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RESEARCH ARTICLE

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Effort-reward imbalance at work and weight changes in a nationwide cohort of workers in Denmark

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Abstract

Objective: To investigate the relation between effort-reward imbalance (ERI) at work and subsequent weight changes.

Methods: We included participants from a population-based cohort of workers in Denmark (mean age = 47 years, 54% women) with two (n = 9005) or three repeated measurements (n = 5710). We investigated the association between (a) ERI (ie, the mismatch between high efforts spent and low rewards received at work) at baseline and weight changes after a 2-year follow-up (defined as ≥5% increase or decrease in body mass index (BMI) vs stable), and (b) onset and remission of ERI and subsequent changes in BMI. Using multinomial logistic regression we calculated risk ratios (RR) and 95% confidence intervals (CI), adjusted for sex, age, education, cohabitation, migration background, and follow-up time.

Results: After 2 years, 15% had an increase and 13% a decrease in BMI. Exposure to ERI at baseline yielded RRs of 1.09 (95% CI: 0.95-1.25) and 1.04 (95% CI: 0.90-1.20) for the increase and decrease in BMI, respectively. There were no differences between sex and baseline BMI in stratified analyses. The onset of ERI yielded RRs of 1.04 (95% CI: 0.82-1.31) and 1.15 (95% CI: 0.84-1.57) for subsequent increase and decrease in BMI. The RRs for the remission of ERI and subsequent increase and decrease in BMI were 0.92 (95% CI: 0.71-1.20) and 0.78 (95% CI: 0.53-1.13), respectively. Of the ERI components, high rewards were associated with a lower risk of BMI increase.

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Conclusion: ERI was not a risk factor for weight changes. Future studies may investigate whether this result is generalizable to other occupational cohorts and settings.

KEYWORDS

epidemiology, non-randomized experiment, obesity, observational, occupation, population-based, pseudo-trial, psychosocial work environment, stress, work

1 | INTRODUCTION

Overweight and obesity have a substantial impact on morbidity, mortality, quality of life, and healthcare expenditures and have become a public health concern in many countries.[1-3] To date, interventions targeting weight change and risk factors for overweight and obesity have achieved limited effect at the population level,[4] and new strategies to address current obesity trends are warranted.[5]

Risk factors for overweight and obesity are numerous and include genetics, certain diseases and drugs, environmental, and socioeconomic aspects, as well as experiences of stress.[1,6,7] The hypothesized mechanisms linking work stressors with weight gain are likely multifaceted and may involve a complex interplay of neural processes and subsequent disruption of the regulation of the hypothalamus-pituitary-adrenal axis.[8] This disruption may be causing secretion of cortisol and glucocorticoids, which are involved in the regulation of appetite and obesity.[9] Other potential pathways between work stressors and weight gain include (a) changes in health-related behavior, for instance, consumption of unhealthy food, eating patterns and dietary habits,[10,11] and physical inactivity,[12] and (b) psycho-physiological disturbances such as depressive disorders and sleep disturbances,[13] which are known to be linked with metabolic disturbances. However, studies investigating possible associations between different measures of potential stress-eliciting psychosocial working conditions and risk of weight gain have yielded mixed findings,[14-20] leaving the potential for psychosocial workplace prevention unresolved. Further, previous research has mainly looked at exposure to adverse working conditions measured at one point in time and change in weight at a later point in time. This is a limitation, because the length of time participants have been exposed to the stressor is unknown, which may limit conclusions about temporal relationships. From a public health intervention perspective, this makes it difficult to determine whether onset and remission of adverse psychosocial working conditions are associated with altered risk of weight changes. In addition, previous research has mainly focused on the overall relationship between adverse working conditions and weight change, generally not considering that individuals may respond differently to stressors.[21] The association between stressors at work and weight change may be modified by sex, as some research suggests that stressed men may be at risk of weight increase, whereas women may lose weight.[22] Interactions have also been reported between work stressors and weight. While the effect of work stressors on nonoverweight individuals may be associated with weight loss, individuals with overweight may gain weight.[23]

A widely studied measure of a work-related stressor is the model of effort-reward imbalance (ERI). The ERI model hypothesizes that work conditions, where efforts exceed the rewards received in return, i.e. high cost/low gain situations, cause emotional distress and contribute to increased risk of ill-health.[24] Previous research has shown that ERI is associated with a higher risk of coronary heart diseases,[25] depressive disorders,[26] and diabetes.[27-29] These associations may be mediated by a higher risk of overweight and obesity,[1] but we are aware of only two prospective studies that have examined the association between ERI and weight gain directly.[30,31] Kivimäki et al (2002)[30] studied 812 industrial workers and found an association between high ERI at baseline and slightly higher body mass index (BMI) at 10-year follow-up, compared to those with low ERI at baseline. No interaction was found between ERI and sex. Berset et al (2011)[31] examined 70 Swiss service providers and found a suggestive, albeit statistically nonsignificant association ($P < .1$) between ERI at baseline and risk of higher BMI at 2-year follow-up. Modification by sex was not tested. None of the studies investigated possible interactions of ERI with baseline weight. This is a limitation as to the potential interactions between sex, ERI and baseline weight may be important for guiding future interventions.

In the present study, we investigated the relation between ERI, the components of ERI and weight changes, and tested whether the relationships were modified by sex, baseline weight or both in a population-based cohort of workers in Denmark. To strengthen conclusions about the causal relationship, we used two different analytical approaches. We applied both a two-wave design, assessing exposure at one point in time and change in BMI up to a 2-year follow-up, and a three-wave design investigating onset and remission of ERI and its components and subsequent change in BMI.

2 | METHODS

2.1 | Study design and population

The population under study were participants from the nationwide occupational cohort "Work Environment and Health in Denmark 2012-2020" (WEHD). WEHD was initiated in 2012 and consists of biennial surveys aimed at the general working population in

Denmark, with the purpose of national surveillance of the work environment. Inclusion criteria were (a) employed persons 18 to 64 years of age, (b) liable to pay taxes and registered with an address in Denmark and (c) monthly working hours ≥35 and a monthly income of ≥3000 Danish kroner ($530/€400). In 2012, a letter was sent to a total of 50 796 individuals with a link to an online questionnaire focusing on the work environment, health and health-related behavior. Those not responding were sent a follow-up letter, and subsequently contacted by telephone and finally, a hard copy of the questionnaire was sent out. In 2012, 50% responded and met the inclusion criteria, of which 66% responded again in 2014 and of those, 70% responded again in 2016. Compared to nonrespondents, respondents of wave 2012 were older, had higher education, were more often cohabiting, had less often a migration background, and were more often women (Appendix A). A more detailed description of WEHD is published elsewhere.[32]

We included participants with repeated measurements in waves 2012 and 2014 (n = 10 320) for the two-wave design, and participants with repeated measurements to waves 2012, 2014, and 2016 for the three-wave design (n = 6878). A detailed overview of the criteria for inclusion into the study and illustrations showing the conceptual study designs are presented in Figure 1.

For the two-wave design, we excluded participants with missing data on ERI (n = 675), height and weight (n = 152) and participants with a difference of more than 5 cm in self-reported height between waves (n = 180) or extreme weight change (≥50% decrease or increase, n = 5), that were likely to be reporting or data entering errors, women who in any wave were pregnant at the time of answering the questionnaire, defined as answering within a period of 9 months before or 3 months after the first date of register-based maternity leave (n = 243), and participants with missing data on the covariates (n = 60) yielding an eligible study sample of 9005 participants (Figure 1).

For the three-wave design where we investigated onset and remission of ERI, efforts and rewards and subsequent changes in BMI, we included participants with repeated measurements to waves 2012, 2014, and 2016, and repeated the exclusion process from the two-wave design, yielding a sample of 5710 participants (Figure 1).

There were no considerable differences regarding sex, age, cohabitation status, and migration background between participants who provided data for the two-wave design and participants who provided data for the three-wave design. Participants who provided data for the three-wave design had a slightly higher educational level compared to participants who provided data for the two-wave design (Appendix A).

The study was approved by The Danish Data Protection Agency through the joint notification of the National Research Centre for the Working Environment, Copenhagen, Denmark (no. 2015-57-0074). According to Danish legislation, research projects involving surveys with a questionnaire and register-based data only, do not need approval from The National Committee on Health Research Ethics. We obtained register-based information from Statistics Denmark (no. 706706) and Sundhedsdatastyrelsen ("The Danish Health Authority," no. FSEID-00003251 and no. FSEID-00003281).

2.2 | Effort-reward imbalance

The scales on efforts and rewards in WEHD have previously been described in detail.[29] In short, self-reported efforts at work were measured with a scale consisting of six items (Cronbach's α = .77), assessing time pressure, work pace and work time. Self-reported rewards at work were measured with a scale consisting of five items (Cronbach's α = .67), assessing esteem, financial and career-related rewards, and job security. We included participants with answers to more than half of the items on each scale, that is, ≥4 items on efforts and ≥3 items on rewards, and imputed missing items by the scale mean. We computed sum scale scores with high scores denoting high efforts and high rewards, respectively. We calculated the ERI-ratio in accordance with the literature,[24] by dividing efforts by rewards multiplied by a correction factor of 5/6, to take into account the unequal number of items in the two scales. We defined dichotomous exposures for potential health-hazardous exposure to ERI as scoring in the highest tertile of the ERI-ratio, for high efforts as the highest tertile of the effort-score, and for low rewards as scoring in the lowest tertile of the reward-score, in all analyses.

2.3 | Body mass index

We calculated the median height of each individual across the waves and computed BMI as self-reported weight in kilograms divided by self-reported height in meters squared. We computed relative changes in BMI between 2012 and 2014 (two-wave design) and between 2014 and 2016 (three-wave design), and categorized change with 5% boundaries into "increase," "stable," and "decrease," because 5% change in weight may be of clinical importance.[33] For descriptive purposes, BMI was categorized according to the World Health Organization guidelines into underweight (<18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25-29.9 kg/m^2), and obese (≥30 kg/m^2).

2.4 | Confounders

We linked participants to nationwide registers using a unique personal identification number that is assigned to all residents in Denmark[34] and obtained information about sex, age, socioeconomic status (SES), cohabitation and migration background. All covariates have previously been associated with both work stressors and weight change[1,15,35-37] and were, therefore, considered potential confounders. Age was included as a continuous variable. We defined SES as the highest achieved an educational level in three categories (high, ≥13 years; intermediate, 10-12 years; low, ≤9 years). Cohabitation was defined as either cohabiting or living alone. Having migration background was defined according to the categorization by Statistics Denmark into no (Danish) or yes (immigrant or descendent of an immigrant without Danish citizenship).[38]

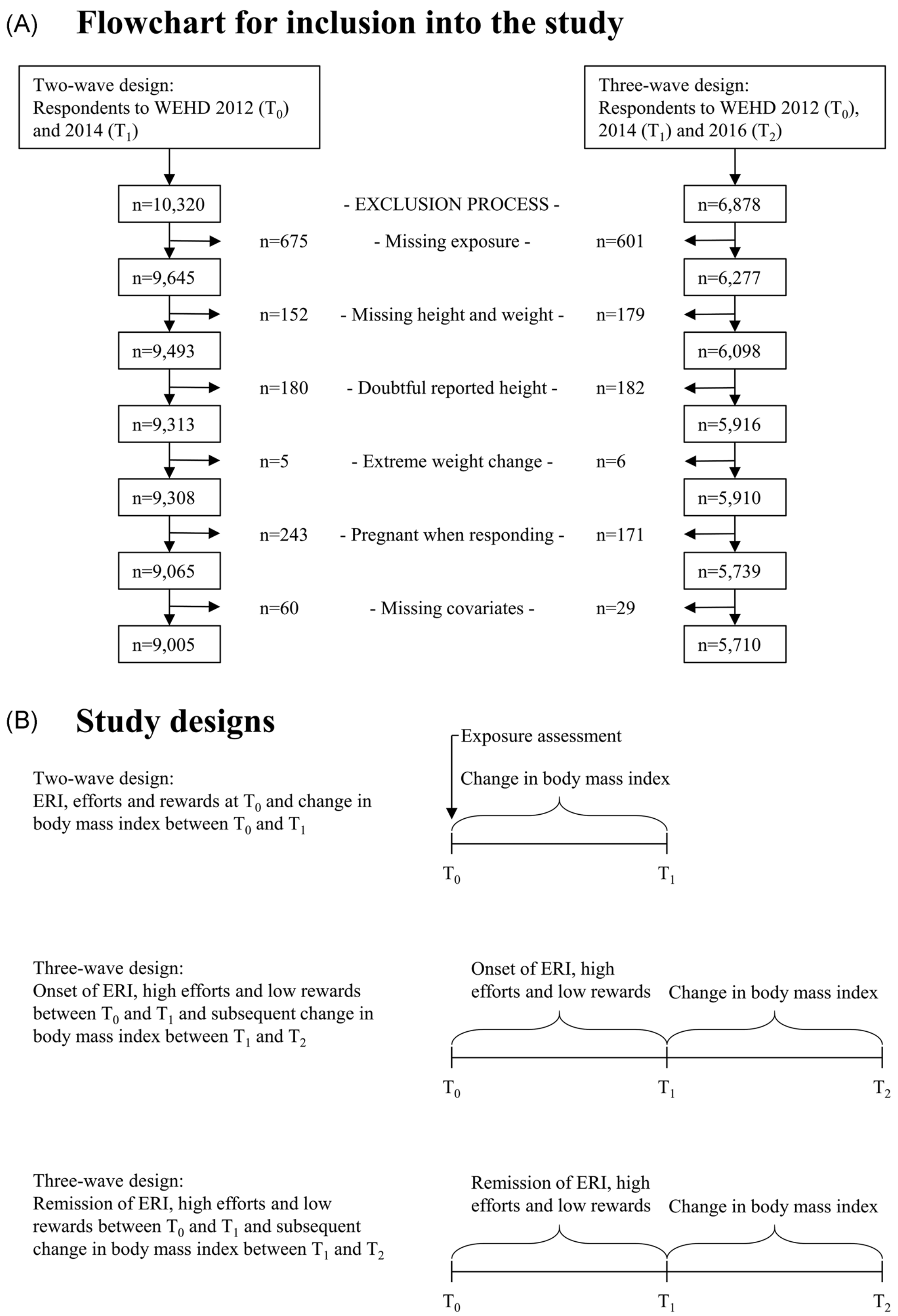

FIGURE 1 Flowchart (A) and overview of study designs (B). ERI, effort-reward imbalance; WEHD, Work Environment and Health in Denmark 2012-2020

2.5 | Statistical analyses

2.5.1 | Two-wave design

An overview of the study design is presented in Figure 1. We examined the associations between ERI, and efforts and rewards at baseline and changes in BMI of 5% or more (increase or decrease vs stable) between baseline and follow-up (two-wave design) in separate multinomial logistic regression models, adjusted for follow-up time between waves (model 1), further adjusted for sex and age (model 2) and further adjusted for baseline measures of educational level, cohabitation, and migration background (model 3). Estimates are presented as risk ratios (RR) with 95% confidence intervals (CI).

To examine whether associations were different for men and women, we repeated model 3 and included interaction terms between sex and ERI, and sex and the ERI components (efforts and rewards) in separate models. Similarly, to test whether associations depended on baseline BMI, we tested the interaction between BMI dichotomized (BMI: <25 kg/m^2; BMI: ≥25 kg/m^2) and ERI, and efforts and rewards. The tests of whether the relationships were modified by sex or baseline weight were performed in the two-wave analyses only, because of concerns about statistical power to also test interactions in the three-wave analyses.

2.5.2 | Three-wave design

An overview of the study designs is presented in Figure 1. In the three-wave design, we analyzed temporal relationships between onset and remission of ERI and subsequent change in BMI, in an effort to emulate the design of an experimental study with the use of observational data.[39] We established the baseline as the date the participants filled in the questionnaire (T_0). When analyzing the onset of ERI and subsequent change in BMI of 5% or more, we excluded participants with ERI at T_0 and the assessed onset of ERI at first follow-up in 2014 (T_1) and subsequent change in BMI between T_1 and second follow-up in 2016 (T_2). Thereby, at baseline, no participant was exposed to ERI and at T_1 we had a group of exposed and unexposed participants. This three-wave design ensured temporal order between the onset of ERI and subsequent change in BMI (Figure 1). We used participants without the onset of ERI at T_1 as a reference. For studying remission of ERI and subsequent change in BMI, we excluded participants without ERI at T_0 and assessed remission of ERI at first follow-up in 2014 (T_1) and subsequent change in BMI between T_1 and second follow-up in 2016 (T_2). Thus, at baseline, all participants were exposed to ERI and at T_1 we had a group of participants with remission of ERI and a group who were still exposed to ERI (Figure 1). When examining the associations between the components of ERI and change in BMI, we repeated the designs and studied onset and remission of high efforts and low rewards, respectively. The three-wave analyses were performed with multinomial logistic regression, with the outcomes "increased" and "decreased" compared to "stable BMI." Since exposure to ERI, efforts, and rewards were not assigned at random, as it would have been in a randomized trial, we adjusted for potential confounders to take into account possible nonexchangeability between those with and without onset and remission of the exposures, and adjusted for follow-up time (model 1) and baseline values of sex and age (model 2), and educational level, migration background, and cohabitation (model 3). Estimates are presented as RR with 95% CI.

2.5.3 | Sensitivity analyses

In sensitivity analyses, we repeated the main analyses from the two-wave and three-wave design while excluding participants with extreme values of BMI (<15 and >50 kg/m^2) as these extreme measures may have been due to reporting or data entering errors. Concerns have been raised regarding potential underlying common causes of work stressors and weight change, which may include depressive symptoms that may affect both reporting of work stressors and weight,[17,40] and therefore mental health may be adjusted for when estimating the relation between work stressors and weight change. Further, smoking may be associated with feelings of relaxation or may act as a coping mechanism to work stressors and may, therefore, mitigate perceived work stressors. Smoking may also be associated with appetite regulation and, therefore, may influence one's weight. However, mental health and smoking may also be on the causal pathway from ERI to weight change and in this case, should not be adjusted for. To investigate the influence of mental health and smoking, we further adjusted model 3 for symptoms of depression, measured with baseline values of the Major Depression Inventory (MDI) (continuous), and self-reported smoking status at baseline (current/former vs never smoker). The measurements of MDI and smoking in WEHD have previously been described in detail.[41]

All analyses were computed using the statistical software R version 3.5.1.

3 | RESULTS

3.1 | Baseline characteristics

Table 1 shows the characteristics of the study population at baseline. The mean age was 47 years (standard deviation [SD] = 10.1) and 53.9% were women. Approximately 50% had normal BMI (18.5-24.9 kg/m^2), 35.7% were overweight (BMI: 25-29.9 kg/m^2), 13.5% were obese (BMI: ≥30 kg/m^2) and less than 1% were underweight (BMI: <18.5 kg/m^2). Men had slightly higher ERI score (mean = 0.93; SD = 0.31) compared to women (mean = 0.91; SD = 0.32), and women had lower BMI (mean = 25.1; SD = 4.71) than men (mean = 26.2; SD = 3.76). The mean ERI score was higher among those living alone, respondents with a migration background, obese respondents, and in the group with high education. There were no substantial differences in mean BMI across background characteristics.

3.2 | ERI, its components and BMI (two-wave design)

In the two-wave design, 15% had a BMI increase between T_0 and T_1 and 13% had BMI decrease. Table 2 shows the association between ERI, and efforts and rewards at baseline and changes in BMI at a 2-year follow-up (mean = 1.95 years). The fully-adjusted RR for exposure to ERI at baseline and a BMI increase of 5% or more between baseline and follow-up was 1.09 (95% CI: 0.95-1.25), and the RR for a decrease in BMI of 5% or more was 1.04 (95% CI: 0.90-1.20). When

TABLE 1 Baseline characteristics of the study population (two-wave design)

			ERI-ratio		Body mass index	
	n or (Mean)	% or (SD)	Mean	(SD)	Mean	(SD)
Total	9005	100	0.92	(0.31)	25.6	(4.34)
Sex						
Women	4858	53.9	0.91	(0.32)	25.1	(4.72)
Men	4147	46.1	0.93	(0.31)	26.2	(3.76)
Age, y	(47.0)	(10.1)				
Educational level						
High	4087	45.4	0.92	(0.29)	25.0	(4.15)
Intermediate	3885	43.1	0.91	(0.33)	26.1	(4.42)
Low	1033	11.5	0.91	(0.36)	26.2	(4.44)
Cohabitation						
Yes	7157	79.5	0.91	(0.31)	25.6	(4.21)
No	1848	20.5	0.94	(0.34)	25.7	(4.81)
Migration background						
No	8625	95.8	0.91	(0.31)	25.6	(4.36)
Yes	380	4.2	0.96	(0.38)	25.1	(3.99)
Body mass index						
Underweight, <18.5 kg/m^2	82	0.9	0.91	(0.30)	17.7	(0.69)
Normal weight, 18.5-24.9 kg/m^2	4492	49.9	0.91	(0.31)	22.5	(1.63)
Overweight, 25-29.9 kg/m^2	3216	35.7	0.92	(0.31)	27.1	(1.38)
Obese, ≥30 kg/m^2	1215	13.5	0.94	(0.34)	33.7	(3.76)

Abbreviations: ERI, effort-reward imbalance; SD, standard deviation.

analyzing the components of ERI separately, high rewards at baseline was associated with a lower risk of BMI increase at follow-up with a RR of 0.85 (95% CI: 0.75-0.97), but not BMI decrease (RR: 0.93; 95% CI: 0.81-1.06). The RRs for high efforts and BMI increase and decrease were 1.00 (95% CI: 0.87-1.15) and 1.04 (95% CI: 0.90-1.20), respectively.

We found no statistically significant interactions between ERI, and efforts and rewards, and sex (Appendix B). There were also no

TABLE 2 Multinomial logistic regression of ERI, and efforts and rewards at baseline (T_0) on change in BMI between T_0 and T_1 (two-wave design)

		Change in body mass index								
		Increase			Stable			Decrease		
	n Total/exposed	n	RR	(95% CI)	n	RR	(95% CI)	n	RR	(95% CI)
ERI	9005/2996	382			2280	1	(Ref)	334		
Model 1			1.09	(0.89-1.18)					1.09	(0.95-1.25)
Model 2			1.11	(0.97-1.27)					1.04	(0.90-1.20)
Model 3			1.09	(0.95-1.25)					1.04	(0.90-1.20)
High efforts	9005/2990	357			2299	1	(Ref)	334		
Model 1			0.97	(0.85-1.11)					1.05	(0.88-1.17)
Model 2			0.98	(0.85-1.12)					1.03	(0.89-1.18)
Model 3			1.00	(0.87-1.15)					1.04	(0.90-1.20)
High rewards	9005/5076	572			3958	1	(Ref)	546		
Model 1			0.82	(0.72-0.93)					0.91	(0.80-1.04)
Model 2			0.82	(0.72-0.93)					0.92	(0.80-1.05)
Model 3			0.85	(0.75-0.97)					0.93	(0.81-1.06)

Note: Model 1: adjusted for time of follow-up; Model 2: adjusted for time of follow-up+sex+age; Model 3: adjusted for variables of model 2+ educational level+cohabitation+migration background.
Abbreviations: BMI, body mass index; CI, confidence interval; ERI, effort-reward imbalance; RR, risk ratio; Ref, reference.

TABLE 3 Multinomial logistic regression of onset and remission of ERI, and high efforts and low rewards between T_0 and T_1 and subsequent change in BMI between T_1 and T_2 (three-wave design)

		Change in body mass index								
		Increase			Stable			Decrease		
	n Total[a]/cases[b]	n	RR	(95% CI)	n	RR	(95% CI)	n	RR	(95% CI)
Onset										
ERI	3813/681	108			518	1	(Ref)	55		
Model 1			1.08	(0.86-1.36)					1.17	(0.86-1.60)
Model 2			1.03	(0.82-1.30)					1.15	(0.84-1.57)
Model 3			1.04	(0.82-1.31)					1.15	(0.84-1.57)
High efforts	4252/595	109			447	1	(Ref)	39		
Model 1			1.23	(0.98-1.54)					0.95	(0.67-1.35)
Model 2			1.19	(0.95-1.50)					0.94	(0.66-1.33)
Model 3			1.21	(0.96-1.53)					0.95	(0.67-1.36)
Low rewards	3209/537	81			414	1	(Ref)	42		
Model 1			1.06	(0.82-1.38)					1.18	(0.83-1.68)
Model 2			1.04	(0.80-1.35)					1.17	(0.82-1.66)
Model 3			1.01	(0.77-1.31)					1.11	(0.77-1.58)
Remission										
ERI	1897/710	115			551	1	(Ref)	44		
Model 1			0.96	(0.74-1.24)					0.77	(0.53-1.12)
Model 2			0.92	(0.71-1.19)					0.76	(0.52-1.11)
Model 3			0.92	(0.71-1.20)					0.78	(0.53-1.13)
High efforts	1458/600	91			468	1	(Ref)	41		
Model 1			0.97	(0.72-1.30)					0.81	(0.54-1.21)
Model 2			0.95	(0.71-1.28)					0.79	(0.53-1.18)
Model 3			0.92	(0.68-1.24)					0.78	(0.52-1.17)
Low rewards	2501/1073	179			821	1	(Ref)	72		
Model 1			0.94	(0.76-1.69)					0.81	(0.60-1.10)
Model 2			0.88	(0.71-1.10)					0.79	(0.58-1.07)
Model 3			0.90	(0.72-1.12)					0.82	(0.60-1.11)

Note: Model 1: adjusted for time of follow-up; Model 2: adjusted for time of follow-up+sex+age; Model 3: adjusted for variables of model 2+educational level+cohabitation+migration background.
Abbreviations: BMI, body mass index; CI, confidence interval; ERI, effort-reward imbalance; RR, risk ratio; Ref, reference.
[a]Respondents without the exposure at baseline for the onset analyses and respondents with the exposure at baseline for the remission analyses.
[b]Respondents who have onset and remission of the exposure, respectively.

statistically significant interactions between ERI and baseline BMI and between rewards and baseline BMI (Appendix B). We found a statistically significant interaction between efforts and baseline BMI for BMI decrease ($p_{\text{Efforts*BMI, BMI decrease}} = 0.04$), but there were no statistically significant associations between efforts and BMI decrease for participants with BMI: <25 kg/m^2 (RR: 0.84; 95% CI: 0.66-1.09) and participants with BMI: ≥25 kg/m^2 (RR: 1.13; 95% CI: 0.95-1.35), in stratified analyses (Appendix B).

3.3 | Onset and remission of ERI, high efforts, and low rewards and subsequent change in BMI (three-wave design)

Table 3 shows the association between onset of ERI, high efforts and low rewards from T_0 to T_1 and subsequent changes in BMI from T_1 to T_2. Twelve percent had a BMI increase between T_1 and T_2 and 5% had BMI decrease. In respondents with the onset of ERI, the RR for the subsequent increase in BMI was 1.04 (95% CI: 0.82-1.31), and the RR for the subsequent decrease in BMI was 1.15 (95% CI: 0.84-1.57). Regarding the onset of high efforts, the RRs for increase and decrease in BMI were 1.21 (95% CI: 0.96-1.53) and 0.95 (95% CI: 0.67-1.36), respectively. Regarding the onset of low rewards, the RRs for increase and decrease in BMI were 1.01 (95% CI: 0.77-1.31) and 1.11 (95% CI: 0.77-1.58), respectively.

Table 3 also shows the remission of each of the exposures and subsequent changes in BMI. Remission of ERI yielded a RR of 0.92 (95% CI: 0.71-1.20) for the subsequent increase in BMI and a RR of 0.78 (95% CI: 0.53-1.13) for the subsequent decrease in BMI. The estimates regarding remission of high efforts and low rewards were similar (Table 3).

When we excluded extreme values of BMI and further adjusted the main analyses for mental health and smoking status, the results remained the same as in the main analyses (results not shown).

4 | DISCUSSION

4.1 | Summary of findings

In this nationwide cohort study of workers in Denmark, ERI was not associated with weight changes. The associations did not differ with regards to sex or baseline BMI in stratified analyses. When investigating the onset and remission of ERI, and efforts and rewards, and subsequent changes in BMI of 5% or more in a three-wave design, we did not find statistically significant associations. Of the two components of ERI, high rewards at baseline were associated with a lower risk of BMI increase of 5% or more at 2-year follow-up, whereas high efforts at baseline were not associated with BMI at follow-up.

4.2 | Comparison with previous studies

To our knowledge, this is the first study to investigate the prospective association between ERI, efforts and rewards and BMI in a nationwide occupational cohort. Previous studies have reported associations between ERI and increased BMI over a 10-year period in 812 Finnish workers from the metal industry[30] and a small statistically insignificant association between ERI and increased BMI in a small sample (n = 70) of Swiss service providers.[31] These previously reported associations were not supported in our data. However, comparing our findings with findings of the previous studies should be done with caution due to differences in the operationalization of ERI, study populations, and sample sizes. For example, our sample size was more than 10 times larger than the previous studies,[30,31] likely yielding more precise estimates.

Our analyses of the association between onset and remission of ERI and subsequent changes in BMI were novel, as using observational data in an attempt to emulate the design of an experimental study is a relatively new approach.[39] With regard to ERI, we are aware of only one study that previously examined the onset of ERI and risk of subsequent musculoskeletal pain in Swedish workers,[42] but we are not aware of any study that used this approach in analyses on BMI or weight changes.

4.3 | Strengths and limitations

The main strength of the study is the use of a large population-based sample of workers not restricted to specific job groups or type of work. The large sample size of more than 9000 participants in the two-wave analysis enabled us to test interaction effects between ERI and sex, and ERI and baseline BMI in relation to changes in BMI at follow-up. Another strength of the study is the use of up to three repeated measures and the application of different analytical approaches, including both a traditional prospective study with measurement of ERI at baseline and change in BMI from baseline to follow-up and a three-wave design, examining the association between onset and remission of ERI and its components and subsequent change in BMI. As these different types of analyses all showed a lack of association between ERI and weight changes, we are confident in the robustness of the results.

It may be considered a limitation that we used self-reported height and weight, which may be prone to misclassification due to social desirability.[43] However, such misclassification is less likely to have had a major impact on the results, since we used the relative change in BMI based on a continuous variable rather than a categorical variable,[44] although differential misclassification due to seasonal weight fluctuations may be a potential concern.[45]

Further limitations may apply to the three-wave design, where we investigated the onset and remission of the exposures and subsequent changes in BMI, thereby imitating the design of an experimental study. Given that we were obviously unable to assign the exposure at random, this may have introduced confounding by indication, which would arise if, for instance, some underlying personality factors are associated with ERI and BMI. Further, with biennial data collection, we were unable to determine the exact date of onset and remission, respectively, and change in BMI.

Another concern regarding the interpretation of the results is potential bias arising from selective nonresponse. We compared sociodemographic characteristics between the study population and nonrespondents and found some indications suggesting that our analytical sample may not be representative of the general working population in Denmark, in that participants in the analytical samples were older, more often women, with higher education, more often cohabiting and less often had a migration background. However, whether this affected the results and thereby the generalizability is unknown.

Finally, we acknowledge that there are numerous ways of defining psychosocial work stressors[46] and that our study was limited to selected working conditions as described in the theoretical model of ERI. In the conceptual framework of ERI, a hypothesized personality aspect of "overcommitment" is assumed to amplify the detrimental health effects of ERI, in that people scoring high on overcommitment may be especially vulnerable to the adverse effects produced by ERI.[47] The aspect of overcommitment was, however, not included in the analyses due to lack of measurement in WEHD, which may be considered a limitation. We encourage future studies to investigate the aspect of overcommitment and the role of other psychosocial working conditions for the risk of weight changes.

5 | CONCLUSION

In conclusion, our data indicate that ERI was not associated with weight changes in the general working population. Of the two ERI components, our results suggest that high rewards may be protective for weight increase, whereas high efforts were not associated with weight changes. Future studies may investigate ERI and weight changes in other study populations, and using different analytical approaches they may be able to clarify whether our results are generalizable to other working populations.

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CONFLICTS OF INTEREST

The authors disclose conflicts of interest per AJIM policy and declare that MN, IEHM, LRMP, and RR received support from The Danish Working Environment Research Fund for the submitted work. LLMH reports financial relationship outside the submitted work with Swedish Research Council as a reviewer. All other authors declare no conflicts of interest.

DISCLOSURE BY AJIM EDITOR OF RECORD

Paul Algirdas Landsbergis declares that he has no conflict of interest in the review and publication decision regarding this article.

AUTHOR CONTRIBUTIONS

Conception and design: all authors. Analysis and interpretation of the data: MN, RR, and LRMP. Drafting of the article: MN. Critical revision of the article and final approval of submission: all authors. MN is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

ETHICS STATEMENT

The work was performed at the National Research Centre for the Working Environment, Copenhagen, Denmark. The study was approved by The Danish Data Protection Agency through the joint notification of the National Research Centre for the Working Environment, Copenhagen, Denmark (no. 2015-57-0074). According to Danish legislation, research projects involving surveys with the questionnaire and register-based data only, do not need approval from The National Committee on Health Research Ethics. We obtained register-based information from Statistics Denmark (no. 706706) and Sundhedsdatastyrelsen ("The Danish Health Authority," no. FSEID-00003251 and no. FSEID-00003281).

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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