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Research paper

Impact of effort reward imbalance at work on suicidal ideation in ten European countries: The role of depressive symptoms

Zhuo Lai-Bao[a], Yao Wu[a], Yan Zhen[b,*], Giron Maria S.T.[c], Pei Jin-Jing[d], Wang Hui-Xin[a,d,e,*]

[a] College of Public health, Zhengzhou University, Zhengzhou, Henan, China
[b] College of Public Health, Hainan Medical University, 3 Xueyuan Road, Haikou, China
[c] Institute on Aging, National Institutes of Health, University of the Philippines, Philippines
[d] Stress Research Institute, Stockholm University, Frescati Hagväg 16A, 114 19 Stockholm, Sweden
[e] Aging Research Center, Department of Neurobiology, Caring Sciences and Society, Karolinska Institutet and Stockholm University, Stockholm, Sweden

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ABSTRACT

Background: Evidence of the association between effort reward imbalance (ERI) and suicidal ideation is sparse. This study examined the influence of ERI at work on suicidal ideation and the mediating effect of depressive symptoms.

Methods: There were 4963 workers aged 50+ without suicidal ideation at baseline in the Survey of Health, Aging and Retirement in Europe, these workers were followed-up for 8-years to detect incident suicidal ideation. ERI was measured by a short ERI questionnaire. Suicidal ideation was evaluated by one item derived from the 12-item Europe-depression scale, and depressive symptoms were assessed by the remaining 11 items in the scale. Cox models were employed to explore the relationship adjusting for potential confounders. Mediation analysis was used to test the mediating effect of depressive symptoms.

Results: A significantly higher incidence of suicidal ideation was related with high effort ($HR = 1.51$) and low reward ($HR = 1.42$), respectively. A high effort–low reward imbalance was associated with even higher risk of suicidal ideation ($HR = 1.96$) as compared to low effort-high reward combination. The association was varied by gender, region, education and household income. Depressive symptoms mediated a modest proportion (natural indirect effect 14.4%) of the total association between ERI and suicidal ideation.

Limitation: Suicidal ideation definition based on self-administered questionnaires which could lead to false negatives. And some unmeasured confounders might have biased the results.

Conclusions: Efforts in promoting balanced effort–reward at work may reduce suicidal ideation among working population aged 50+. Avoiding depressive symptoms may further enhance such efforts.

1. Introduction

Suicide is an important health problem worldwide. The World Health Organization reports that about 800,000 die each year due to suicide and even many more people attempt to take their own lives (World Health Organizaton, 2019). Psychosocial factors, such as low socioeconomic position, chronic psychological distress and serious mental illness, have been related to elevated suicide rates (Batty et al., 2018). According to the three-step theory of suicide, suicidal ideation due to psychological or emotional distress is the first step of suicide (Klonsky et al., 2015). Previous studies have shown that suicidal ideation may contribute to the risk of suicide attempts (Simon et al., 2017; Ten Have et al., 2009). Moreover, suicide ideation and attempts are important predictors of suicide, leading to negative consequences such as loss of liberty, injury and hospitalization (Nock et al., 2008a; Nock et al., 2008b; World Health Organizaton, 2014). From the perspective of primary prevention of suicide, it is critical to identify risk factors affecting suicidal ideation.

Workers are exposed to stressful working conditions that impact on physical and mental health (Iliceto et al., 2013; Pompili et al., 2008). In international research two complementary theoretical models of measuring work stress are most often used. The demand-control (or 'job strain' model) focuses on a health-adverse combination of job task characteristics in terms of high demands and low control or decision latitude (Karasek, 1979). The effort-reward imbalance model is concerned with the work contract, where stressful experience results from an imbalance between high costs spent by employees (high effort) and low rewards provided in turn by the employer or organization (low

* Corresponding authors.
E-mail addresses: yanzhen@zzu.edu.cn (Z. Yan), huixin.wang@su.se (H.-X. Wang).

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reward: salary, promotion prospects, job security, esteem) (Siegrist, 1996). Both models were shown to predict elevated risks of coronary heart disease (Dragano et al., 2017), diabetes (Nyberg et al., 2014; Kumari et al., 2004), and hypertension (Babu et al., 2014; Gilbert-Ouimet et al., 2014), and depression (Madsen et al., 2017; Rugulies et al., 2017).

Suicidal ideation has only rarely been studied in relation to work stress, and if so, most often in cross-sectional studies (Byun et al., 2016; Loerbroks et al., 2016; Milner et al., 2017; Li et al., 2017). Further, effort-reward imbalance model focuses on core frustrated social rewards in occupational life with substantial impact on despair and reduced self-esteem, which may play a particularly important role in the occurrence of suicidal ideation. However, evidence concerning effort-reward imbalance in relation to suicidal ideation is sparse. With this study, we set out to analyze prospectively associations of work stress, as measured by the effort-reward imbalance model, with suicidal ideation among a working population aged 50+, using data from the Survey of Health, Aging, and Retirement in Europe (SHARE). Moreover, given evidence on depression as a potential predictor of suicidal ideation (Batterham et al., 2012), we test a mediating role of depression in this association.

2. Methods

2.1. Study population

The study population was derived from Wave 1, Wave 2, Wave 4, and Wave 5 of SHARE. SHARE is a prospective cohort study and includes health, socioeconomic status, mental health and social networks data of individuals aged 50 and older, living in 11 European countries (Austria, Germany, Sweden, Netherlands, Spain, Italy, France, Denmark, Greece, Switzerland, Belgium) and Israel. The SHARE target population is defined as: participants born in 1954 or earlier and have their regular residence in the respective SHARE country. People were excluded if they were hospitalized, incarcerated, not living in the country during the survey period, or did not speak the native language (s). The survey began in 2004–2005 (wave 1) and follow up data collection was performed every two years. Computer-assisted personal interviewing (CAPI) was used to collect most of the data and additional information was collected through self-administered questionnaire (Börsch-Supan et al., 2013). Specific details about the survey are available elsewhere (Börsch-Supan et al., 2008; Börsch-Supan et al., 2013a; Börsch-Supan et al., 2013b; Börsch-Supan et al., 2013). The study was approved by the Ethics Committee of the University of Mannheim and the Ethics Council of the Max Planck Society.

In order to explore the association between ERI and suicidal ideation among middle-aged and older workers, the study population included respondents who were aged 50 years or above and currently employed. Participants in Italy and Israel were excluded due to missing information on ERI (Italy) or on education and income (Israel), leaving 7270 participants. Among them, 359 with missing information on ERI and 27 on suicidal ideation were excluded, leaving 6884 eligible participants at baseline. To study the influence of baseline ERI on incidence of suicidal ideation, 229 participants who had suicidal ideation at baseline and 1692 individuals with missing information on suicidal ideation during the follow-up were excluded, leaving 4963 subjects in the analysis (Fig. 1).

2.2. Measures

2.2.1. Effort-reward imbalance

A short effort-reward imbalance (ERI) model questionnaire (Siegrist et al., 2009) was used to measure perceived job stress in one's main job. It contains two dimensions: job effort and job reward. Job effort was assessed by two items: 'my job is physically demanding' and 'I am under constant time pressure due to a heavy workload'. Job reward was measured with five items: 'received adequate support, recognition from work, adequate salary, poor job promotion, and poor job security'. All items were measured on a 4-point scale (1 = strongly agree, 2 = agree, 3 = disagree, 4 = strong disagree). The sum score of each dimension was calculated. Considering there are different welfare state regimes and socioeconomic conditions across Europe, which may have an impact on job effort and job reward. Individuals with scores above the country-specific low tertile were defined as 'high effort' or 'high reward' because the sum score of these two dimensions didn't follow the normal distribution, more participants were in the low tertile compared with the remaining tertiles. To take into account the interaction between job effort and job reward and country differences, we combined the two components and generated a four-category variable based on the cross-tabulation of the dichotomized job effort and job reward variables: (1) low effort and high reward (2) high effort and high reward (3) low effort and low reward (4) high effort and low reward (high ERI, defined as the predictor with highest stress-theoretical significance). In addition, the sum score of job effort and job reward was weighted by the number of items. Then the ERI ratio was calculated by dividing the weighted effort scale by the reward scale.

2.2.1.1. Suicidal ideation. Suicidal ideation was assessed by the following question: "In the last month, have you felt that you would rather be dead?" The item was derived from the Europe-depression (EURO-D) scale, it has been used in some research as an indicator of suicidal ideation (Mellqvist Fassberg et al., 2014; Stolz et al., 2016). Responses who answered "yes" were considered as having suicidal ideation. The incident suicidal ideation cases included all individuals who developed suicidal ideation during the 8-year follow-up (95 cases in Wave 2, 89 in Wave 4 and 81 in Wave 5).

2.3. Depressive symptoms

The EURO-D scale was employed to assess depressive symptoms in wave 1. The structured scale contains 12 items that measures depression, pessimism, suicidality, guilt, sleep, interest, irritability, appetite, fatigue, concentration, enjoyment and fearfulness in the last month, respectively. All items are dichotomous (0 = no, 1 = yes). The item of suicidality was excluded from the total because it was used as the outcome variables in this study. Depressive symptoms were calculated by the total score of the other 11 items of the scale, with higher score indicating more severe depression. The internal consistency of the depressive symptoms was high (α = 0.74) in the current study.

2.4. Covariates

Covariates were collected at baseline, including gender, age, marital status, educational attainment, regions, comorbidity and average household income. Age was treated as a continuous variable in all analyses. Marital status was categorized as: divorced/separated, never married, widowed and married. Educational attainment was divided into three categories according to International Standard Classification of Education-97 (ISCED-97) (Educationalinnovation, 1999): low (ISCED 0-2), medium (ISCED 3-4) and high level of education (ISCED 5-6). European countries were divided into three regions: North (Denmark, Netherlands, and Sweden), Central (Austria, France, Germany, Switzerland, and Belgium), and South (Spain and Greece). Comorbidities were assessed through self-reported fourteen health conditions, such as heart attack, hypertension, cerebrovascular disease, malignancy, diabetes mellitus, etc. The existence of any two of these conditions is defined as having comorbidity. Average household income was calculated by dividing total household income over the household size and grouped into two categories by country-specific median (high income and low income).

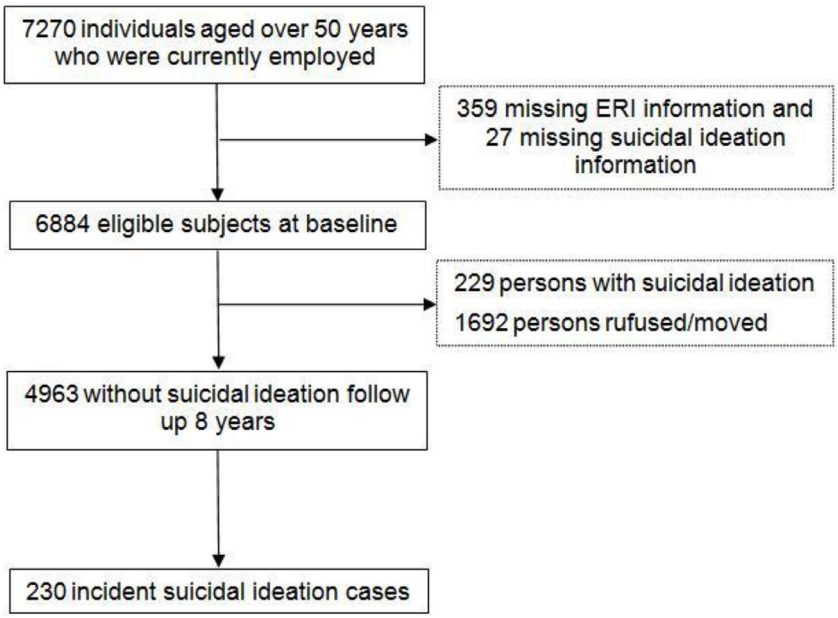

Fig. 1. Flowchart of the study population in the Survey of Health, Aging and Retirement in Europe (SHARE).

2.5. Statistical analysis

We used univariate logistic regression to estimate crude odds ratios (*ORs*) of the prevalence of suicidal ideation related to covariates and ERI. Chi-square test or *t*-test was employed to examine associations between covariates at baseline and the incidence of suicidal ideation during the 8-year follow-up. Cox proportional hazards model was applied to estimate the hazard ratios (*HRs*) and 95% confidence intervals (CIs) of suicidal ideation in relation to different levels of job effort, reward, and ERI during the 8-year follow-up, adjusting for gender, age, marital status, educational attainment, region, comorbidity, average household income. For people without suicidal ideation, the follow-up time was calculated from baselines survey to the date of last follow-up investigation or death. For subjects with incident suicidal ideation, the follow-up time was calculated as the time from date of baseline survey to the date of the follow-up survey.

Further, there may be interactions between ERI with age, gender, marital status, education attainment, regions, comorbidity and household income in relation to suicidal ideation. Thus, statistical interactions between ERI with those variables in relation to suicidal ideation were tested by introducing interaction terms into the Cox proportional hazards models. Stratified analyses by gender, region, education and average household income were performed because their significant interaction with ERI in relation to suicidal ideation.

Depressive symptoms were not included in the model for adjustment because previous studies have shown that depression can be a consequence of job strain (Grynderup et al., 2013; Theorell et al., 2015) and a potential cause of suicidal ideation (Batterham et al., 2012) and that adjusting a mediating variable in multivariate model is not recommended in epidemiological studies (Rothman et al., 2008). Depressive symptoms may operate as an intermediate variable in the relationship between job strain and suicidal ideation (Loerbroks et al., 2016). According to the results from multivariate analysis, the effects of low effort-low reward and high effort-high reward on suicidal ideation were similar as low effort-high reward, they were merged into one group and served as reference to confirm the effect of high ERI on suicidal ideation. Causal mediation analysis (Valeri et al., 2015) were performed to explore the roles of depressive symptoms as possible intermediate variable in the association between ERI and suicidal ideation. We calculated *HRs* and 95% CI for the natural direct effect—the effect of ERI on suicidal ideation not through depressive symptoms; the natural indirect effect—the effect of ERI on suicidal ideation mediated by depressive symptoms; the total effect—the association between ERI and suicidal ideation. The interaction term of exposure-mediator was omitted from the models because it was not statistically significant. The proportion mediated through depressive symptoms was calculated using the formula $[HR_{NDE}*(HR_{NIE}-1)]/(HR_{NDE}*HR_{NIE}-1)$. All statistical tests were 2-sided, and $P < 0.05$ was considered significant. All analyses were performed using SPSS software, version 21.0 and SAS version 9.4 software.

In additional analysis, marginal model was used to confirm our results considering the possibility of the recurrence of suicidal ideation during the 8-year follow-up.

3. Results

As compared to nonparticipants, participants were more likely with higher education (33.1% vs 29.7%), living in the north region (40.3% vs. 30.9%) and with more comorbidities (58.0% vs. 54.1%) (data not shown). There were no significant differences between participants and nonparticipants in other characteristics. Characteristics of the study population in relation to the risk of suicidal ideation are shown in Table 1. The majority of the participants were men (54.2%) and the median age was 55 years. A total of 229 participants (3.3%) was reported to have suicidal ideation in last 12-months. Suicidal ideation was higher in women (4.7%) than in men (2.1%). Low reward was significantly related to suicidal ideation. Participants were more likely to report suicidal ideation if they were with low effort-low reward (*OR* = 1.70), and high effort-low reward (*OR* = 2.41) in contrast with those with low effort in combination with high reward.

Table 2 displays the baseline characteristics of the population without suicidal ideation and those who developed suicidal ideation during the 8-year follow-up. Individuals who developed incident suicidal ideation were younger, women, with comorbidity, and living in the central region at baseline.

The results of Cox proportional hazards model are shown in Table 3. Job effort and reward were simultaneously introduced into the multivariate model, high effort (*HR* = 1.51; 95%CI = 1.13–2.02) and low reward (*HR* = 1.42; 95%CI = 1.08–1.87) were both related to a significantly higher incidence of suicidal ideation. When job effort and reward were combined following the effort-reward-imbalance model, a significant higher risk of suicidal ideation was associated with high ERI

Table 1
Characteristics of the study population and crude odd ratio (*OR*s) with 95% confidence interval (95%CI) of suicidal ideation (N = 6884).

Characteristic	N (%)/M (Q)	Suicidal ideation N (%)/M (Q)	*OR* (95%CI)
Total	6884 (100)	229 (3.3)	
Gender			
Men	3730 (54.2)	80 (2.1)	1
Women	3154 (45.8)	149 (4.7)	**2.26 (1.72–2.98)**
Age	55 (6)	55 (6)	0.99 (0.95–1.03)
Marital status			
Married	5472 (79.5)	137 (2.5)	1
Divorced/separated	721 (10.5)	54 (7.5)	**3.15 (2.28–4.36)**
Never married	463 (6.7)	22 (4.8)	**1.94 (1.23–3.08)**
Widowed	228 (3.3)	16 (7.0)	**2.94 (1.72–5.02)**
Educational attainment [a,b]			
High	2203 (32.0)	62 (2.8)	1
Medium	2517 (36.6)	75 (3.0)	1.06 (0.75–1.49)
Low	2113 (30.7)	89 (4.2)	**1.52 (1.09–2.11)**
Region [c]			
North	2609 (37.9)	59 (2.3)	1
Center	3097 (50.0)	138 (4.5)	**2.02 (1.48–2.75)**
South	1178 (17.1)	32 (2.7)	1.21 (0.78–1.87)
Comorbidity [a]			
No	2992 (43.5)	67 (2.2)	1
Yes	3891 (56.5)	162 (4.2)	**1.90 (1.42–2.53)**
Average household income			
Low	3414 (49.6)	133 (3.9)	1
High	3470 (50.4)	96 (2.8)	**0.70 (0.54–0.92)**
Effort			
Low	3058 (44.4)	87 (2.8)	1
High	3826 (55.6)	142 (3.7)	1.32 (1.00–1.73)
Reward			
High	3879 (56.3)	86 (2.2)	**1**
Low	3005 (43.7)	143 (4.8)	**2.20 (1.68–2.89)**
Effort and reward [d]			
LE + HR	1932 (28.1)	44 (2.3)	1
HE + HR	1947 (28.3)	42 (2.2)	0.95 (0.62–1.45)
LE + LR	1126 (16.3)	43 (3.8)	**1.70 (1.11–2.61)**
HE + LR	1879 (27.3)	100 (5.3)	**2.41 (1.68–3.46)**

N: numbers; M: median; Q: inter-quartile range.
Bold values indicate a significance level of $P < 0.05$.
All *OR*s were crude without adjusting.
[a] Fifty-one participant with missing value in educational attainment, and one in comorbidity.
[b] Educational attainment: low level of education: ISCED 0–2; medium level of education: ISCED 3–4; high level of education: ISCED 5–6.
[c] Region: North (Denmark, the Netherlands, and Sweden); Center (Austria, France, Germany, Switzerland, and Belgium); South of Europe (Spain and Greece).
[d] Effort and reward: LE: low effort HE: high effort LR: low reward HR: high reward.

(*HR* = 1.96; 95%CI = 1.33–2.89) but not with other categories of the perceived work stress model, after adjusting for gender, age, marital status, educational attainment, region, comorbidity and average household income. Similar to the results from Cox regression, the marginal model showed that high ERI (*HR* = 2.11; 95%CI = 1.42–3.12) was related to a significantly higher incidence of suicidal ideation (data not shown). We also performed analysis using ERI ratio, similar results were observed (data not shown).

The relationships between incidence of suicidal ideation and ERI stratified by gender, region, education and average household income are shown in Fig. 2. Our results suggested that high ERI in women (*HR* = 2.20; 95%CI = 1.33–3.65) but not in men increased the risk of suicidal ideation as compared with low effort combined with high reward. The effect of high ERI on suicidal ideation was only shown in central region (*HR* = 2.18; 95%CI = 1.34–3.56), while the effect disappeared in north and south region. When stratified by education level, the associations between suicidal ideation and high ERI were only present in people with low level of education (*HR* = 2.82;

Table 2
Baseline characteristics of participants without suicidal ideation and with incident suicidal ideation during 8-year follow-up, n (%).

Variables	participants without suicidal ideation, n = 4733	Incident suicidal ideation, n = 230	*P* value
Gender			**0.000**
Men	2637 (55.7)	97 (42.2)	
Women	2096 (44.3)	133 (57.8)	
Age [a]	55.0 (6.0)	54.0 (5.0)	**0.001**
Marital status			0.554
Married	3774 (79.7)	181 (78.7)	
Divorced/separated	484 (10.2)	24 (10.4)	
Never married	309 (6.5)	13 (5.7)	
Widowed	166 (3.5)	12 (5.2)	
Educational attainment [b,c]			0.214
High	1566 (33.1)	66 (28.7)	
Medium	1705 (36.0)	81 (35.2)	
Low	1433 (30.3)	81 (35.2)	
Region [d]			**0.000**
North	1941 (41.0)	61 (26.5)	
Center	1983 (41.9)	139 (60.4)	
South	809 (17.1)	30 (13.0)	
Comorbidity [b]			**0.001**
No	2011 (42.5)	72 (31.3)	
Yes	2721 (57.5)	158 (68.7)	
Average household income			0.941
Low	2334 (49.3)	114 (49.6)	
High	2399 (50.7)	116 (50.4)	

Bold values indicate a significance level of $P < 0.05$.
[a] Age was described using median and interquartile range.
[b] Thirty-one participant with missing value in educational attainment and one in comorbidity.
[c] Educational attainment: low level of education: ISCED 0–2; medium level of education: ISCED 3–4; high level of education: ISCED 5–6.
[d] region: North (Denmark, the Netherlands, and Sweden); Center (Austria, France, Germany, Switzerland, and Belgium); South of Europe (Spain and Greece).

95%CI = 1.29–6.18) or medium level of education (*HR* = 2.35; 95%CI = 1.24–4.46), not in those with high level of education. In addition, high ERI was related to a significantly higher incidence of suicidal ideation in high-income individuals (*HR* = 2.39; 95%CI = 1.39–4.10) but not in low-income individuals.

In causal mediation analysis (Fig. 3), the natural direct effect of high ERI on suicidal ideation (*HR* = 1.57; 95% CI = 1.17–2.12) was statistically significant and there was also a significant natural indirect effect (*HR* = 1.06; 95% CI = 1.02–1.10) of high ERI via depressive symptoms. Depressive symptoms explained a modest fraction (14.4%) of the association between ERI and suicidal ideation, suggesting depressive symptoms partially mediated the association between ERI and suicidal ideation.

4. Discussion

To our knowledge, this is the first study that examined the association of ERI with suicidal ideation longitudinally and explored the role of depressive symptoms in this association in a working population 50 years and above in 10 European countries. Results from this study showed that high effort, low reward, and high ERI increased the incidence of suicidal ideation over the 8-year follow-up. High ERI was related to a high incidence of suicidal ideation in women, among those living in central region, people with low or medium level of education, and those with high-income. Causal mediation analysis results indicated that depressive symptoms explained a modest (14.4%) proportion of the association between ERI and suicidal ideation.

A number of previous studies have been performed in an attempt to

Table 3
Adjusted hazard ratio (HR) and 95% confidence interval (CI) of incident suicidal ideation in relation to perceived job strain.

Variables	participants without suicidal ideation, n = 4733	Incident suicidal ideation, n = 230	*HR* (95%*CI*)
Job effort			
Low	2140	81	1.00
High	2593	149	**1.51 (1.13–2.02)**
Job reward			
High	2706	109	1.00
Low	2027	121	**1.42 (1.08–1.87)**
Effort and reward [a]			
LE + HR	1357	45	1.00
HE + HR	1349	64	1.37 (0.91–2.06)
LE + LR	783	36	1.26 (0.79–2.02)
HE + LR	1244	85	**1.96 (1.33–2.89)**

HRs were adjusted for gender, age, marital status, educational attainment, region, comorbidity, average household income.
Bold values indicate a significance level of $P < 0.05$.
[a] Effort and reward: LE: low effort HE: high effort LR: low reward HR: high reward.

explore the association between job stress and suicidal ideation (Choi, 2018; Dalglish et al., 2015; O'Connor et al., 2000). A majority of them was based on a cross-sectional design and focused on the job demand-control model (JDC model) (Dalglish et al., 2015; Loerbroks et al., 2016; O'Connor et al., 2000). Less studies explored the role of work stress in terms of effort-reward imbalance (Byun et al., 2016; Li et al., 2017; Loerbroks et al., 2016; Milner et al., 2017) in relation to suicidal ideation although this model may be of particular interest to the study of despair, given its focus on the frustration of core rewards in occupational life.

Our results revealed that high effort, low reward, and high ERI were positively associated with suicidal ideation after adjusting for potential confounders. These findings are consistent with a previous study in Korea subway drivers (Byun et al., 2016), in which low reward was positively associated with suicidal ideation, although there was no separate analysis for job effort in that study. Similar result was reported in another study in Australian male workers (Milner et al., 2017). Further,

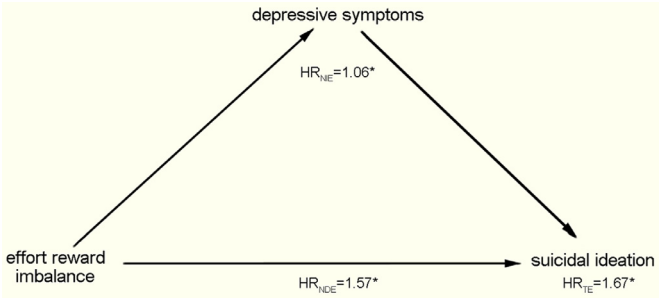

Fig. 3. Natural direct effect of effort-reward imbalance and natural indirect effect via depressive symptoms on risk of suicidal ideation. Model were adjusted for gender, age, marital status, educational attainment, region, comorbidity and average household income. Effort reward imbalance: high effort in combination with low reward vs other categories combined. HR: hazard ratio, NDE: natural direct effect, NIE: natural indirect effect, TE: total effect * $P < 0.05$.

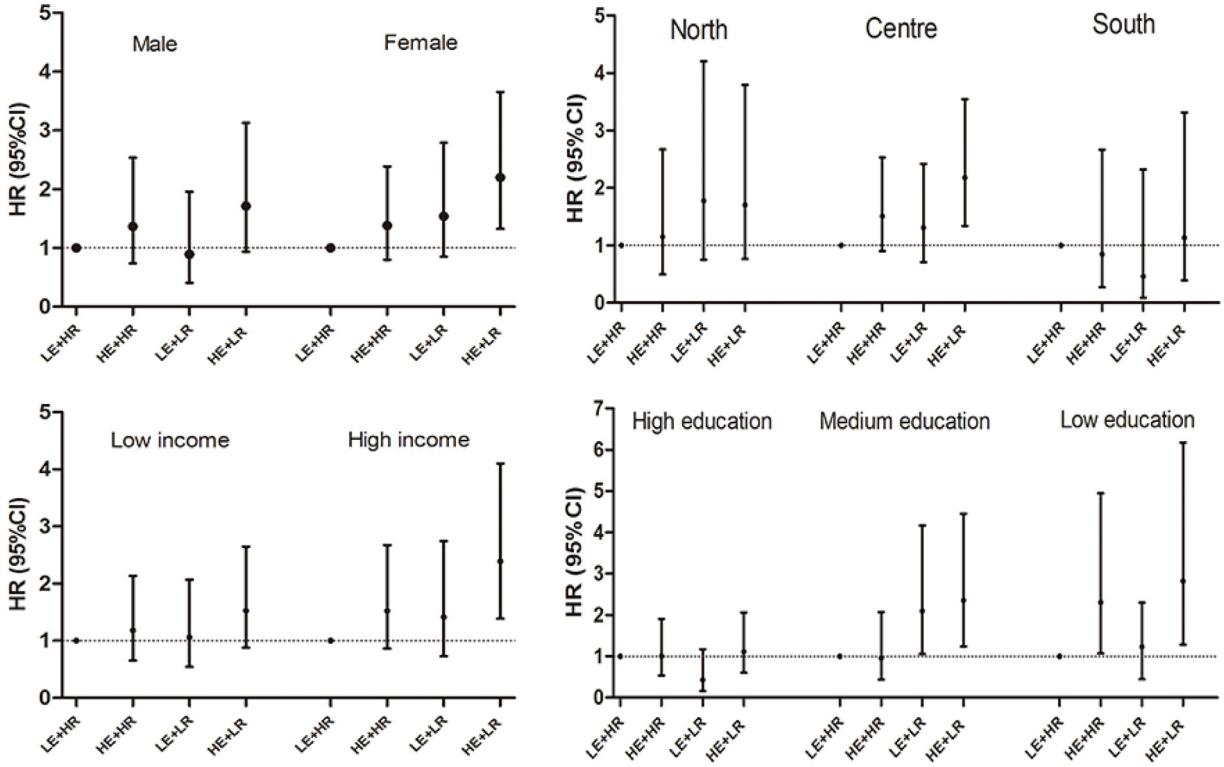

Fig. 2. Adjusted hazard ratio (HR) and 95% confidence interval (95% CI) of incident suicidal ideation in relation to ERI over 8 years' follow-up stratified by sex, region, education and average household income. LE: low effort HE: high effort LR: low reward HR: high reward.

these results were also in line with a previous meta-analysis (Loerbroks et al., 2016), which had pooled data from six epidemiological datasets and reported that effort-reward imbalance could lead to suicidal ideation. Participants in this study were aged younger than 50 years old from four countries: South Korea, China, Australia, and Germany. Although the potential effect of depression was mentioned in these studies to explain the findings, unfortunately, there was no formal statistical test for the role of depression in the studied association.

The association between ERI and suicidal ideation was varied by gender, region, education and household income. The current study indicates that high ERI was related to increased risk of suicidal ideation in women, but not in men. The possible explanation can be that the differences in levels of effort and reward in women are larger than that in men. In other words, the differences in men is smaller compared to that in women. Indeed, our further analysis showed that the difference between high effort and low reward was 1.27 in women vs. 1.14 in men. In contrast, the difference between low effort and high reward was −0.87 in women vs. −0.89 in men. The bigger numerator and smaller denominator in women than that in men confirmed the above speculation. In addition, women might also suffer from other unmeasured pressures, such as multiple tasks outside work (Tsai et al., 2016), social discrimination, family chores, and physiological stress, which may interact with ERI affect the occurrence of suicidal ideation. This may imply that on top of these multiple stressors, if women also experience stress from work (i.e. ERI), they may have a higher likelihood to have suicidal ideation compared to women without such work stress.

We found that high ERI was related to increased risk of suicidal ideation in central Europe, but not in other regions. One explanation for the difference may be cultural differences (Borsch-Supan et al., 2005) and the style in reporting suicidal ideation. In addition, there are different welfare state regimes (Craveiro, 2017) and socioeconomic conditions (Borsch-Supan et al., 2005) across Europe. A more explicit family-based social policy has been provided in central Europe due to low response or absence of public services. Also we found the effect of high ERI was only shown in people with medium or low level of education, not in those with high level. People with medium or low levels of education may have some characteristics, such as lack of social skills (Kaneko et al., 2007) and low sense of mastery (Dalgard et al., 2007), which could increase their level of stress and thus their likelihood of experiencing suicidal ideation. Surprisingly, we found that high ERI was related to increased risk of suicidal ideation among individuals with high-income, but not among those with low-income. It is possible that workers with high income often experience high demands and high levels of stress, and for those who had low levels of education, this would be a particularly stressful condition (Dalgard et al., 2007), but the latter hypothesis needs to be tested in further research.

High effort and low reward was also shown to predict elevated risk of depression (Rugulies et al., 2017), and our finding of a partial mediation of depression in the link between ERI and suicidal ideation adds to this line of interpretation (Cukrowicz et al., 2009). As briefly mentioned, the association between ERI and suicidal ideation might be explained by depression. The recurrent severe frustration of core rewards in occupational life that is experienced as unfair and unjust can generating feelings of humiliation, lack of self-esteem, and despair, which may lead to depression. As a matter of fact, compared to healthy people, those with depressive symptoms may experience more despair and distress caused by recurrent work stress. When these exceed the personal tolerance, more serious outcomes, such as suicidal ideation, may occur.

Furthermore, ERI can lead to a decline in subjective health and well-being (Inoue et al., 2011), which might lead to suicidal ideation. In line with this notion, our additional analysis examining the mediating effect of quality of life in the association revealed a significant indirect effect of high ERI via poor quality of life on risk of suicidal ideation. However, because 30.5% (n = 1513) of our study population had missing values on quality of life, this analysis could only be performed in a subpopulation and is therefore not included in this report. More research in other European countries is needed to confirm our results and to explore other unconsidered factors (e.g., religious belief and social support) that may be involved in a more complex association between ERI and suicidal ideation.

There are several strengths in the current study. First, the current study is one of the few cohort studies that provided evidence on the association between ERI and suicidal ideation, especially in middle-aged and older working population. SHARE is a prospective study with follow-up data collections, data on exposures were collected before the outcome, which minimizes recall bias and increases the potential for better causal inference. Second, the relatively large sample size ensures the validity of the results. Third, a number of potential confounders have been taken into account in the analysis and additional stratified analyses were performed to eliminate confounding effects. Finally, using data gathered from different regions of European countries increased the generalizability of the findings.

Nevertheless, some limitations of this study should be considered. First, suicidal ideation was obtained from the self-administered questionnaires. Suicide-related behaviors were criticized around the world (World Health Organizaton, 2014), thus it was possible that some participants might not report suicidal ideation even if they have experienced it. This information bias may lead to underestimation of the observed association. Second, our indicator of suicidal ideation was derived from a single item of the EURO-D. Although this single item has been shown to be able to predict suicidal ideation in a previous study, a more valid questionnaire to measure suicidal ideation is needed. Third, the variables in this study were all based on self-reported data and did not include macro factors, such as financial stability. Unmeasured confounders might have biased the observed results. Fourth, information on ERI and depressive symptoms were both obtained from wave 1. Therefore, the temporality of the relationship between work stress and depression remains unclear, and reverse causation cannot be excluded. Fifth, compared to non-participants in this study, participants were more likely to have higher education, to live in Northern Europe, and to report more co-morbidities. Therefore, generalization of findings of this study may be limited. Finally, results from subgroup analyses were based on a small sample of participants with suicidal ideation, therefore the results should be interpreted with caution. Further research is required to confirm these findings.

5. Conclusion

In conclusion, high ERI is associated with suicidal ideation in European working populations aged 50 and above. The association between ERI and suicidal ideation varies by gender, region, education and household income. Further, depressive symptoms may mediate the association between ERI and suicidal ideation. These results may provide guidance on the screening of high-risk groups with suicidal ideations and on the development of intervention strategies in working population.

Ethics approval

Ethics Committee of the University of Mannheim, Ethics Council of the Max Planck Society.

Availability of data and materials

We undertook a secondary analysis of data obtained under the SHARE Data Access Rules (http://www.share-project.org/). SHARE data can be accessed by anyone who abides by those rules.

CRediT authorship contribution statement

Zhuo Lai-Bao: Data curation, Formal analysis, Writing - review &

editing, Validation. **Yao Wu:** Validation, Writing - review & editing. **Yan Zhen:** Validation, Writing - review & editing. **Giron Maria S.T.:** Validation, Writing - review & editing. **Pei Jin-Jing:** Validation, Writing - review & editing. **Wang Hui-Xin:** Data curation, Validation, Writing - review & editing.

Declaration of Competing Interest

None.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jad.2019.09.007.

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