

## Short Communication

# Relationships between Effort-Reward Imbalance, Over-Commitment, and Fatigue in Japanese Information-Technology Workers

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Siegrist has suggested that situations in which people believe they have expended high effort, but perceive themselves to have reaped relatively little reward, lead to a state of emotional distress<sup>1,2</sup>. People's ability to cope with stress varies, and the effort-reward imbalance (ERI) model can accommodate this. People who are over-committed will exaggerate their efforts because of their desire for esteem and approval, and will find the discrepancy between effort and reward particularly stressful<sup>1-3</sup>. Therefore, Siegrist proposed that over-commitment not only results in emotional exhaustion but also exacerbates the negative effects of the ERI<sup>1,2,4</sup>. In Japan, the economic recession of the 1990s and increased international competition have forced companies to restructure. The Japanese traditional systems, which include lifetime employment and seniority-constrained wages and promotions, are being dismantled. Consequently a performance-based pay system has been introduced that has resulted in a competitive working climate, over-commitment, and job insecurity among workers. Fatigue may lead to occupational accidents in the workplace, as well as negative health outcomes. In this study, Siegrist's hypothesized model, the negative effect of ERI on fatigue and its exacerbation through over-commitment, was assessed in Japanese overtime workers<sup>1,2,4</sup>.

## Methods

The study participants were workers who had been engaged in computer work for less than 20 yr in a Japanese information service company in Tokyo. The company employed a total of 1,000 workers, and the

participants had worked 80 h of overtime or more in at least one month during the period April 2003 to January 2004. Overtime work was confirmed on the basis of the company payroll records. Participants were engaged in consultation, system integration solutions, and data management relevant to information-technology (IT). None of them had suffered from major or chronic diseases, as confirmed by annual health examinations. Because evidence suggests that Siegrist's ERI model applies to both sexes<sup>1</sup>, there were male and female participants in the study. The study design received ethical approval from the company's Committee of Labour and all participants gave their informed written consent. We observed the universal ethical guidelines established by the Declaration of Helsinki in conducting the study.

All the participants were asked to come to the health center at the company and complete two questionnaires, the Effort-Reward Imbalance Questionnaire (ERIQ) and Profile of Mood States (POMS).

A Japanese version of the ERIQ, developed by Tsutsumi et al., has three main scales: extrinsic effort, reward, and over-commitment<sup>4</sup>. Extrinsic effort refers to the demanding aspects of the work environment (subjective evaluation of the workload). Reward refers to three subscales: financial remuneration, esteem, and career opportunities, which includes job security. A score for the effort-reward ratio was obtained by calculating the logarithmic-transformed ratio between extrinsic effort and reward as a continuous measure<sup>5,6</sup>. Over-commitment indicates a state of exhaustive coping that reflects frustrated but continued efforts and associated negative feelings. A score for over-commitment was obtained from the sum score.

The POMS is a self-administered questionnaire that assesses the mood of a subject<sup>7</sup>. Fatigue was evaluated using the sum score of POMS fatigue items. The validity and reliability of the Japanese version of POMS have been confirmed<sup>8</sup>.

The internal consistencies of the three main scales of the ERIQ and the POMS fatigue scale were determined according to Cronbach's alpha coefficient<sup>9</sup>. Partial correlations adjusted for age and sex, were assessed by regression models with the POMS fatigue score as the dependent variable. Standardized regression coefficients were used as the partial correlation coefficients. Interaction effects of ERI and over-commitment on fatigue were assessed by hierarchical multiple regression analyses as follows. In the first step, variables of age, sex, and the ERIQ effort-reward ratio and over-commitment scores were entered into a multiple regression model with the POMS fatigue score as the dependent variable. In the second step, the interaction term of the ERIQ effort-reward ratio and over-commitment scores (both continuous variables) were

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**Table 1.** Participant characteristics and partial correlations with fatigue (n=94)

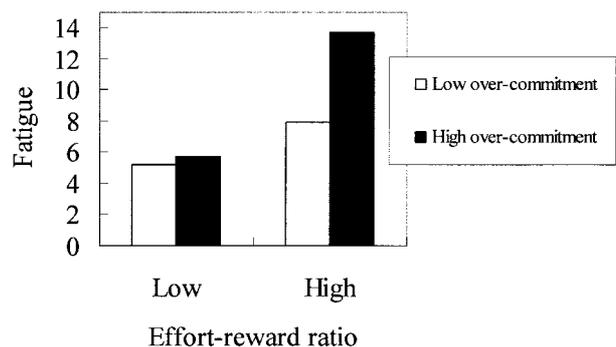
	Mean	SD	Minimum	Maximum		
Age (yr)	28.2	4.0	23	44		
POMS* fatigue score	8.7	6.1	0	26		
	N	%				
Male sex	83	88.3				
	Mean	SD	Minimum	Maximum	pr <sup>†</sup>	P value
Mean overtime work hours per month	112.5	12.3	96.5	156.6	0.12	0.310
ERIQ <sup>‡</sup> extrinsic effort score	13.1	4.7	5	41	0.31	0.002
ERIQ reward score	45.7	6.9	25	55	-0.47	<0.001
ERIQ reward subscale score of financial remuneration	15.7	3.1	6	20	-0.44	<0.001
ERIQ reward subscale score of esteem	21.3	3.6	9	25	-0.44	<0.001
ERIQ reward subscale score of career opportunities	8.7	1.4	4	10	-0.14	0.226
ERIQ effort-reward ratio	-0.50	0.42	-1.61	0.65	0.49	<0.001
ERIQ over-commitment score	14.1	3.3	7	22	0.43	<0.001

\*The Profile of Mood States. †Partial correlation coefficients with the POMS fatigue score adjusted for age and sex. ‡The Effort-Reward Imbalance Questionnaire.

entered into the regression model<sup>10,11</sup>). All variables were centered to adjust for artificially induced multicollinearity<sup>11</sup>). All the *p* values were two-tailed. All statistical analyses were conducted using SPSS (Version 12.0J, Tokyo).

**Results**

Ninety-four individuals participated in this study. All participants were Japanese. The internal consistencies of each scale were 0.54 for ERIQ extrinsic effort, 0.86 for ERIQ reward, 0.78 for ERIQ over-commitment, and 0.92 for POMS fatigue. Participant characteristics and partial correlations adjusted for age and sex are shown in Table 1. ERIQ extrinsic effort, over-commitment, and effort-reward ratio scores were positively associated with the POMS fatigue score after adjustment for age and sex with statistical significance (all *p*<0.005). The ERIQ reward score and reward subscale scores of financial remuneration and esteem were negatively associated with the POMS fatigue score after adjustment for age and sex with statistical significance (all *p*<0.001). The interaction effect of the ERIQ effort-reward ratio and over-commitment scores on the POMS fatigue score was significant (R<sup>2</sup> change, 0.059; F to test change, 8.465; *p*=0.005). The regression lines and predicted values illustrating significant interaction were constructed from the non-standardized regression coefficients and are depicted in Fig. 1. Values that were 1 SD above and below the mean were used to represent typical high and low scores for both the ERIQ effort-reward ratio and over-commitment. Increase of the POMS fatigue score



**Fig. 1.** Interaction effects of effort-reward ratio and over-commitment evaluated using the Effort-Reward Imbalance Questionnaire on fatigue evaluated using the Profile of Mood States. Values that were 1 SD above and below the mean were used to represent typical high and low scores.

accompanying the increase of the ERIQ effort-reward ratio score was greater in individuals with high ERIQ over-commitment scores than in those with low ones.

**Discussion**

In Japanese overtime workers, ERI was associated with fatigue, and increase of fatigue accompanying the increase of ERI was greater in individuals with high over-commitment than in those with low over-commitment. These results agreed with Siegrist’s hypothesized model that describes the negative effect of ERI and its

exacerbation with over-commitment<sup>1,2,4</sup>).

To our knowledge, there have been relatively few studies demonstrating the interaction effects of ERI and over-commitment<sup>1,12-14</sup>. A study of 204 German female nurses showed interaction effects on emotional exhaustion and personal accomplishment, but not on depersonalisation<sup>1,12</sup>. A study of 11,175 Dutch employees showed interaction effects on emotional exhaustion and job dissatisfaction, but not on psychosomatic symptoms or physical symptoms<sup>1,13</sup>. Additionally, a study of 167 Dutch ancillary health care workers failed to show such effects on exhaustion, job dissatisfaction, psychosomatic complaints, or physical symptoms<sup>1,14</sup>. The authors suggested that this failure could have been due to the small sample size<sup>14</sup>. In our study, despite the relatively low explanatory power of our analyses, owing to the small sample size, a significant interaction effect on fatigue was detected. ERI and over-commitment seem to be important factors for Japanese overtime workers in an IT company.

There are some limitations to our study. As the study sample was restricted to Japanese overtime workers in an IT company, the results may not be applicable to all Japanese workers. However, at present in most Japanese companies, computer work is common and overtime work is unavoidable; extended working periods, which prevent sufficient time for rest, continue to be on the rise.

As this was a cross-sectional study, causal relationships were not determined. However, because over-commitment is defined as an intrinsic factor, like personality<sup>15,16</sup>, it may be antecedent to fatigue.

Fatigue may induce occupational accidents in the workplace, and lead to negative health outcomes. The results suggest the need for interventions to reduce workers' ERI and over-commitment, in order to reduce workers' fatigue, improve productivity and limit occupational accidents.

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