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The long-term impact of a change in Effort–Reward imbalance on mental health—results from the prospective MAN-GO study

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Background: Little is yet known on the long-term effects of stress management interventions (SMIs) in the workplace. The aim this study was to prospectively examine the effect of an improvement of psychosocial working conditions measured by the Effort–Reward (E–R) Imbalance model within 2 years following an SMI, and mental health 7 years later. **Methods:** The study sample consisted of 97 male industrial workers from southern Germany. Data were collected pre- and post-intervention in 2006 (T1) and 2008 (T2), respectively, as well as in 2015 (T3). Change scores were computed by subtracting T1 from T3 values. The associations between E–R ratio at T1, T2 and the change score, respectively, with depression and anxiety 7 years later were estimated by means of linear regression analysis. Analyses were adjusted for baseline levels of the exposure and outcome variables, socio-demographic-, health- and work-related covariates. **Results:** Within-person comparisons revealed a significant reduction (i.e. improvement) in E–R ratio post-intervention (−0.103, SD 0.24, $P = 0.000$). This improvement in the E–R ratio was significantly associated with lower anxiety ($\beta = 0.358$, $P = 0.001$) and depression ($\beta = 0.246$, $P = 0.031$) scores in the fully adjusted models. The association between change scores and mental health were slightly stronger than associations with absolute values at T1 and T2. **Conclusions:** An improvement in E–R ratio following an SMI, was significantly associated with lower anxiety and depression 7 years later. These results strongly support the importance of improving psychosocial working conditions in order to protect the mental health of employees in the long-run.

Introduction

Poor mental health has been on the rise in the past decades, impacting the workability and quality of life of those affected.[1] Though the aetiology of mental illness is multifactorial, there is strong evidence to suggest that adverse psychosocial working conditions can indeed be detrimental to mental health.[2,3] To this end, common mental disorders are becoming the leading cause for sickness absence and long-term work-disability in many countries.[4] Therefore, a greater emphasis on prevention of work-related health impairments is called for.[5]

Adverse psychosocial working conditions are considered to be an occupational stressor and thereby negatively influence health.[6,7] Research to date has evaluated a number of theoretical models of occupational stress in order to explain their relationship. In this respect two models have received broad attention, namely the Demand-Control[8] as well as the Effort–Reward Imbalance (ERI)[9] models, both of which have been linked to adverse health outcomes.[2,3,7] The Demand-Control model focuses on job features and posits that working conditions which are characterized by high demands with simultaneous low control can lead to psychological strain.[10] To this end, the model concentrates on the job content at task level and does not consider person-related characteristics (e.g. coping mechanisms). The ERI model on the other hand considers broader individual contractual employment domains rather than particular characteristics of the job.[6] The ERI posits that a lack of reciprocity between the efforts exerted at work and the rewards received in return, leads to psychological arousal.[11] The model is based on the assumption that employees expect a fair exchange for their efforts at work in terms of wages, esteem, career opportunities and job security. The extent to which an asymmetry is considered strenuous also depends on individual factors, such as alternatives on the labour market or personality traits. People exhibiting an excessive degree of commitment at work and a high need for approval (over-commitment) are more likely to suffer from an ERI. The ERI model offers a comprehensive approach to capturing occupational stress in a globalized working environment which is influenced by labour market restraints.[6] There is ample prospective evidence indicating that an ERI is harmful to mental health.[2,11–14] Henceforth, 'effort–reward imbalance' or 'ERI' refers to the ERI model as a whole, and 'E–R ratio' to the calculated ratio of E–R.

However, the predominantly observational design of these studies could not provide strong evidence for causal inference between a reduction in ERI and subsequent improvements in mental health.[15,16] This requires a randomized controlled design (RCT).[16] Though a number of interventional studies on ERI have been conducted, the majority had a quasi-experimental design, as the implementation of a RCT in the workplace is challenging.[17,18] Moreover, the evaluated interventions on ERI to date were predominantly primary interventions (i.e. aimed at decreasing stressors[19]) focusing on changing the working environment on an organizational

level (e.g. work schedule), rather than aiming at enhancing employees' coping skills to effectively master adverse psychosocial working conditions.[17] Though the scope of these studies also encompasses improvements in health outcomes, most studies have short follow-up periods (3–12 months), with hardly any beyond 3 years.[20] However, as resulting improvements in health may take longer to develop,[21] there is a call for evaluations of longer follow-up periods and more than one post-intervention assessment.[17] Furthermore, most studies have merely assessed the association of the E–R ratio with mental health, but not the individual contribution of efforts, rewards and over-commitment on the association.[22] This knowledge may improve the efficacy of future interventions, as it provides insights into potential extrinsic and intrinsic targets of intervention. Therefore, the aim of this study was to prospectively examine across different time lags the long-term effect of an improvement in psychosocial working conditions, measured by the ERI model (including E–R ratio and all respective model components), resulting from an randomized-controlled individual-level workplace intervention,[23] on mental health 7 years later.

Methods

Setting and sample description

Data were derived from the 7-year follow-up of a stress management intervention (SMI), conducted as a randomized-controlled study (details are described elsewhere).[23] Participants were randomly allocated to either an intervention (IG) or waiting-control group (CG). The intervention was based on the ERI model and was designed to enhance participants' ability to identify and cope with typical stressors in their working environment, as well as seek and enhance resources in their surrounding.[23] Participants took part in a 2-day training, followed by a half-day booster session after 4 and 6 months, respectively.

In total 189 male employees participated in the intervention between 2006 and 2008 (IG: 2006–07, CG: 2007–08). Data were collected in 2006–08 and 2015. Data from 2007 were not included in this study, as only post-intervention data for the entire sample was used for the present analyses. Baseline data (pre-intervention, 2006) will be further referred to as T1, post-intervention data (2008) as T2 and follow-up data (2015) as T3. Inclusion criteria for this study were (i) participation at T1, T2, as well as T3 and (ii) no missing values. This led to a total sample of 97 participants. A drop-out analysis revealed that there were no significant differences in for any of the study variables between the included and excluded (n = 92) participants (supplementary table S1). In order not to further decrease the sample size participants with missing values on over-commitment (n = 11) were only excluded in analyses using this as an exposure variable. The study was approved by the local ethics committee and followed the declaration of Helsinki. Each participant provided written informed consent.

Measures

Effort–reward imbalance

The German version of the ERI questionnaire was used, consisting of a total of 23 items, divided into three components[11] effort (6 items), reward (11 items) and over-commitment (6 items). The reward scale in turn comprises three subscales: esteem (5 items), promotion/career opportunity (4 items) and job security (2 items). Answers are given on a five-point Likert scale for efforts and rewards, ranging from '1 = unexposed to adverse condition' to '5 = exposed to adverse condition and very distressed', and a four-point Likert scale for over-commitment scale, ranging from '1 = strongly disagree' to '4 = strongly agree'. In addition to the sum-scores of the respective (sub-)scales, the ratio of efforts/rewards (E–R ratio) is also computed according to a standard algorithm.[11] Higher scores of E–R ratio indicate higher stress. The ERI scale has been validated in a number of settings and has been shown to be sensitive to changes.[24] The scales displayed satisfactory reliability in this study (Cronbach's α for T1 and T2: 'Effort': 0.726, 0.771/'Reward': 0.771, 0.830/'Esteem': 0.646, 0.770/'Promotion': 0.695, 0.578/'Job security': 0.624, 0.616/'Over-commitment': 0.780, 0.729).

Mental health

Mental health was measured using. the German version of the Hospital Anxiety and Depression Scale (HADS-D).[25] The scale consists of seven items to assess anxiety and depression, respectively. Both the reliability and validity of the HADS-D questionnaire have been demonstrated in the general population.[26] The scales displayed satisfactory reliability in this study (Cronbach's α for T1 and T3: 'Anxiety': 0.728, 0.713/'Depression': 0.777, 0.761).

Baseline covariate assessment

A set of literature-based covariates were included in the analysis in order to account for potential influencing factors on ERI and/or mental health. Low 'Educational level'[27] is defined as <9 years of schooling. 'Illness' is specified as reporting at least one of the following health problems: a serious illness in the past, current chronic or acute illness or medical treatment, current cardiovascular disease, pulmonary disease or mental illness. 'Life events'[28] were assessed using the LTE questionnaire[29] and were defined as reporting any of the events in the time period between 2006 and 2015. Furthermore, 'age',[30] 'partnership',[31] 'shift-work'[32] and 'BMI'[33] were controlled for.

Statistical analysis

Descriptive characteristics are reported by means and SDs (95% CI for change scores) and by % of observations. Mean differences between groups were assessed by t-test and $?^2$, respectively. Within-person comparisons were performed using the paired samples t-test.

Multivariate linear regression analyses were performed in order to assess the effect of an improvement in E–R imbalance between T1 and T2 on anxiety and depression at T3. Change scores were computed by subtracting the T1 value from the T2 score. A decrease in E–R ratio signifies a perceived improvement in the imbalance between efforts and rewards. In addition, the association between ERI at T1 and T2, respectively, with mental health at T3 was assessed, in order to examine prospective associations between ERI and mental health across different time lags.

In a first step (model 1), age and educational level were controlled for, followed by additional adjustments for shift-work, BMI, partnership, illness and life events in model 2. All analyses were also adjusted for baseline levels of outcome- and exposure-variables (in order to account for floor- and ceiling-effects) as well as for subjects' allocation to IG or CG (in order to account for the different timings of intervention–participation). As an in-depth analysis all inferential analyses were additionally repeated after excluding participants who reported to suffer from a mental illness at baseline (n = 7). This did not alter results substantially (data not shown).

Standardized coefficients (β), P-values and proportion of explained variance (R^2) are reported. For all statistical analyses, a P values < 0.05 was considered to be statistically significant. SPSS Version 23 (IBM Corp, Chicago, IL) was used for all statistical analyses.

Results

Descriptive analyses

Mean age at baseline was 41.46 years (SD 7.33), ranging from 26 to 58 years and 58% of all participants had a low educational level (table 1). Eight percent of participants were not living in a

Table 1 Baseline (T1) characteristics of the sample

Characteristic	% (*n*)/mean ± SD	Total *n*
Age (years)	41.46 ± 7.33	97
Living alone	8.2 (8)	97
Low educational level	57.7 (56)	97
Shift-work	56.7 (55)	97
BMI (kg/m^2)	28.31 ± 4.04	97
Illness	58.8 (57)	97
Life events between T1 and T4	83.5 (81)	97
E–R ratio	0.69 ± 0.20	97
Effort[a]	16.41 ± 3.10	97
Reward[b]	45.12 ± 6.46	97
Over-commitment[a]	14.06 ± 3.63	86
Depression[c]	4.57 ± 3.14	97
Anxiety[c]	6.02 ± 3.05	97

a: min:6/max:30.
b: min:11/max:55.
c: min:0/max:21.

relationship, 84% reported at least one life event since 2006, 59% reported to have an illness and more than half (57%) of the sample worked in shifts. Average BMI was 28.31 kg/m^2 (SD 4.04), slightly below the threshold to obesity ($\leq$30 kg/m^2). Average levels at T1 were 6.02 (SD 3.05) for anxiety and 4.57 (SD 3.14) for depression.

There was a significant drop in both anxiety [−1.43, 95% CI (−0.81)–(−2.05), $P < 0.001$] and depression [−1.34, 95% CI (−0.76)–(−1.91), $P < 0.001$] between T1 and T2 (data not shown). On average, the E–R ratio [−0.103, 95% CI (−0.06)–(−0.15), $P < 0.001$], efforts [−1.58, 95% CI (−0.88)–(−2.27), $P < 0.001$], and over-commitment [−1.08, 95% CI (−0.35)–(−1.82), $P = 0.004$] significantly decreased, while rewards (3.11, 95% CI 1.61–4.62, $P < 0.001$) significantly increased within the 2-year period. Moreover, esteem (1.16, 95% CI 0.31–2.02, $P = 0.008$), promotion/career opportunities (1.18, 95% CI 0.53–1.82, $P < 0.001$) and job security (0.77, 95% CI 0.33–1.12, $P = 0.001$) had significantly increased.

Association of ERI at T1, T2 and change score (T2–T1) with anxiety at T3

Effort at T1 was most strongly associated with anxiety at T3 (model 1: $\beta = 0.282$, $P = 0.004$; model 2: $\beta = 0.301$, $P = 0.003$). Furthermore, E–R ratio at T1 was significantly associated with anxiety at T3 in the basic model ($\beta = 0.201$, $P = 0.044$) and including all covariates (model 2) further strengthened this association ($\beta = 0.214$, $P = 0.033$; table 2).

E–R ratio (model 1: $\beta = 0.334$, $P < 0.001$; model 2: $\beta = 0.353$, $P < 0.001$) and over-commitment (model 1: $\beta = 0.335$, $P < 0.001$; model 2: $\beta = 0.349$, $P < 0.001$) at T2 were most strongly associated with anxiety at T3. Moreover, both effort (model 1: $\beta = 0.287$, $P = 0.002$; model 2: $\beta = 0.313$, $P = 0.001$) and reward (model 1: $\beta = -0.278$, $P = 0.004$; model 2: $\beta = -0.301$, $P = 0.002$) at T2 were significantly associated with anxiety at T3.

An improvement (i.e. reduction) in over-commitment between T1 and T2 was most strongly and significantly associated with lower levels of anxiety at T3 (model 1: $\beta = 0.480$, $P < 0.001$; model 2: $\beta = 0.500$, $P < 0.001$). Furthermore, the E–R ratio change score was significantly associated with anxiety at T3 (model 1: $\beta = 0.339$, $P = 0.002$; model 2: $\beta = 0.358$, $P = 0.001$). Change scores for reward (model 1: $\beta = -0.324$, $P = 0.006$; model 2: $\beta = -0.347$, $P = 0.004$) were more strongly associated with anxiety at T3 than effort change scores (model 1: $\beta = 0.205$, $P = 0.045$; model 2: $\beta = 0.228$, $P = 0.025$).

Association of ERI at T1, T2 and change score (T2–T1) with depression at T3

Effort at T1 was most strongly associated with depression at T3 (model 1: $\beta = 0.227$, $P = 0.023$; model 2: $\beta = 0.270$, $P = 0.008$; table 3). E–R ratio at T1 was only significantly associated with depression at T3 in the fully adjusted model (model 1: $\beta = 0.190$, $P = 0.062$; model 2: $\beta = 0.221$, $P = 0.032$).

At T2, E–R ratio (model 1: $\beta = 0.247$, $P = 0.012$; model 2: $\beta = 0.265$, $P = 0.007$) was most strongly associated with depression at T3, followed by reward (model 1: $\beta = -0.225$, $P = 0.026$; model 2: $\beta = -0.240$, $P = 0.019$). Effort at T2 was only significantly associated with depression at T3 in the fully adjusted model (model 1: $\beta = 0.175$, $P = 0.075$; model 2: $\beta = 0.198$, $P = 0.045$).

An improvement (i.e. increase) in reward between T1 and T2 was most strongly and significantly associated with lower levels of depression at T3 (model 1: $\beta = -0.246$, $P = 0.044$; model 2: $\beta = -0.265$, $P = 0.032$). Furthermore, the E–R ratio change score was significantly associated with depression at T3 (model 1: $\beta = 0.233$, $P = 0.042$; model 2: $\beta = 0.246$, $P = 0.031$).

Discussion

In this prospective study, initiated with a RCT and followed-up with a post-trial survey, we found that an improvement in ERI during the intervention stage significantly predicted lower anxiety and depression 7 years later. Moreover, a change in over-commitment significantly predicted lower anxiety. To the best of our knowledge, this is the first study to provide empirical evidence that a change in ERI following a SMI might affect mental health in the long-term.

Our results are in line with previous findings where a change in the E–R ratio was prospectively associated with mental health.[22,34,35] Bourbonnais et al.[20] have demonstrated in a follow-up that the improvements in psychosocial working conditions as well as mental health had persisted 3 years after the intervention. To this end, our findings further extend the current knowledge base in terms of the time lag: we found that mental health was directly affected by absolute levels of E–R ratio at T1 and T2, as well as a change in E–R ratio between T1 and T2 even 7 years later, a time horizon not studied so far.

Our results indicate that in most cases, the change scores rendered slightly stronger model fits and regression coefficients, compared with absolute scores at T1 or T2 (tables 2 and 3). These findings are in line with a previous study by Li et al.,[22] whereby the change score across two waves was a slightly better predictor of depression than a single measurement. However, we found that association patterns differed in our study. Although e.g. absolute levels of both E–R ratio and over-commitment at T2 had comparable associations with anxiety at T3, a change in over-commitment was the strongest predictor of anxiety at T3 by far. Moreover, effort at T1 and T2 was more strongly associated with anxiety at T3 than reward at T1 or T2, but a change in reward was most strongly associated with anxiety at T3. This is in line with previous findings, whereby multiple measurements rendered superior estimates between occupational stress and health.[30,36]

Interestingly, anxiety at follow-up was most strongly predicted by a change in over-commitment, the intrinsic component of the ERI model. Individuals scoring high on it are characterized by a high need for approval, thus potentially also being at an increased risk of developing anxiety in the face of failure.[11] Furthermore, over-commitment may be an individual coping strategy in order to deal with high efforts.[9] It is imaginable that subjects improved this coping skill after participating in the intervention, thus not feeling as anxious any more when faced with stressors. Moreover, an improvement in rewards was more strongly associated with lower anxiety 7 years later than a decrease in efforts. This may be an indication for an effect of the intervention, as participants were sensitized to the

Table 2 Association of E–R imbalance at T1, T2- and change score (T2–T1) with anxiety at T3 (n = 97) in the fully adjusted model

	T1			T2			Change score[a]		
	β	*P*	R^2	β	*P*	R^2	β	*P*	R^2
E–R ratio	0.214	0.033	0.263	0.353	0.000	0.342	0.358	0.001	0.351
Effort	0.301	0.003	0.301	0.313	0.001	0.316	0.228	0.025	0.257
Reward	−0.100	0.329	0.231	−0.301	0.002	0.304	−0.347	0.004	0.305
Esteem	−0.124	0.226	0.236	−0.286	0.003	0.297	−0.323	0.006	0.301
Promotion	−0.006	0.948	0.223	−0.213	0.032	0.264	−0.318	0.030	0.265
Job Security	−0.106	0.306	0.232	−0.225	0.023	0.268	−0.267	0.041	0.269
Over-comm.[b]	0.108	0.374	0.249	0.349	0.000	0.327	0.500	0.000	0.420

Notes: Analyses adjusted for baseline values of age, education, anxiety, randomization (model 1), partnership, shift-work, BMI, illness and life events (model 2). To improve readability, only coefficients from model 2 are shown, models 1 are shown in supplementary table S2.
a: Change score = (T2–T1 score), additionally adjusted for T1 score.
b: n = 86.

Table 3 Association of E–R imbalance at T1, T2- and change score (T2–T1) with depression at T3 (n = 97) in the fully adjusted model

	T1			T2			Change score[a]		
	β	p	R^2	β	p	R^2	β	p	R^2
E–R ratio	0.221	0.032	0.228	0.265	0.007	0.251	0.246	0.031	0.269
Effort	0.270	0.008	0.250	0.198	0.045	0.223	0.101	0.344	0.258
Reward	−0.116	0.276	0.196	−0.240	0.019	0.236	−0.265	0.032	0.239
Esteem	−0.109	0.306	0.195	−0.204	0.044	0.223	−0.227	0.064	0.227
Promotion	−0.052	0.612	0.188	−0.197	0.060	0.218	−0.279	0.071	0.218
Job Security	−0.107	0.316	0.195	−0.195	0.055	0.220	−0.224	0.094	0.221
Over−comm.[b]	−0.061	0.595	0.216	0.129	0.207	0.200	0.221	0.074	0.249

Notes: Analyses adjusted for baseline values of age, education, anxiety, randomization (model 1), partnership, shift-work, BMI, illness and life events (model 2). To improve readability, only coefficients from model 2 are shown, models 1 are shown in supplementary table 3.
a: Change score = (T2–T1 score), additionally adjusted for T1 score.
b: n = 86.

importance of resources (such as e.g. esteem) and were trained to actively seek feedback from supervisors and colleagues.

With regard to ERI model components, depression was merely significantly linked to a change in rewards. In contrast, one of the few studies which examined the association between changes to the components and depression found somewhat different effects: an increase in all subscales was associated with an increase in depression 4 years later.[22] The discrepancy in our findings might be due to differences in participants' occupations, depression measures, and time lag of follow-ups.

It is noteworthy that deterioration in the E–R ratio was more strongly associated with anxiety than depression in this study. This is in line with findings reported by Strazdins et al.[37] in their study on the effect of a change in psychosocial working conditions on both anxiety and depression. Furthermore, the average level of anxiety was 37% higher in our sample compared with the mean value reported for the corresponding age group in the German population (6.02 vs. 4.4).[27] Higher anxiety levels might be a result of circumstances in the company at that time: a workplace-reorganization had been announced prior to the beginning of the interventional study. Indeed, organizational instability has been shown to increase psychological strain in affected employees.[38,39]

Strengths and limitations

The strengths of this study lie in its prospective design, the long follow-up period as well as the analysis of the contributions of the individual components of the ERI model. Our analytical strategy of controlling for baseline levels of exposure and health, together with the experimental design of the interventional study, lends support to the assumption that changes in ERI are causally related to changes in mental health. The use of a validated and well-established scale to assess exposure is a further strength.

Nevertheless, some limitations apply. First, the relatively small and homogenous male sample does not allow for generalizations across different occupational groups or gender. However, in their meta-analytic review on the effects of psychosocial working conditions on mental health, Stansfeld and Candy[2] did not find gender-specific differences for ERI. Second, the assessment of both exposure and outcome variables by means of self-reports increases the risk of common method bias. The temporal distance between the assessment of ERI (T1, T2) and mental health (T3) might partly compensate for this.[40] Third, we cannot rule out selection bias at T3, as participation was voluntary and restricted to employees still working at the company. However, a drop-out analysis revealed no significant differences in any of the study variables at baseline between participants of this study and drop-outs (supplementary table S1). Based on recommendations from recent research, the commonly used missing data imputation technique 'last observation carried forward' (LOCF) was not applied, as LOCF may produce biased results.[41] Fourth, the risk of multicollinearity cannot be ruled out in our regression analyses. However, we calculated the tolerance statistic for all independent variables and found all values to be well above 0.2 (data not shown), indicating low collinearity.[42]

Conclusions

Our article prospectively establishes within a 7-year follow-up that a change in ERI qualifies as an important indicator of future mental health, even in the long term. Our findings suggest that interventions should particularly focus on reducing over-committed attitudes and behaviours of employees (intrinsic target of intervention), and work

towards improving rewards (extrinsic target of intervention). Concerning effective mental health prevention, a person's need for medical attention certainly precedes the threshold for meeting full criteria for psychiatric diagnosis. Thus, the identification of subthreshold disorder as well as of easily assessable risk factors for future mental complaints may represent the frontier of research and service reform in mental healthcare. This more preventive approach measures up to the standards of the rest of healthcare.[5]

Supplementary data

Supplementary data are available at *EURPUB* online.

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Conflict of interest: None declared.

Key points

- This study provides evidence for the long-term impact of an improvement in effort–reward imbalance on mental health 7 years later, a time lag which has not been studied so far. This study underlines the importance of stress management interventions at work in order to protect the mental health of employees in the long-run.
- The predominant body of studies has not assessed the individual contribution of the single components of the ERI model (efforts, rewards, over-commitment), which was done in this study. This may lead to a better understanding of underlying mechanisms and improve the efficacy of interventions, as it provides insights into potential extrinsic and intrinsic targets of intervention.
- Considering the implications of impaired mental health for employees, employers and the social security system, it is in the interest of all to work towards healthier working environments.

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Sex-specific associations of different anthropometric indices with acute and chronic insomnia

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Background: Sleep disorders, including insomnia, are risk factors for weight gain. However, few epidemiological studies have investigated the association of anthropometric markers with insomnia as an outcome. **Methods:** In this observational, cross-sectional study, we assessed the association of 3 different anthropometric indices with acute and chronic insomnia. We used data from 13 389 French adults (mean age= 51.9 ± 13.1 years; 70.3% women) enrolled in the NutriNet-Santé-Biobank cohort. Body weight, height, waist and hip circumference were measured once during a clinic visit (2011–14). Body mass index (BMI), waist circumference (WC) and waist-to-hip ratio (WHR) were the main predictors. Acute (past 8 days) and chronic (≥3 months) insomnia were assessed in 2014 via a self-report questionnaire. We fit multivariable logistic regression models providing odds ratios (OR) and 95% confidence intervals (CI). **Results:** Overweight ($25.0 \leq BMI < 30.0\ kg/m^2$) and general obesity ($BMI \geq 30.0\ kg/m^2$) appeared to have an inverse association with acute insomnia only among men (overweight: OR= 0.80, 95% CI: 0.70, 0.92; obesity: OR= 0.78, 95% CI: 0.63, 0.98). Obesity assessed by BMI and WHR appeared to be positively associated with chronic insomnia only among women (BMI: OR= 1.23, 95% CI: 1.04, 1.45; WHR: OR= 2.24, 95% CI: 1.07, 4.72). WC did not display any significant associations in either sex. **Conclusions:** These cross-sectional results revealed sex-specific associations of overweight/obesity with different types of insomnia, and merit confirmation longitudinally with objectively assessed sleep parameters. Nonetheless, the findings reinforce the critical importance of joint health behaviour promotion.

Introduction

Globalisation, technological innovations and penetration of modern food systems into all societies have resulted in alarming rates of obesity via increased sedentariness and detrimental dietary practices.[1–3] In 2014, 39% of adults worldwide were overweight (Body mass index (BMI) between 25.0 and 29.9 kg/m^2) and 13%—obese ($BMI \geq 30.0\ kg/m^2$).[4] High BMI is a risk factor for diabetes, cardiovascular diseases, osteoarthritis and certain types of cancer.[4] Likewise, obesity potentiates obstructive sleep apnea (OSA),[5] and is associated with difficulties maintaining sleep, insomnia,[6,7] reduced sleep efficiency and daytime sleepiness.[8] However, it is not well understood when and whether obesity as an exposure might be associated with insomnia as an outcome. Insomnia, along with short/long total sleep time, OSA and hypersomnia, is one of several common sleep disorders.[9] Like obesity, it is a public health challenge given its deleterious impact on health, work performance, road safety and quality of life.[10–12] It is estimated that severe insomnia affects around 10% of the general population in industrialised countries.[12] In France, an estimated 30–50% of adults report ≥1 sleep disorder, with insomnia affecting 15–20% of the general population.[13]

Whereas the links between insomnia and other sleep disorders (such as short sleep) as predictors of weight gain have been established,[14] few epidemiological studies have explored the association of different anthropometric indices with insomnia as an outcome.[6,7,15] Moreover, epidemiological research on acute insomnia is virtually