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ORIGINAL ARTICLE

Adverse effects of effort–reward imbalance on work ability: longitudinal findings from the German Sociomedical Panel of Employees

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Abstract
Objective The aim of this paper was to analyse the longitudinal effects of effort–reward imbalance (ERI) on work ability, mental health and physical functioning.
Methods A total of 603 men and women aged 30–59 years participating in the first two waves of the German Sociomedical Panel of Employees were included in the analyses. Work ability was assessed using the Work Ability Index. Mental health and physical functioning were assessed using scales of the Medical Outcomes Study 36-item Short-Form Health Survey.
Results Our longitudinal analysis showed that high ERI-related work stress exposure at baseline was associated with a decrease in work ability, mental health and physical functioning over time. In case of work ability ($b = -0.512$; 95% CI −1.018 to −0.006) and mental health ($b = -2.026$; 95% CI −3.483 to −0.568), this also held true after adjusting for other factors of the work environment (physical demands, job control and psychological job demands).
Conclusions Work stress by ERI has an impact on work ability independent of and above that of other known explanatory variables.

Keywords Work ability · Mental health · Physical functioning · Effort–reward imbalance · Cohort study

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Introduction

The baby boomers were the backbone of the workforce of the last decades. But this generation is ageing, and most European countries are expecting a remarkable loss of workforce in the next decade if the low labour participation of people aged 55 and older (Germany 53.8%; EU-27 45.6%) continues (European Commission 2009; Ilmarinen 2009). The reasons for the low employment rates of older people are manifold. From a health-related perspective, the decline in work ability with ageing is an important factor that at least partly mediates the increased risk of job loss, disability pension and early retirement for older workers (van den Berg et al. 2009). Though different patterns of decline were recently identified by von Bonsdorff et al. (2011), only half of employees seem to maintain their work ability on at least a moderate level throughout their lifespan.

For this reason, the member states of the European Union agreed on a policy of active ageing (cf. resolutions of the European Council in Stockholm 2001 and Barcelona 2002) and acknowledged the urgent need for strategies and concepts to enable a longer work life (Ilmarinen 2006). These current advances in active ageing policy are strongly influenced by the work of Ilmarinen and colleagues from the Finnish Institute of Occupational Health. Starting in the 1980s, they developed a comprehensive conceptual model describing work ability as the interaction of individual determinants, e.g. health, competence and attitudes, on the one hand, and the work environment on the other. Furthermore, they constructed the Work Ability Index (WAI) to operationalise this concept, and conducted a series of studies to explore the determinants of work ability (Ilmarinen et al. 1991; Tuomi et al. 1991). These and other studies have identified a number of risk factors for restrictions of work

ability. As summarised in a review by van den Berg et al. (2009), these factors include a lack of physical activity, poor musculoskeletal capacity, obesity, high mental work demands, lack of autonomy, poor physical work environment and high physical work demands. Individual determinants, work demands and exposures were frequently represented in the studies evaluated in the review, whereas determinants that concerned organisation, leadership and equity were not.

One model that covers these latter aspects of the work environment is the effort–reward imbalance (ERI) model (Siegrist 1996). The ERI model is based on the equity theory and the notion of contractual reciprocity. According to Siegrist (1996), the beneficial effects of employment (participation, self-efficacy and approval) depend on fairness in the relationship between employer and employee. Most importantly, employees expect adequate rewards (income, esteem, career opportunities and job security) for their efforts. The ERI model therefore assumes that a lack of reciprocity (e.g. high effort and low reward) results in emotional distress and adverse health effects.

Cumulative evidence from high-quality cohort studies and meta-analyses support the hypothesis that ERI contributes to adverse health effects, especially coronary heart disease and mental disorders (Kivimaki et al. 2006; Sanderson and Andrews 2006; Stansfeld and Candy 2006; Nieuwenhuijsen et al. 2010; Siegrist et al. 2004). Moreover, ERI is also linked to sick leave, intention to retire and exit from paid employment (Head et al. 2007; van den Berg et al. 2010; Siegrist et al. 2007).

Epidemiological evidence regarding the effects of ERI on work ability comes only from lower-quality cross-sectional studies, which showed a strong association between ERI-related work stress and reduction of work ability, with adjusted odds ratio ranging from 2.4 to 2.9 (Conway et al. 2008; Bethge et al. 2009). Although these cross-sectional studies support the notion that fairness and reciprocity are relevant for work ability, they are not sufficient to establish causal relations (Rothman 2002). Consequently, the present study was designed to analyse the longitudinal effects of ERI on work ability in a cohort of German workers and to complement these findings by additionally analysing the effects of ERI on mental health and physical functioning.

Methods

Setting and participants

Data were collected during the first two waves of the German Sociomedical Panel of Employees (SPE) (Bethge et al. 2009; Bethge and Radoschewski 2010a, b). The German SPE is a large-scale postal survey designed to identify environmental and personal risk factors affecting work ability and vocational participation (Bethge et al. 2009). A total of 6,400 subjects aged 30–59 years who were randomly selected from the registers of three German pension insurance funds (GPIF) were invited to participate in the survey. Men and women were sampled separately to achieve an equal sample size for both sexes. The first wave of questionnaires was mailed in September 2007, and the second wave was dispatched 1 year later, in September 2008. The study was approved by the data protection commissioner of the GPIF.

Work ability index

Work ability was assessed as a dependent variable using the German version of the WAI (Tuomi et al. 2001), a health-related instrument assessing the degree to which workers consider their state of health adequate to cope with the demands of their jobs. This is determined based on the answers to questions considering the physical and mental demands of the job and the worker's health status and resources. The questionnaire comprises the following items: (1) current work ability compared with lifetime best, (2) work ability in relation to the demands of the job, (3) number of current diseases diagnosed by a physician, (4) estimated work impairment due to diseases, (5) sick leave during the past year, (6) own prognosis of work ability 2 years from now and (7) mental resources. The WAI score varies from 7 to 49, with higher scores indicating better work ability. According to Tuomi et al. (2001), WAI scores are categorised into four groups: poor (7–27), moderate (28–36), good (37–43) and excellent (44–49). The test–retest reliability of the WAI was found to be consistent (de Zwart et al. 2002). Moreover, several studies confirmed poor work ability as a risk for productivity loss at work, retirement intentions, long-term sickness absence and early retirement (Alavinia et al. 2009; Bethge and Radoschewski 2010b; Lindberg et al. 2009; Salonen et al. 2003; Sell et al. 2009; Tuomi et al. 1997; van den Berg et al. 2011).

Mental health and physical functioning

Mental health and physical functioning were measured using the corresponding scales of the Medical Outcomes Study 36-item Short-Form Health Survey (SF-36) (Ware and Sherbourne 1992). The mental health scale includes five items regarding feelings of nervousness and depressions, and the physical functioning scale includes ten items asking about limitations concerning different activities, including walking, climbing stairs or lifting of objects. Item scores of the multi-item scales were summed, averaged and transformed into values ranging from 0 to 100, with higher values indicating better mental or physical health.

Effort–reward imbalance

ERI-related work stress exposure was measured using a validated questionnaire containing 17 items (Siegrist et al. 2004), six of which assessed efforts invested, and 11 of which assessed rewards obtained in terms of (a) salary and job promotion, (b) esteem and (c) job security. To mirror the notion of non-reciprocal exchange at work, the effort–reward ratio (ER ratio) was calculated based on the ratio of both scales. For this ratio, the reward was multiplied by a correction factor to account for the different numbers of items in the numerator and the denominator. An ER ratio >1 indicates that efforts are higher than rewards.

Covariates

Socio-demographic data and socioeconomic situation

Gender and age were considered as relevant socio-demographic variables. Education and job position were added as indicators of socioeconomic position. Education was assessed according to the International Standard Classification of Education (ISCED-97) (OECD 1999). The ISCED-97 considers general, vocational and academic degrees on six levels. Levels of education were categorised as low (ISCED-97 <4) or high (ISCED-97 ≥ 4). As for the participants' job position, blue- and white-collar workers were distinguished. Educational level and job position were aggregated, and white-collar workers with higher educational level were categorised as persons with higher socioeconomic status (SES).

Social inclusion

Family status and level of perceived social support were used as indicators of social inclusion. Regarding family status, we distinguished between singles, persons with a partner but without children and partnered persons with children. Social support was assessed using four items of the Social Support Questionnaire by Fydrich et al. (1999). These items refer to emotional and practical support (e.g. knowing who to contact when depressed) and were measured on a five-point scale. Item scores were summed, so higher values represent higher social support.

Health-related behaviour

Physical exercise (at least 2 h per week, less than 2 h per week), cigarette smoking (never smoker, current/former smoker) and body mass index (BMI <25 kg/m^2, BMI ≥ 25 kg/m^2) were selected as relevant indicators of health-related behaviour. These variables were aggregated to an index of health-related behaviour with values from 0 to 3, so that higher values represent a healthier life style.

Physical demands

Physical demands were assessed using a list of different occupational tasks. This list was a shortened version of the instrument that was used in the German Cardiovascular Prevention Study (GCP Study Group 1988). Responders were asked to state how demanding these tasks were (not demanding, little, strong, very strong). Principal components factor analysis identified six items that described primarily physical demands such as carrying heavy loads or working in physically awkward positions. These items were summed to yield an index score. As for its skewed distribution, this score was dichotomised using the upper tertile as the cut-off point, whereby scores ≥ 3 were categorised as high physical work demands.

Psychological job demands and job control

To describe the psychosocial work environment, we assessed both dimensions of Karasek's demand–control model (DCM): psychological job demands and job control (Karasek et al. 1998). Both dimensions of the DCM were operationalised by short proxy measures on a five-point scale. Job control (e.g. getting enough opportunities to use one's abilities) was assessed using four items, and psychological job demands (e.g. working fast or conflicting instructions) were assessed using five items. Scores of these short-form multi-item scales were calculated by averaging the summed non-weighted item sores.

Data analyses

Multivariate analyses of the longitudinal effects of ERI on the dependent variables were performed by estimating linear regression models. Our analyses were based on a three-model approach for each outcome, with the first model adjusting for baseline score, age and gender, the second model additionally adjusting for SES, social inclusion and health-related behaviour, and the third model additionally adjusting for physical demands and indicators of the DCM. Adjustment was done to rule out that the association of ERI and work ability resulted from influences of established risk factors. Independent continuous variables were standardised using a z-transformation, so that the parameter estimates represented the effects on the dependent variables when increasing the independent variables about one standard deviation. Test statistics were regarded as significant if the two-sided P value was <0.05. All calculations were performed with PASW Statistics 18.

Results

Participants

In the first wave of the survey, 6,400 questionnaires were mailed. 341 questionnaires were returned as undeliverable. With only one reminder, 2,092 utilisable questionnaires were returned, corresponding to a response rate of 34.5%. Only full-time blue- and white-collar workers surveyed in the first wave ($n = 1{,}001$) were included in the longitudinal analyses presented here. Unemployed ($n = 401$) and self-employed persons ($n = 211$), persons who were paid a pension for reduced earning capacity ($n = 17$) and persons with part-time employment ($n = 462$) were excluded. Another 62 participants were excluded because of missing data for one of the explanatory variables. Of the 939 remaining responders, 787 (83.8%) consented to participate in a second survey 1 year later. A total of 644 (81.8%) persons responded to the second questionnaire, 41 of whom were excluded because of missing data for one of the dependent variables. As a result, a total of 603 persons (200 women and 403 men) were included in the longitudinal analysis (Fig. 1).

Sample characteristics

The mean age of the participants was 45.8 (SD = 7.6) years, and 66.8% were male. Three-quarters (75.8%) of the sample were white-collar workers. Sample characteristics are summarised in Table 1. The mean work ability scores were 39.6 (SD = 6.9) at baseline and 39.2 (SD = 7.2) at 1-year follow-up. Work ability at follow-up was excellent for 31.8% (baseline 33.5%), good for 39.0% (baseline 37.8%), moderate for 21.9% (baseline 21.9%) and poor for 7.3% of the respondents (baseline 6.8 %). While 20.7% of the respondents experienced a decline in work ability by about at least one category, 19.6% showed improvement. Correlations between work ability, mental health and physical functioning at follow-up indicated that work ability was strongly related to mental health ($r = 0.61$) and physical functioning ($r = 0.67$). Correlation between mental health and physical functioning was moderate ($r = 0.36$).

Longitudinal effects of effort–reward imbalance on work ability

In the longitudinal analysis, a higher ER ratio was significantly associated with decreased work ability over time in all three models (Table 2). After adjusting for baseline work ability, age and gender in Model 1, an increase of the ER ratio about 1 standard deviation decreased the follow-up WAI by about 0.8 points ($b = -0.779$; 95% CI −1.182 to −0.376). Additionally adjusting for SES, social inclusion and health-related behaviour in Model 2 did not

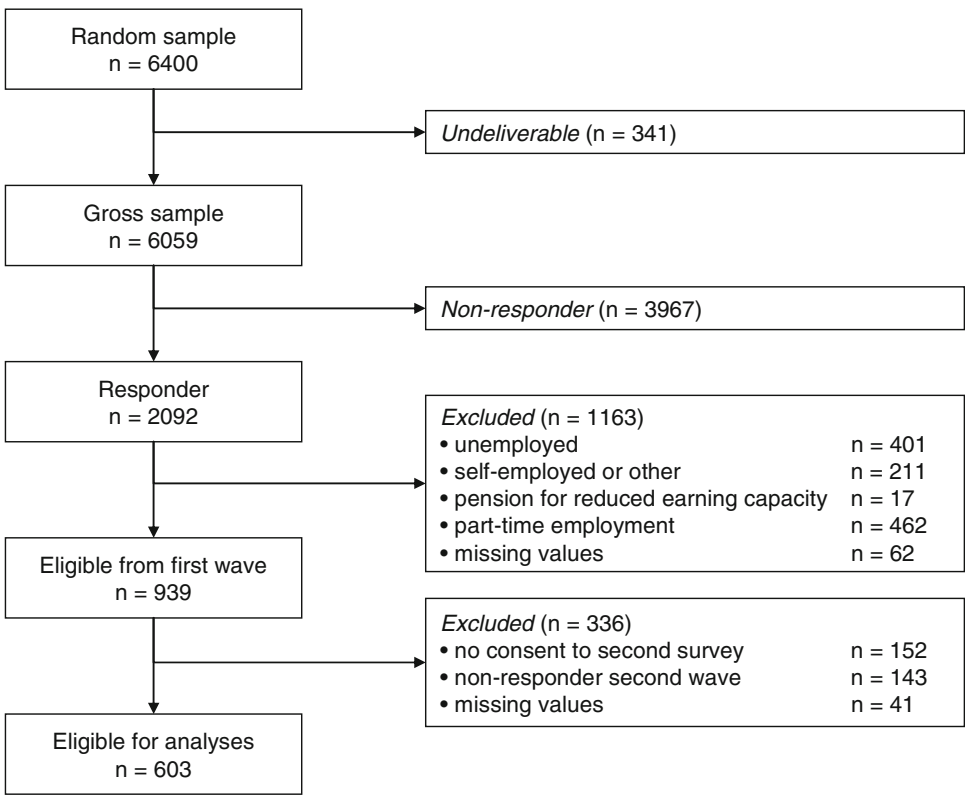

Fig. 1 Flow diagram of participants in the German Sociomedical Panel of Employees, Germany, 2007–2008

Table 1 Descriptive statistics of sample characteristics in the German Sociomedical Panel of Employees, Germany, 2007–2008

Variables		Cronbach's α
Follow-up		
Work ability index, mean (SD)	39.2 (7.2)	0.84
Excellent (%)	31.8	
Good (%)	39.0	
Moderate (%)	21.9	
Poor (%)	7.3	
Mental health index, mean (SD)	72.3 (17.7)	0.89
Physical functioning, mean (SD)	89.1 (15.8)	0.90
Baseline		
Work ability index, mean (SD)	39.6 (6.9)	0.83
Excellent (%)	33.5	
Good (%)	37.8	
Moderate (%)	21.9	
Poor (%)	6.8	
Mental health index, mean (SD)	72.7 (17.4)	0.87
Physical functioning, mean (SD)	90.2 (15.2)	0.89
Age, mean (SD)	45.8 (7.6)	
Gender (% male)	66.8	
Educational level (% low)	41.3	
Job position (% white-collar)	75.8	
SES (% low)	47.6	
Family status		
Single (%)	18.1	
Partner without children (%)	36.3	
Partner and children (%)	45.6	
Social support, mean (SD)	4.4 (0.7)	0.80
BMI ≥25 kg/m^2 (%)	57.2	
Exercise (% at least 2 h per week)	58.4	
Smoking (% never)	44.8	
Health-related behaviour, mean (SD)	1.3 (0.9)	
Physical demands, mean (SD)	2.0 (2.8)	0.74
Physical demands (% high)	29.7	
Effort, mean (SD)	15.7 (4.8)	0.79
Reward, mean (SD)	45.5 (8.1)	0.88
ER ratio, mean (SD)	0.7 (0.3)	
Psychological job demands, mean (SD)	1.2 (0.9)	0.80
Job control, mean (SD)	3.1 (0.7)	0.74

SES Socioeconomic status, *BMI* body mass index, *ER* effort–reward ratio, *SD* standard deviation

$n = 603$

substantially affect the estimated regression coefficient ($b = -0.812$; 95% CI −1.216 to −0.406). Though the final adjustment for physical demands and both indicators of the DCM reduced the regression coefficient, the adverse effect of a high ERI remained significant in Model 3 ($b = -0.512$; 95% CI −1.018 to −0.006). The strongest predictor of follow-up work ability, however, was its baseline measurement. There was also a significant impact of age on work ability, and, though not significant, work ability tended to be lower for respondents with lower SES and higher psychological job demands.

Longitudinal effects of effort–reward imbalance on mental health

Higher ERI-related work stress exposure was also significantly associated with lower mental health (Table 3). In the fully adjusted model an increase of the ER ratio about 1 standard deviation was associated with a reduction in mental health by 2 points ($b = -2.026$; 95% CI −3.483 to −0.568). The strongest predictor in the final model was baseline mental health. Furthermore, women had lower mental health after 1 year. Additionally, both indicators of the DCM helped explaining follow-up mental health: Higher job control was associated with better mental health, and, though not significant, follow-up mental health tended to be lower for respondents with higher psychological job demands.

Longitudinal effects of effort–reward imbalance on physical functioning

Higher ERI-related work stress exposure was significantly associated with lower physical functioning in the first two models (Table 4). However, adjusting for the indicators of the DCM reduced the parameter estimate that represented the effect of ERI-related work stress. Though physical functioning further tended to be lower with a higher ER ratio, the parameter estimate was no longer significant ($b = -1.186$; 95% CI −2.411 to 0.040). The strongest predictor was baseline physical functioning. Moreover, lower SES and higher psychological job demands were significantly associated with decreased physical functioning at follow-up. Additionally, physical functioning tended to be lower for older people.

Discussion

The aim of our study was to analyse the longitudinal effects of ERI on work ability, mental health and physical functioning. After adjusting for baseline scores, age and gender as well as for indicators of socioeconomic status, social inclusion and health-related behaviour, a high ER ratio had an adverse effect on all outcomes. In case of work ability and mental health, this also held true after additionally adjusting for other factors of the work environment (physical demands, job control and psychological job demands), indicating that reciprocity and fairness at work, as operationalised by Siegrist's ERI model, have a relevant

Table 2 Results of linear regression analysis: effects of effort–reward imbalance on work ability in the German Sociomedical Panel of Employees, Germany, 2007–2008

	Model 1		Model 2		Model 3	
	b	95% CI	*b*	95% CI	*b*	95% CI
WAI baseline	5.177***	4.768; 5.586	5.102***	4.672; 5.531	4.985***	4.532; 5.438
Gender: female	−0.304	−1.047; 0.439	−0.156	−0.941; 0.628	−0.173	−0.958; 0.612
Age	−0.459*	−0.816; −0.102	−0.413*	−0.781; −0.045	−0.449*	−0.821; −0.077
SES: low			−0.704‡	−1.432; 0.024	−0.768‡	−1.535; 0.000
Family: single			−0.546	−1.555; 0.463	−0.488	−1.500; 0.525
Family: partner without children			−0.495	−1.288; 0.297	−0.466	−1.259; 0.327
Social support			−0.207	−0.575; 0.160	−0.222	−0.591; 0.147
Health-related behaviour			0.139	−0.239; 0.516	0.099	−0.281; 0.479
Physical demands: high					−0.294	−1.201; 0.613
Psychological job demands					−0.421‡	−0.911; 0.070
Job control					0.091	−0.315; 0.498
ER ratio	−0.779***	−1.182; −0.376	−0.812***	−1.216; −0.408	−0.512*	−1.018; −0.006
R^2	0.633		0.638		0.640	

Model 1: adjusted for baseline score, age and gender. Model 2: additionally adjusted for SES, indicators of social inclusion and health-related behaviour. Model 3: additionally adjusted for physical demands and indicators of the demand–control model

WAI Work Ability Index, *SES* socioeconomic status, *ER ratio* effort–reward ratio, *b* unstandardised parameter estimate, *CI* confidence interval

$n = 603$; ‡ $p < 0.1$; * $p < 0.05$; *** $p < 0.001$

Table 3 Results of linear regression analysis: effects of effort–reward imbalance on mental health in the German Sociomedical Panel of Employees, Germany, 2007–2008

	Model 1		Model 2		Model 3	
	b	95% CI	*b*	95% CI	*b*	95% CI
MH baseline	10.744***	9.614; 11.874	10.705***	9.497; 11.912	10.233***	8.985; 11.481
Gender: female	−2.277*	−4.464; −0.090	−2.580*	−4.912; −0.248	−2.647*	−4.971; −0.323
Age	−0.450	−1.469; 0.570	−0.581	−1.648; 0.485	−0.616	−1.684; 0.451
SES: low			0.939	−1.181; 3.059	0.749	−1.489; 2.987
Family: single			0.050	−2.907; 3.006	−0.065	−3.021; 2.891
Family: partner without children			1.294	−1.031; 3.618	1.368	−0.949; 3.685
Social support			0.067	−1.056; 1.190	0.064	−1.059; 1.187
Health-related behaviour			0.227	−0.862; 1.316	0.160	−0.937; 1.258
Physical demands: high					1.749	−0.898; 4.397
Psychological job demands					−1.440‡	−2.881; 0.001
Job control					1.201*	0.017; 2.385
ER ratio	−2.799***	−3.921; −1.677	−2.824***	−3.951; −1.697	−2.026**	−3.483; −0.568
R^2	0.487		0.489		0.496	

Model 1: adjusted for baseline score, age and gender. Model 2: additionally adjusted for SES, indicators of social inclusion and health-related behaviour. Model 3: additionally adjusted for physical demands and indicators of the demand–control model

MH Mental health, *SES* socioeconomic status, *ER ratio* effort–reward ratio, *b* unstandardised parameter estimate, *CI* confidence interval

$n = 603$; ‡ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

impact on work ability independent of and above that of other known explanatory variables. Moreover, the significant effect of the continuous ER ratio indicates an exposure–response relationship between ERI and WAI. The results of our study therefore complement existing cross-sectional study findings about the association between ERI and work ability by providing a longitudinal perspective.

Age was also a relevant predictor of follow-up work ability. Comparing the strength of associations, however,

Table 4 Results of linear regression analysis: effects of effort–reward imbalance on physical functioning in the German Sociomedical Panel of Employees, Germany, 2007–2008

	Model 1		Model 2		Model 3	
	b	95% CI	*b*	95% CI	*b*	95% CI
PF baseline	10.073***	9.121; 11.025	9.968***	9.007; 10.929	9.901***	8.938; 10.864
Gender: female	1.150	−0.721; 3.021	1.340	−0.617; 3.298	1.253	−0.684; 3.190
Age	−0.849‡	−1.761; 0.063	−0.800‡	−1.732; 0.132	−0.836‡	−1.766; 0.094
SES: low			−3.257***	−5.062; −1.453	−3.961***	−5.853; −2.069
Family: single			0.270	−2.248; 2.787	0.559	−1.939; 3.057
Family: partner without children			0.683	−1.301; 2.667	0.759	−1.203; 2.721
Social support			−0.273	−1.182; 0.635	−0.278	−1.185; 0.628
Health-related behaviour			0.399	−0.533; 1.331	0.160	−0.772; 1.092
Physical demands: high					−1.492	−3.739; 0.754
Psychological job demands					−2.247***	−3.448; −1.045
Job control					−0.591	−1.571; 0.389
ER ratio	−2.859***	−3.779; −1.939	−2.786***	−3.703; −1.869	−1.186‡	−2.411; 0.040
R^2	0.524		0.537		0.550	

Model 1: adjusted for baseline score, age and gender. Model 2: Additionally adjusted for SES, indicators of social inclusion and health-related behaviour. Model 3: Additionally adjusted for physical demands and indicators of the demand–control model

PF Physical functioning, *SES* socioeconomic status, *ER ratio* effort–reward ratio, *b* unstandardised parameter estimate, *CI* confidence interval
$n = 603$; ‡ $p < 0.1$; * $p < 0.05$; *** $p < 0.001$

our results evidently illustrate that adverse effects of the psychosocial work environment as described by the ERI model and the DCM are stronger than the effect of ageing. Regarding other work-related factors, we could not confirm an association between physical demands and work ability. This is in contrast to the findings of the review by van den Berg et al. (2009), and might be due to our mainly white-collar sample with relatively low physical demands. For our analyses, high physical demands were defined by sample distribution. But even when we used the upper tertile as threshold, high demands were not high in an absolute manner. Consequently, the psychosocial work environment of our white-collar workers sample had a higher impact on work ability, mental health and physical functioning than physical demands. The strongest effects of the psychosocial work environment were on mental health. Moreover, we identified a low SES as a risk factor for work ability especially for physical functioning.

However, careful consideration of the limitations of our study is needed when interpreting the results for the following reasons:

1. The response rate of the first wave was low and, though small, differences between responders and non-responders in age and gender indicated that the sample was not fully representative of all eligible subjects (Bethge et al. 2009). Another potential selection bias could have been introduced due to the fact that drop-out after the first wave was linked to characteristics of the participants. Additional analyses indicated differences between responders and non-responders of the second wave concerning some baseline characteristics. However, there were no differences in baseline scores for the examined outcomes or ER ratios.
2. Modelling the adverse effects of ERI was restricted to single-point measurement of the explanatory variable. Therefore, the estimated regression coefficients might have been underestimated as the time of exposure is relevant to establish causal relations, and measures of continuous exposure to ERI seem to be stronger predictors of adverse effects than single-point measures (Godin et al. 2005).
3. The measurements of ERI, work ability and health-related quality of life were based on self-reported data. Consequently, they are susceptible to reporting bias.
4. Due to the specific sample characteristics (inclusion of mainly male white-collar workers), careful replication of the study in different samples and other welfare systems are needed for generalisation of the results.

Despite these limitations, our results are in line with recent evidence of adverse effects of ERI on self-rated health, mental health and cardiovascular diseases. Overall, these results indicate that an adequate effort–reward balance at work is a crucial dimension of good work. In this context, the ERI model offers options to promote work ability at the individual, interpersonal and organisational level (Siegrist 2005).

Interventions at the individual level can involve identifying and challenging irrational reward beliefs, coping with

job insecurity, managing conflicts with supervisors and colleagues, reducing overcommitment and perfectionism, learning self-assertion and relaxation techniques, and developing a balanced ratio of work and private life. Such individual-level interventions have proven to be effective in both primary intervention (Limm et al. 2011) and rehabilitation (Bethge et al. 2011).

While individual-level interventions focus on coping with the existing stressors (e.g. reducing overcommitment in order to rebalance efforts and rewards), interventions at the interpersonal or organisational level can be designed to modify stressors of an adverse work environment more directly. For instance, Bourbonnais et al. (2006) described a participatory intervention approach in an acute care hospital in Canada. Following the concepts of German health circles, a multi-professional team of staff members and researchers identified 56 intervention targets and developed proposals for solutions. For example, perceived inequities in access to training sessions (target) were overcome by annual training plans that were available for all (recommended solution), and the low esteem of beneficiary attendants and their feelings of being at the bottom of the social ladder (target) were overcome by job enrichment and training (recommended solution). This controlled trial demonstrated that ERI decreased after 1 and 3 years in the intervention group compared to the controls and showed that most of the recommended solutions could be permanently implemented (Bourbonnais et al. 2011).

Future epidemiological research within the framework of the work ability concept should examine leadership, personal management and other aspects of work organisation and their impact on work ability (van den Berg et al. 2009). For example, there is increasing evidence that procedural and relational injustice have adverse health effects (Kivimaki et al. 2006; Nieuwenhuijsen et al. 2010), but studies concerning associations between procedural and relational injustice and work ability are lacking. According to established recommendations, these studies should have a longitudinal design and should make use of established theory-guided multi-item measures when operationalising potential risks or protective factors that could affect work ability.

In conclusion, the exposure to ERI was associated with decreased work ability after 1 year. Moreover, the impact of work stress by ERI was independent of and above that of other known explanatory variables. Individual, interpersonal and organisational level interventions that enable to cope with ERI or address indicators of ERI directly could support maintenance of work ability.

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Conflict of interest The authors declare that they have no competing interests.

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