The Causal Structure of the Effort-Reward Imbalance Model and Absenteeism in a Cohort Study of German Employees

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Abstract

The present study contributes to previous research by assessing the validity of the causal structure of the Effort-Reward Imbalance model in relation to the psychosocial mechanisms involved in sickness absenteeism. To this end, data from the German Cohort Study on Work, Age, Health and Work Participation are analysed (lidA Study, $n = 6,270$). The main hypotheses concerning short- and long-term sick-leave rates are investigated with six hurdle regression models. The results suggest that a high effort-reward imbalance, and high efforts and low rewards at work are associated with an increasing likelihood of sick leave. However, the combination of high effort-reward imbalance and high overcommitment was associated with lower sick-leave rates, in contradiction to the hypothesis postulating cumulative adverse effects of increased effort-reward imbalance and high overcommitment on health-related outcomes. Long-term sick-leave rates among workers of higher occupational and educational status were substantially lower in comparison to those among workers of lower status categories. Even though most hypotheses of the Effort-Reward Imbalance model are suitable for explaining the patterns of absenteeism in this sample, the results point to more complex motivational processes and socioeconomic characteristics of employees moderating and mediating the associations between perceived efforts and rewards at work and absenteeism.

Keywords Sick leave · Work stress · Cohort study

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Introduction

The Effort-Reward Imbalance model (ERI) is one of the most frequently investigated job-stress models in occupational health (Siegrist, 2016). The model, originally proposed in the mid 1990's (Siegrist, 1996b), states that the experience of lack of reciprocity in terms of high efforts and low rewards at work elicit negative emotions and stress reactions afflicting the individual health and well-being of workers (Siegrist, 2016). According to the ERI model, a lack of social reciprocity in the work environment reflects thus the imbalance between the extrinsic efforts demanded from the individual workers, and three types of experienced rewards at work, namely, financial rewards (salary or wages), rewards in terms of the social status (career promotion or job security), and socio-emotional rewards (esteem or recognition of one's work performance). In addition, according to the ERI model, the experienced (im)-balance between efforts and rewards is assumed to be influenced by the intrinsic motivation of individual workers to commit themselves to the fulfilment of the extrinsic demands implied by the job assignment or the organisational control structure. From the perspective of the stress-coping theories of the 1980's and 1990's, the ERI model posits that the failure to withdraw from work obligations is a form of health-adverse coping pattern, or "overcommitment" (Siegrist, 1996b). Therefore, the degree of overcommitment to one's job duties is expected to moderate the relationship between the experience of lacking reciprocity at work and health outcomes (Siegrist, 2016). In summary, the causal structure of the ERI model postulates that (i) each single dimension of the model, namely, efforts, rewards and overcommitment, have a large impact on health, (ii) the ratio of effort and rewards (the so-called ERI ratio) has an additional explanatory power over the single effort and reward dimensions, and (iii) the degree of overcommitment moderates the associations between the ERI ratio and health outcomes (Siegrist, 2016).

However, in spite of being one of the most influential job-stress models, an investigation of the validity of the whole causal structure of the ERI model has been less frequently conducted in empirical research, especially concerning the moderating role of overcommitment (Siegrist & Li, 2016). While the expected associations between effort, reward, the ERI ratio and health have received some support in previous reviews focusing, for instance, on health indicators of cardiovascular and cardiometabolic risk (Backé et al., 2012; Kivimäki et al., 2018; Eddy et al., 2017; Tsutsumi & Kawakami, 2004), the results concerning the moderation hypothesis of overcommitment for health indicators such as psychosomatic complaints, blood pressure, physical health and depressive symptoms have been more heterogeneous (Siegrist & Li, 2016; Koch et al., 2014). Thus, the exploration of the causal structure of the ERI model is needed not only to assess the adequacy of the postulated psychosocial mechanisms in accounting for the perception of job-related stress, but also to guide the design of effective workplace interventions addressing specific stressors in the work environment.

On the other hand, one of the most important and complex outcomes in occupational health research is sickness absenteeism which has a profound impact on the work processes of organisations. Even though sickness absences are usually related to medical conditions, the frequency and length of sick-leave spells depend also on the

characteristics of the work environment, the definition of work tasks, personal socioeconomic constraints and several work-related emotional and motivational processes related to the decision to attend to scheduled work (Montano, 2020). In particular, psychosocial characteristics of the work environment leading to increased activation of stress responses such as high workload, role ambiguity and role conflict have been found to be associated with higher levels of absenteeism in a previous meta-analytic study (Bowling et al., 2015). Concerning the ERI model, some previous findings point to substantial associations between absenteeism patterns, the ERI ratio, high efforts and low rewards (Ala-Mursula et al., 2005; Godin & Kittel, 2004; Götz et al., 2018; Ndjaboue et al., 2014). Nonetheless, the causal structure of the ERI model regarding absenteeism does not seem to have been investigated so far according to the results of a relatively recent systematic review (Siegrist & Li, 2016), despite the fact that the theoretical background of the ERI model relies on affective and motivational coping processes which may have a large effect on the frequency and spell length of sickness absences. Hence, the present study contributes to previous research by assessing the validity of the causal structure of the ERI model in relation to the psychosocial mechanisms involved in sickness absenteeism. In this respect, the present study is a sort of “replication study” investigating the extent to which the original hypotheses of the ERI model are adequate to explain absenteeism patterns in a large sample of German employees. A detailed description of the theoretical rationale behind the ERI hypotheses has been provided elsewhere (Siegrist, 1996a, 1996b, 2005, 2016).

Research Hypotheses

According to a recently proposed psychosocial theory of sick leave, the likelihood of employees attending to scheduled work is driven by three major factors: (i) work-specific determinants resulting from organisational and task-related processes, (ii) the effects on the organism and the reactions, coping and adaptive behaviour of employees, and (iii) different mediators and moderators at the individual and societal level (e.g., earnings, education, occupation, age, social policy regulations, etc.) (Montano, 2020). Since the causal structure of the ERI model pertains first of all the socio-emotional experiences of employees (Siegrist, 2005), it can be expected that increasing levels of emotional distress and the inability or failure to cope and adapt to stressful constraints of the work environment would result in employees reporting an increasing number of sick-leave days. Thus, regarding sick-leave as a work-related health indicator, the causal structure of the ERI model implicates the following research hypotheses (H1 to H3, see Fig. 1):

Hypothesis 1 (H1) (a) High efforts, (b) low rewards and (c) high overcommitment at work are positively related to the number of sick-leave days.

Hypothesis 2 (H2) An increased ERI ratio is associated with an increasing number of sick-leave days, and shows a larger explanatory power in comparison to the effort and reward scales taken individually.

Fig. 1 Causal structure of the Effort-Reward Imbalance model and corresponding research hypotheses (H). +: positive association; -: negative association. Adapted from (Montano et al., 2016)

Hypothesis 3 (H3) The degree of overcommitment moderates the association between the ERI ratio and the number of sick-leave days, so that the combination of high overcommitment and high ERI ratio levels are associated with particularly higher rates of sickness absence.

Furthermore, as postulated in the psychosocial theory of sick leave, the decision to attend to scheduled work is also the result of the health status, gender-specific tendencies, financial requirements of households, educational level, occupation or contractual employment arrangements (Montano, 2020). Hence, after controlling for some of these sociodemographic and occupational variables, the magnitude of the marginal effects of the ERI dimensions on sickness absenteeism are expected to reflect more reliable effect-size estimates. In particular, previous findings suggest that women and men differ regarding their attitudes and motivations to attend work due to factors such as gender-specific job satisfaction, household commitments or perceived responsibilities (VandenHeuvel & Wooden, 1995; Ichino & Moretti, 2009). Similarly, the causal role of education, occupation and health status on sickness absenteeism has received consistent support from studies investigating sick-leave rates in large samples of employees in Finland and Norway (Airaksinen et al., 2018; Madsen, 2019). Against this background, the research hypotheses of the present study consider the following set of control variables contributing to explained variance: education, earnings, profession, employment status, gender and the self-rated health status.

Methods

Data and variables

The German Cohort Study on Work, Age, Health and Work Participation (lidA Study) is a population study of employed individuals born in either 1959 or 1965 and subject to social security contributions in Germany (Hasselhorn et al., 2014). The data considered in the present investigation correspond to the first lidA wave collected in 2011 and comprises 6,270 records (47% males, 53% females). Participants were sampled from the “Sample of Integrated Labour Market Biographies” dataset held by the German Institute for Employment Research (IAB) (Dorner et al., 2010), which itself is a random sample of all employees subject to social security contributions in Germany. The components of the Effort-Reward Imbalance model were measured with the long version of the ERI-Questionnaire comprising three scales: job efforts (six items), job rewards (11 items) and overcommitment (six items) (Siegrist et al., 2004). The answer format of the effort and reward items consists of a two-step procedure: First, participants are asked whether they agree or disagree to the item’s content (“no, I don’t agree”/ “yes, I agree”), and, subsequently, they are asked to evaluate the extent to which they feel distressed by the work situation described by the item’s content (1: not distressed, 2: somewhat distressed, 3: distressed, 4: very distressed). Following the scoring recommendation proposed by the psychometric study of Tsutsumi et al. (2008), the answer category “no, I don’t agree” from the first step, was collapsed with the “not distressed” category from the second step, yielding thus four-point Likert items for the effort and reward scales. The overcommitment scale consists of four-point Likert items rated as follows: 1: strongly disagree, 2: disagree, 3: agree, 4: strongly agree. The scores of the effort, reward and overcommitment scales were calculated as mean scores ranging from 1 to 4, if at least 70% of the items defining the scale were answered. This simple scoring procedure represents a sort of “self imputation” and yields satisfactory results under the conservative assumption of up to 30% missing items per record (Schafer & Graham, 2002). Higher scores of the effort and reward scales point to higher efforts and low rewards at work, respectively. The effort-reward ratio (ERI ratio) was calculated by dividing the effort and the (reversed) reward mean scores, so that higher scores indicate a higher effort-reward imbalance.

Education was operationalised following the CASMIN classification with three educational levels: basic education, intermediate and maturity (Brauns et al., 2003). Earnings were measured with five income levels: < 1,000 EUR, < 2,000 EUR, < 3,000 EUR, and $\geq$ 3,000 EUR per month. Since information on earnings usually has high non-response rates, an additional category “refused” was explicitly considered in order to adjust for missing values on earnings. Occupation was operationalised with the ISCO 2008 major occupational classes: managers (ISCO-1), professionals (ISCO-2), technicians (ISCO-3), clerical workers (ISCO-4), service and sales (ISCO-5), skilled agricultural occupations (ISCO-6), craft and trades (ISCO-7), plant and machine operators (ISCO-8), elementary occupations (ISCO-9) and other non-classifiable occupations (ILO, 2012). Employment status corresponded to three levels: full-time, part-time, and other employment arrangements. The all-cause number of sick-leave days was measured by self-report with the item: “Over the past 12

months how many days did you not attend work due to illness?”. The perceived health status was measured with the single item: “How would you describe your current health status?” (1: very good, 2: good, 3: fair, 4: not so good, 5: poor).

Statistical Analysis

The research hypotheses were investigated with the so-called hurdle models which take into account that the observed frequencies of sick-leave days include more zeros than theoretically expected from count data processes, such as the simple Poisson process (Mullahy, 1986; Atkins et al., 2013; Zeileis et al., 2008). Hurdle models of the number of sick-leave days Y consist of a mixture of two distributions: a binomial f_b , and a truncated Poisson distribution f_p with $Y > 0$, accounting for the binomial or zero-inflation and the count processes, respectively. The hurdle distribution f_u is thus specified as:

$$f_h(y; x, \beta, \theta) = \begin{cases} f_b(0; x, \theta), & y = 0 \\ \frac{(1 - f_b)f_p(y; x, \beta)}{1 - f_p(0; x, \beta)}, & y > 0 \end{cases} \quad (1)$$

where θ and β are regression and variance components parameters, and x a set of predictors. The regression coefficients of the binomial distribution correspond to the odds ratios of a typical logistic regression, whereas the incidence rate ratios are obtained from the truncated Poisson distribution (i.e., sick-leave days for which $Y > 0$). In the context of absenteeism research, the interpretation of the hurdle models is straightforward: Whereas the regression coefficients of the binomial process correspond to the odds-ratio estimates of short-term absence spells, the corresponding rate estimates of the count process represent long-term spells, i.e., the number of days absent from work once workers are on sick leave. In this manner, the hurdle models allow the identification of patterns of associations specific to short- and long-term sickness absence spells regarding the same set of dependent variables.

According to the research hypotheses described in the preceding section, the following six hurdle regression models were specified:

$$Y \sim \alpha_1 EFF + \alpha_2 REW + \alpha_3 SEX \quad (M1)$$

$$Y \sim \alpha_1 EFF + \alpha_2 REW + \alpha_3 SEX + \alpha_4 \mathbf{X}^T \quad (M2)$$

$$Y \sim \alpha_1 ERI + \alpha_2 SEX \quad (M3)$$

$$Y \sim \alpha_1 ERI + \alpha_2 OC + \alpha_3 SEX \quad (M4)$$

$$Y \sim \alpha_1 ERI + \alpha_2 OC + \alpha_3 (ERI \times OC) + \alpha_4 SEX \quad (M5)$$

$$Y \sim \alpha_1 ERI + \alpha_2 OC + \alpha_3 (ERI \times OC) + \alpha_4 SEX + \alpha_5 \mathbf{X}^T, \quad (M6)$$

with ERI = effort-reward ratio, OC = overcommitment, EFF = efforts, and REW = rewards. The transpose design matrix $\mathbf{X}^T$ represents a $(5 \times n)$ -matrix with the following five control variables: education, earnings, vocational training, employment and health status. The regression coefficients α_i , $i = 1, \dots, 5$ are reported in their exponential form as $\exp(\alpha)$, and represent the odds ratios and incidence rates of the binomial and count processes, respectively.

It should be kept in mind that the specification of the statistical models M1 to M6 is not the most parsimonious way of assessing main and interaction effects. This is due to the fact that the regression models translate the causal assumptions stated in the theoretical formulation of the ERI model in the form of statistical equations. The theoretical formulation of the ERI model actually implies the estimation of four main effects, namely, efforts, rewards, overcommitment and the ERI ratio (a linear combination of efforts and rewards), plus the interaction effects of the ERI ratio and overcommitment. Overall, after consideration of the contribution of the control variables to explained variance, at least six regression equations are required. The regression models M1, M3 and M4 investigate the main effects of the effort, reward, overcommitment and the ERI ratio (hypotheses H1a-c and H2). The assumption that the ERI ratio shows a larger explanatory power than the effort and reward dimensions (hypothesis H2), is evaluated by performing a likelihood-ratio test of models M3 and M1, with the null hypothesis of the ERI ratio being as predictive of sick-leave days as the single effort and reward scales. Model M4 investigates, at the same time, the assumption that the main effects of the ERI ratio is positively associated with

Table 1 Descriptive statistics of the lidA sample

Variable	Statistics
Males	47%
Females	53%
Basic education	27%
Intermediate education	41%
Maturity	32%
ISCO-1	6%
ISCO-2	18%
ISCO-3	28%
ISCO-4	12%
ISCO-5	10%
ISCO-7	11%
ISCO-8	9%
ISCO-9	4%
Other occupations	2%
Full-time	68%
Part-time	26%
Other employment type	6%
Earnings < 1,000	22%
< 2,000	41%
< 3,000	21%
≥ 3000	11%
Refused	5%

Table 1 (continued)

Variable	Statistics	Correlations				
		Efforts	Low rewards	ERI ratio	Over-commitment	Self-rated health
Efforts	1.70 (0.59), $\alpha = 0.74$					
Low rewards	1.20 (0.30), $\alpha = 0.82$	0.44				
ERI ratio	0.40 (0.15)	0.94	0.64			
Over commitment	2.80 (0.74), $\alpha = 0.82$	−0.54	−0.33	−0.54		
Self-rated health	2.00 (1.48)	0.26	0.25	0.29	−0.23	
Sick-leave days	2.00 (2.97)	0.15	0.16	0.17	−0.09	0.30

Sample size with missings: $n = 6,270$. Statistics: proportions (%) for nominal variables; median and median absolute deviation in parentheses for ordinal variables. Cronbach's α for the ERI scales. Spearman correlations

sick leave (hypothesis H2). Finally, models M2, M5 and M6 evaluate the hypotheses H3 and H4, with the interaction effects $ERI \times OC$ being estimated with centred overcommitment scores in order to avoid multicollinearity. The reported confidence intervals were estimated at the 99% level to reduce the probability of false positives for small effects in large samples (Ioannidis, 2005). P-values are not supplied since they give poor information about the likely result of a future replication (Cumming, 2014). All statistical analyses are performed with the statistical environment R, especially with the estimation routines implemented in the package pscl (Zeileis et al., 2008).

Results

The descriptive statistics of the sample are reproduced in Table 1. In agreement with the research hypotheses H1a-b, high efforts (H1a) and low rewards (H1b) were found to be positively associated with the number of sick leave days (Table 2 and Fig. 2). Nonetheless, as observed in the fully adjusted model M2 (Table 2), the associations of high efforts and low rewards depend on the spell length of sickness absence: Whereas high efforts contribute substantially to longer sickness absence spells (count process), low rewards are important for short-term sick-leave spells (binomial process). Furthermore, hypothesis H1c concerning the main effects of overcommitment was supported by the results of model M4 only in the count, but not in the binomial process (Table 3). Concerning the role of the ERI ratio stated in hypothesis H2, the results support the assumption of a positive relationship between the ERI ratio and

Table 2 Results of the hurdle regression models M1 and M2

Variable	Model M1	Model M2
Count process ($Y > 0$)		
Intercept	8.31 [7.99; 8.64]	4.11 [3.79; 4.46]
Efforts	1.27 [1.25; 1.30]	1.09 [1.07; 1.11]
Rewards	1.24 [1.22; 1.27]	1.01 [0.99; 1.04]
Female (ref. males)	0.97 [0.95; 0.99]	1.00 [0.97; 1.03]
Education: Intermediate (ref. basic)		0.88 [0.86; 0.90]
Maturity		0.83 [0.80; 0.85]
ISCO-2 (ref. ISCO-1)		0.90 [0.85; 0.95]
ISCO-3		1.14 [1.08; 1.21]
ISCO-4		1.14 [1.07; 1.21]
ISCO-5		1.57 [1.47; 1.67]
ISCO-6		1.28 [1.14; 1.43]
ISCO-7		1.20 [1.13; 1.28]
ISCO-8		1.33 [1.25; 1.42]
ISCO-9		1.18 [1.09; 1.27]
Other occupations		1.48 [1.33; 1.65]
Employment: Part-time (ref. full-time)		0.91 [0.88; 0.93]
Other		0.62 [0.57; 0.66]
Income < 2,000 (ref. < 1,000 EUR)		1.23 [1.19; 1.27]
< 3,000		0.94 [0.90; 0.99]
> 3,000		0.70 [0.65; 0.74]
Refused		1.11 [1.05; 1.17]
Poor health status		1.53 [1.51; 1.54]
Binomial process ($Y = 0$)		
Intercept	0.45 [0.34; 0.60]	0.11 [0.06; 0.18]
Efforts	1.32 [1.15; 1.53]	1.03 [0.89; 1.20]
Rewards	1.66 [1.37; 2.01]	1.50 [1.23; 1.83]
Female (ref. males)	1.09 [0.95; 1.25]	1.35 [1.11; 1.65]
Education: Intermediate (ref. basic)		1.04 [0.87; 1.25]
Maturity		1.30 [1.05; 1.61]
ISCO-2 (ref. ISCO-1)		1.44 [1.04; 1.99]
ISCO-3		1.40 [1.02; 1.92]
ISCO-4		1.46 [1.02; 2.08]
ISCO-5		0.99 [0.69; 1.44]
ISCO-6		1.06 [0.48; 2.31]
ISCO-7		1.47 [1.01; 2.14]

Table 2 (continued)

Variable	Model M1	Model M2
ISCO-8		1.19 [0.81; 1.75]
ISCO-9		1.58 [0.99; 2.53]
Other occupations		1.53 [0.69; 3.39]
Employment: Part-time (ref. full-time)		1.02 [0.82; 1.27]
Other		0.56 [0.38; 0.82]
Income < 2,000 (ref. < 1,000 EUR)		1.50 [1.19; 1.90]
< 3,000		1.65 [1.24; 2.22]
> 3,000		1.71 [1.19; 2.46]
Refused		1.26 [0.87; 1.81]
Poor health status		1.64 [1.50; 1.78]
AIC	127320.6	109854.8

The coefficients $\exp(\alpha)$ correspond to the odds ratios and incidence rates of the binomial and count processes, respectively. 99% confidence intervals in brackets

Fig. 2 Marginal effects of the effort and reward scales on the number of predicted sick-leave days obtained from the truncated Poisson distribution of the count process in model M1. The reward levels correspond to 1: strongly disagree, 2: disagree, 3: agree, and 4: strongly agree

Table 3 Results of the hurdle regression models M4 and M5

Variable	Model M4	Model M5	Model M6
Count process ($Y > 0$)			
Intercept	11.37 [10.73; 12.04]	8.93 [8.33; 9.57]	2.65 [2.39; 2.95]
ERI ratio	2.17 [2.09; 2.25]	1.80 [1.71; 1.89]	1.05 [0.99; 1.11]
Overcommitment	1.01 [0.99; 1.03]	1.13 [1.10; 1.16]	1.21 [1.18; 1.24]
ERI x Overcommitment		0.80 [0.77; 0.83]	0.75 [0.72; 0.78]
Female (ref. males)	0.97 [0.95; 0.99]	0.97 [0.95; 0.99]	1.01 [0.98; 1.04]
Education: Intermediate (ref. basic)			0.90 [0.88; 0.92]
Maturity			0.84 [0.81; 0.86]
ISCO-2 (ref. ISCO-1)			0.90 [0.84; 0.95]
ISCO-3			1.14 [1.08; 1.21]
ISCO-4			1.10 [1.04; 1.17]
ISCO-5			1.58 [1.48; 1.68]
ISCO-6			1.25 [1.11; 1.40]
ISCO-7			1.18 [1.11; 1.25]
ISCO-8			1.31 [1.23; 1.39]
ISCO-9			1.15 [1.07; 1.24]
Other occupations			1.46 [1.31; 1.63]
Employment: Part-time (ref. full-time)			0.90 [0.88; 0.93]
Other			0.59 [0.55; 0.63]
Income < 2,000 (ref. < 1,000 EUR)			1.24 [1.20; 1.29]
< 3,000			0.97 [0.93; 1.01]
> 3,000			0.71 [0.67; 0.75]
Refused			1.12 [1.06; 1.18]
Poor health status			1.53 [1.51; 1.55]
Binomial process ($Y = 0$)			
Intercept	0.81 [0.52; 1.27]	1.31 [0.69; 2.52]	0.13 [0.06; 0.29]
ERI ratio	3.57 [2.40; 5.32]	4.15 [2.71; 6.36]	2.41 [1.55; 3.75]
Overcommitment	0.99 [0.88; 1.10]	0.82 [0.66; 1.02]	1.00 [0.79; 1.25]
ERI x Overcommitment		1.50 [1.00; 2.25]	1.29 [0.86; 1.95]
Female (ref. males)	1.10 [0.96; 1.26]	1.11 [0.97; 1.27]	1.35 [1.11; 1.64]
Education: Intermediate (ref. basic)			1.05 [0.87; 1.25]
Maturity			1.33 [1.08; 1.65]
ISCO-2 (ref. ISCO-1)			1.45 [1.05; 2.00]
ISCO-3			1.38 [1.01; 1.90]
ISCO-4			1.47 [1.03; 2.09]
ISCO-5			0.99 [0.68; 1.43]

Table 3 (continued)

Variable	Model M4	Model M5	Model M6
ISCO-6			1.05 [0.48; 2.29]
ISCO-7			1.44 [0.99; 2.09]
ISCO-8			1.17 [0.80; 1.72]
ISCO-9			1.56 [0.97; 2.50]
Other occupations			1.58 [0.71; 3.52]
Employment: Part-time (ref. full-time)			1.01 [0.81; 1.26]
Other			0.57 [0.39; 0.83]
Income < 2,000 (ref. < 1,000 EUR)			1.48 [1.17; 1.88]
< 3,000			1.59 [1.19; 2.13]
> 3,000			1.62 [1.13; 2.31]
Refused			1.22 [0.84; 1.75]
Poor health status			1.67 [1.53; 1.82]
AIC	127165.9	126932.5	109389

The coefficients $\exp(\alpha)$ correspond to the odds ratios and incidence rates of the binomial and count processes, respectively. 99% confidence intervals in brackets

the number of sick leaves in both count and binomial processes (Table 3). Moreover, the hypothesis that the ERI ratio has a larger explanatory power than the single effort and reward dimensions was supported by the significant results of the likelihood-ratio test between models M1 and M3, rejecting the null hypothesis of equal explanatory power ($\chi^2 = 149.43$, $df_{M3} = 6$, $df_{M1} = 8$, $p < 0.001$).

The moderation hypothesis of overcommitment (H3) regarding short-term sickness absences could not be confirmed by the results of the fully adjusted model M6: The increased risk of being in sick leave given a certain ERI ratio level (binomial process in Table 3) was not moderated by overcommitment. Moreover, in contradiction to the assumption of the ERI model, the incidence rates of sick-leave days (count process in Table 3) was negatively moderated by overcommitment, i.e., employees reporting higher levels of overcommitment and effort-reward imbalance reported shorter sick-leave spells than those reporting lower levels (Fig. 3).

A comparison of the results concerning regression models M2 and M6 (Tables 2 and 3) in both the binomial and count processes show substantial decreases of the regression coefficients pertaining the scales of the ERI model, providing evidence of the contribution to explained variance of education, earnings, employment status, gender and health status on sick leave rates. Even though female employees report more frequently ill (binomial process), they do not tend to report much longer sick-leave spells in comparison to male employees (count process). In contrast, large associations were found for professional employees (ISCO-2) with higher education, and higher earnings: These employees tend indeed to report more frequently sick (binomial process), but, once sick, they report a lower number of sick-leave days (count process), in comparison to individuals with basic education and less than 1,000

Fig. 3 Interaction plots of the ERI $\times$ Overcommitment model. Marginal effects on the number of predicted sick-leave days obtained from the truncated Poisson distribution of the count process in model M5. The overcommitment levels correspond to 1: strongly disagree, 2: disagree, 3: agree, and 4: strongly agree.

EUR earnings per month (Tables 2 and 3). On the other hand, individuals working full time reported longer sick-leave spells than employees in part-time or other employment arrangements. Finally, as expected on the basis of the literature discussed in the introduction section, a poor health status was strongly associated with sickness absence both in the short and long term, thereby contributing largely to the explained variance in models M2 and M6.

Discussion

In the present study the validity of the causal structure of the ERI model was investigated in relation to the sick-leave rates in a large cohort of German employees. The results indicate that most of the causal assumptions implicated by the ERI model regarding efforts, rewards and the effort-reward imbalance are suitable for explaining the patterns of absenteeism in this sample: A higher effort-reward imbalance, and high efforts and low rewards at work were found to be associated with an increasing likelihood of sick leave. It should be remarked that the marginal effect-size estimates of the ERI dimensions reported in the present study are expected to be more reliable estimates of the real associations between experienced effort-reward imbalance

and absenteeism, since the explained variance of the ERI dimensions remain rather consistent even after the explicit consideration of the self-reported health status in the regression models. Nonetheless, the role of overcommitment was less consistent. Whereas no associations were observed concerning the main effects of overcommitment on short-term sick-leave spells, these associations were more important in the long term. However, the interaction effect estimates indicate that the combination of high ERI and high overcommitment is associated rather with lower short-term sick-leave rates, in contradiction to the hypothesis of the ERI model postulating cumulative adverse effects on health-related outcomes (Fig. 2). The failure to confirm this moderation hypothesis may be partly explained by the uncertainty of the direction of associations implied in the concept of overcommitment itself. It should be recalled that overcommitment captures the inability to withdraw from work obligations and, consequently, it captures motivational processes as well which must not necessarily be related *per se* to adverse health-related outcomes. Especially for absenteeism, which depends on motivational or attitudinal processes affecting the decision to attend to scheduled work (Halbesleben et al., 2014; Meyer et al., 2002), overcommitment may indicate rather a lower motivation, or an attitudinal tendency not to report ill despite employees being high in effort-reward imbalance. However, the specific cognitive, motivational or personality mechanisms accounting for this tendency are still not clear. On the basis of some research findings it seems that overcommitment is closely related to constructs involving dysfunctional learned coping patterns and dispositional traits such as neuroticism, workaholism or work-related rumination (Avanzi et al., 2020; Vearing & Mak, 2007; Weigelt et al., 2019). Hence, overcommitment may result from the combination of employees having recurrent thoughts on work issues, exposed to high job demands and who, at the same time, tend to be nervous, worried and irritable. The behavioural response of overcommitted individuals would then be manifest by their inability to report sick, even if experiencing mental or somatic symptoms.

This finding seem to agree with previous research focusing on the longitudinal dynamics of the ERI dimensions and revealing that overcommitment is a better predictor of effort-reward imbalance than the opposite (Feldt et al., 2016). Hence, it is likely that the combination of high overcommitment and effort-reward imbalance may foster presenteeism, i.e., attending work while sick, precisely among those experiencing more work-related stress. This observation seems to be supported by the fact that the combination of high effort-reward imbalance and high overcommitment in the lidA sample is much more frequent among the ISCO occupational categories 3 to 9 than 1 to 2, with the means of the interaction term “ERI Ratio $\times$ Overcommitment” being 1.32 and 1.30 vs. 1.19 and 1.20, respectively. As the results of Tables 2 and 3 indicate, employees in ISCO categories 3 and 9 report longer sick-leave spells than managers and professionals in ISCO categories 1 and 2, respectively. Moreover, previous meta-analytic evidence shows that several job-related stressors such as high workload, understaffing, physical demands and time pressure are positively associated with presenteeism (Miraglia & Johns, 2016). Nevertheless, since the dataset of the lidA study provides all-cause sick-leave information only, it was not possible in this study to assess whether overcommitment may be rather related to poor mental health outcomes leading to increased sick-leave spells than to overall absenteeism,

as suggested in two previous studies in Sweden and Germany (Lidwall, 2016; Kunz, 2019).

It is particularly interesting to note that in the 1980's, as the ERI model was being developed, overcommitment was actually thought of as a result of the “fear to lose control”, “either in the form of underestimation of demands and associated overestimation of coping potential, or in the form of overestimation of demands and underestimation of resources” (Matschinger et al., 1986, p. 105). It was assumed back then that the “need of control” formed the cognitive-motivational basis of the individual's coping responses to environmental stressors (Siegrist, 1996a). Moreover, individual workers showing an excessive need of control were expected to be at higher risk of health-adverse outcomes as they would be prone to ignore exhaustion, fatigue, mental or physical symptoms originating from an excessive “overcommitment” to one's job duties (Siegrist, 1996a). However, these health-adverse outcomes were thought to be manifested only in middle adulthood at later stages of the employment career as the ability to cope with stressors depletes with increasing levels of work demands and obligations (Matschinger et al., 1986). From this perspective, the results of the present investigation may provide support to the original notion that both the overestimation of the coping potential and the motivational drive to accomplish one's own job duties increase the likelihood of reporting to work. Therefore, the behavioural result of such motivational and cognitive processes associated with overcommitment would be observed in lower sick-leave rates among workers high on effort-reward imbalance and overcommitment, as reported in the present study.

Furthermore, the results of the regression models M2 and M6 (Tables 2 and 3) point to large effects of health status, education, occupation and employment type, which reveal a more detailed pattern of associations. From the comparison of the binomial and count processes in models M2 and M6 it can be observed that employees with higher education, occupational status and earnings report more frequently short-term sick leave spells, but, at the same time, less frequently long-term absences than their counterparts in the corresponding variable categories. In comparison to managers (ISCO-1), all other workers including technicians (ISCO-3), clerical workers (ISCO-4), service and sales workers (ISCO-5), skilled agricultural workers (ISCO-6), crafts and trades (ISCO-7), plant and machine operators (ISCO-8) and workers in elementary occupations (ISCO-9) reported longer sick-leave spells. These results agree well with the assumptions of the psychosocial theory of sick leave postulating that those characteristics partly reflect (non-observed) working conditions, organisational sick-leave rules for certain occupations or cognitive and attitudinal aspects related to the educational background of employees (Montano, 2020). The fact that increasing earnings are positively associated with short-term, but negatively, with long-term sickness absence (Table 2), illustrates a more complex pattern of associations between work-related rewards and absenteeism, than it was originally conceived in the ERI model (see introduction section). The results suggest that increasing earnings may be an indicator of more favourable organisational rules and working conditions, whereby short absence spells, but not long-term ones, are the most frequent pattern of absenteeism in particular firms (Böckerman et al., 2012). In contrast, lower earnings and occupations in the ISCO categories 3 to 9 associated

with both short and long-term sickness absences would be indicative of adverse work and/or occupational environments associated with more serious health complaints.

Limitations

The present investigation has some limitations. First, although self-reported sickness absences have been found to be valid estimates of record-based measures ($r = 0.73$) (Johns & Miraglia, 2015), there is some tendency to under-report absenteeism largely due to memory constraints in the retrieval of recurring events (Tourangeau et al., 2000). Whereas the under-reporting tendency does not affect the short-term estimates based on the binomial process (absent vs. not absent), the long-term estimates may still have some bias in the point and variance estimates. Second, the lidA data used in the present study is cross-sectional and based on self-reported information which may induce some form of method bias (Podsakoff et al., 2012). However, given that self-reported information on sickness absence is a valid indicator of record-based measures, the magnitude of the potential method bias in the main estimates is not expected to be substantial since they pertain to different domains, namely, assessment of affect-related experiences (ERI dimensions) and retrieval of recurring events in the past 12 months (sickness absences). In addition, data collection on the ERI items and sickness absences are separated from each other and, according to previous research, this may deflate potential biases arising from self-reports or informational clues of item positioning in the questionnaires (Weijters et al., 2009). And third, in order to control for missing data on the ERI items, the so-called “self imputation” method was used to calculate the scores of the effort, reward and overcommitment dimensions. Whereas the proportion of imputed scores for the effort and overcommitment scales was very low (about 4%), the reward scores were imputed in 18% of cases. Nonetheless, the estimates of all regressions models obtained with the non-imputed scores agreed very well with the estimates reported in Tables 2 and 3 (see supplementary file). For instance, the comparison of the interaction effect of the ERI ratio and overcommitment calculated with the imputed and non-imputed scores was 0.75 99% CI [0.72; 0.78] vs 0.79 99% CI [0.76; 0.82], respectively. Hence, the conclusions of the present investigation are not biased by the imputation procedure used in the calculation of the ERI scores.

Conclusion

Even though the present investigation concentrated on the causal structure proposed in the current conceptualisation of the ERI model, the results should be interpreted with some caution due to fact that only cross-sectional data were considered. Although there was evidence partially supporting the main causal hypotheses of the ERI model, further analyses with longitudinal data are required in order to perform more accurate estimations of the potential causal relationships between the ERI dimensions and absenteeism. Notwithstanding, the results point to a more nuanced perspective on the role of the ERI dimensions effort and reward, just as previous research had already suggested regarding potential differential effects of the

reward dimensions on sickness absence (Peter & Siegrist, 1997). In the present study, whereas high efforts seem to increase the likelihood of long-term sickness absence, low rewards seem to be the key characteristic regarding short term-sickness spells. At the same time, in agreement with the assumptions of the ERI model, a more pronounced effort-reward imbalance was confirmed to increase the likelihood of both short- and long-term absenteeism. In general, the results point to more complex motivational processes and socioeconomic characteristics of employees moderating and mediating the associations between perceived efforts and rewards at work and absenteeism.

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Availability of data and material lidA data are available on request as a Scientific Use File from the Forschungsdatenzentrum (FDZ) of the Institute für Arbeitsmarkt- und Berufsforschung at https://fdz.iab.de/de/FDZ_Individual_Data/lidA.aspx.

Declarations

Ethics approval The present investigation is an analysis of data from the German Cohort Study on Work, Age, Health and Work Participation (lidA Cohort Study), which fulfils the requirements of the German data privacy regulations. All participants gave informed consent to the study prior to data collection.

Consent for publication Not applicable.

Competing interests The Authors declare that there is no conflict of interest.

Consent to participate Participation in lidA is voluntary.

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