity and smoking could play an intermediary role between LTPA and LTSA since both have been inversely associated with physical activity[20,37] and directly with sickness absence (1-4 days).[38] In a lesser way, psychosocial work environment and job group variables also attenuated the risk reduction of LTSA. The first has been associated with LTPA (i.e. higher job control led to higher odds of LTPA) among middle-aged workers from the United States,[19] whereas the second has shown different odds for LTPA concerning occupational classes (i.e. manual classes were more prompted to be physically inactive in their leisure time and to be less often active than professional, and semi-professional workers ranked on the two top positions) among a Finnish population of workers.[39] Finally, controlling for previous LTSA and chronic diseases (model 4) did not change the risk estimates further.

It is interesting that in the present study women aged ≤ 45 years found higher risk reduction of LTSA than other subgroups when performing high LTPA. One plausible explanation for this specific finding in women only might be the different baseline levels of vigorous leisure-time PA regarding gender,[5] as well as the increase of the prevalence of chronic diseases with age,[40] which would contribute to attenuate the possible influence of LTPA over LTSA.

Overall, high LTPA seems to be a protective factor for LTSA, which should be emphasised in health-promotion strategies for both companies and public institutions. Future research should focus on high-quality clinical trials involving interventions with vigorous physical activity and specific programs aimed at target groups.

Strengths of the current study include using a large and representative sample of Danish workers, as well as an objective measurement of the outcome variable through a highly reliable register. Also, a step-wise

adjustment for potential confounding factors, appointed by previous research, was included in the analysis. However, several limitations should be taken into consideration for this study. Firstly, the observational nature of the research does not allow for the investigation of a causal relationship between physical activity and LTSA. Secondly, because LTPA and other control variables were self-reported, there is an inherent risk of reporting bias. However, this risk could be, in a way, attenuated due to the previous use of the questionnaire in other studies, as well as because the psychosocial work environment related-questions were extracted from the validated Copenhagen Psychosocial Questionnaire.[25] Despite the fact that we have controlled a wide range of potential confounders, other variables such as occupational physical activity might better reflect the effects of the physical efforts in the workplace, since it has been observed to affect LTPA[41] and LTSA.[12] Besides, some of the control variables, e.g. chronic disease, may act as mediator rather than confounder. Thus, other types of analyses – e.g. a formal mediation analysis – may lead to different results. Thirdly, self-reported data might lead to overestimating LTPA as study subjects tend to overestimate their amount of physical activity.[42] Last is that the present study could have been influenced by selection bias because a significant number of participants refused to participate in the DWECS questionnaire survey (53% response rate). Nevertheless, a robustness analysis showed that detected differences in the response rate regarding gender and educational level scarcely influenced how different job groups rated their working environment. Besides, because the present analysis of associations was mutually controlled for a relevant number of factors, non-response bias is unlikely to have influenced the results to any relevant extent. The results of the present study suggest that being highly physically active during leisure is associated with a lowered risk of LTSA, especially among younger women. Strategies aiming at this specific population should be emphasised to both prevent and equalise absence from work.

5. Perspective

Prevention of sickness absence is a critical public health goal since the costs for workplace absenteeism are critical among countries from the EU.[43] However, it is not only the expenditure but also the health of the workforce; several studies have suggested the association between sickness absence and both mortality and general health.[44,45] Because there are differences among job roles,[46,47] gender[48] or age[9] regarding causes of sickness absence, to investigate possible preventive factors such as tailored physical activity aimed at a specific population of workers could help to define better strategies. The present study contributes to supporting the use of high levels of leisure-time physical activity with a general population of workers, adding more evidence to other research findings in which high levels of physical activity

during leisure have significantly reduced the risk of sickness absence in different populations of workers.[49,50]

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Table 1. Characteristics of the study population.

	N	%	Mean	SD
Age	10427		43.5	11.7
Gender				
Men	4762	45.7		
Women	5665	54.3		
Smoker				
Yes	2356	23.2		
Ex-smoker	2916	28.7		
No	4897	48.2		
BMI (kg m^{-2})				
Underweight (<18.5)	86	0.9		
Normal (18.5 - 24.9)	5319	52.7		
Overweight (25.0 - 29.9)	3399	33.7		
Obese (≥30.0)	1291	12.8		
Depression				
Yes	1272	12.5		
No, never	8938	87.5		
Cancer				
Yes	331	3.2		
No, never	9876	96.8		
Back disorder				
Yes	1650	16.2		
No, never	8551	83.8		
Previous long term sickness absence				
Yes	883	8.5		
No	9544	91.5		
Leisure physical activity				
Low	1365	13.4		
Moderate	6853	67.5		

High	1938	19.1		
Long term sickness absence during 2010 - 2012				
Yes	960	9.2		
No	9467	90.8		
Psychosocial work environment (0 - 100)[a]				
Emotional demands	10154		44.6	25.1
Influence at work	10085		67.4	24.0
Support from colleagues	9473		73.1	21.5
Support from leader	9710		69.7	25.8

[a]0-100: Normalized COPSOQ, where 0 is lowest and 100 is highest.

Table 2. Age and sex, and full-adjusted hazard ratios (95% confidence interval) for the risk of long-term sickness absence in relation to moderate and high leisure-time physical activity (reference: low physical activity) in the entire study population.

	Leisure physical activity	n	%	Model 1[a]	Model 2[b]
All	Low	1365	13%	1	1
	Moderate	6853	67%	0.82 (0.68 - 0.97)	0.89 (0.72 - 1.09)
	High	1938	19%	0.72 (0.57 - 0.91)	0.77 (0.59 - 1.01)

[a]Adjusted for age and gender

[b]Model 1 +BMI, smoking habit, job group, psychosocial work environment, chronic disease, and previous LTSA

Table 3. Adjusted hazard ratios (95% confidence interval) for the risk of long-term sickness absence in relation to moderate and high leisure-time physical activity (reference: low physical activity) in the entire study population and in age and gender subgroups.

	Leisure physical activity	n	%	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[d]
All	Low	1365	13%	1	1	1	1
	Moderate	6853	67%	0.82 (0.68 - 0.97)	0.87 (0.72 - 1.05)	0.89 (0.73 - 1.09)	0.89 (0.72 - 1.09)
	High	1938	19%	0.72 (0.57 - 0.91)	0.80 (0.62 - 1.02)	0.76 (0.58 - 1.00)	0.77 (0.59 - 1.01)
< 45 years	Low	624	13%	1	1	1	1
	Moderate	3157	64%	0.83 (0.62 - 1.11)	0.79 (0.58 - 1.07)	0.81 (0.58 - 1.13)	0.79 (0.56 - 1.09)
	High	1124	23%	0.66 (0.46 - 0.95)	0.64 (0.43 - 0.96)	0.62 (0.41 - 0.95)	0.62 (0.41 - 0.96)
≥ 45 years	Low	741	14%	1	1	1	1
	Moderate	3696	70%	0.81 (0.65 - 1.01)	0.93 (0.73 - 1.18)	0.98 (0.75 - 1.27)	1.00 (0.77 - 1.31)
	High	814	16%	0.80 (0.60 - 1.07)	0.94 (0.68 - 1.30)	0.91 (0.64 - 1.30)	0.96 (0.67 - 1.36)
Men	Low	638	14%	1	1	1	1
	Moderate	2950	64%	0.89 (0.66 - 1.21)	0.95 (0.68 - 1.32)	1.08 (0.75 - 1.55)	1.02 (0.70 - 1.47)
	High	1021	22%	0.90 (0.62 - 1.30)	0.96 (0.64 - 1.44)	0.96 (0.62 - 1.49)	0.94 (0.60 - 1.46)
Women	Low	727	13%	1	1	1	1
	Moderate	3903	70%	0.78 (0.62 - 0.96)	0.83 (0.66 - 1.05)	0.84 (0.65 - 1.08)	0.83 (0.65 - 1.07)
	High	917	17%	0.63 (0.47 - 0.85)	0.71 (0.52 - 0.98)	0.70 (0.49 - 0.98)	0.70 (0.49 - 1.00)
Men < 45 years	Low	273	12%	1	1	1	1
	Moderate	1308	60%	0.81 (0.47 - 1.40)	0.78 (0.43 - 1.44)	0.82 (0.44 - 1.55)	0.73 (0.39 - 1.39)
	High	611	28%	0.86 (0.47 - 1.59)	0.90 (0.46 - 1.78)	0.93 (0.45 - 1.89)	0.87 (0.43 - 1.79)
Women < 45 years	Low	351	13%	1	1	1	1
	Moderate	1849	68%	0.83 (0.59 - 1.17)	0.78 (0.54 - 1.12)	0.77 (0.52 - 1.14)	0.76 (0.51 - 1.13)
	High	513	19%	0.53 (0.33 - 0.85)	0.50 (0.30 - 0.84)	0.44 (0.25 - 0.78)	0.44 (0.25 - 0.78)
Men ≥ 45 years	Low	365	15%	1	1	1	1
	Moderate	1642	68%	0.94 (0.65 - 1.35)	1.02 (0.69 - 1.52)	1.23 (0.78 - 1.94)	1.13 (0.71 - 1.80)
	High	410	17%	0.89 (0.56 - 1.42)	0.95 (0.58 - 1.58)	0.96 (0.53 - 1.73)	0.91 (0.50 - 1.66)

Women ≥ 45 years	Low	376	13%	1	1	1	1
	Moderate	2054	72%	0.73 (0.55 - 0.97)	0.87 (0.64 - 1.18)	0.93 (0.66 - 1.30)	0.96 (0.68 - 1.35)
	High	404	14%	0.75 (0.51 - 1.09)	0.95 (0.62 - 1.44)	1.00 (0.63 - 1.58)	1.06 (0.67 - 1.68)

[a]Adjusted for age and gender (all participants), for gender (< 45 years, ≥ 45 years), for age (men, women) and crude model for gender and age subgroups (men < 45 years, women < 45 years, men ≥ 45 years, women ≥ 45 years).

[b]Model 1 + smoking and BMI.

[c]Model 2 + job group and psychosocial work environment (influence at work, emotional demands, support from colleagues and leader).

[d]Model 3 + chronic disease (depression, cancer, back disease) and previous long-term sickness absence.