The Effort-reward Imbalance Model: Experience in Japanese Working Population

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Abstract: The Effort-reward Imbalance Model: Experience in Japanese Working Population: Akizumi Tsutsumi, et al. Okayama University Graduate School of Medicine and Dentistry—The validity of Siegrist's effort-reward imbalance model was examined in Japanese workers: 105 dental technicians, 902 employees of production companies, and 2,827 selected from staff of hospitals. After controlling for possible confounders, levels of the two stress measures, 'effort-reward imbalance' and 'overcommitment', were similar for both genders. The effort-reward imbalance was most prevalent in the 25–30 age employees and then decreased with age, but the level of overcommitment increased with age. Those with lower educational attainment and others who reported working long hours were more often exposed to effort-reward imbalance and those in the private sector reported higher overcommitment levels than their respective counterparts. Hospital staff (predominantly nurses) had almost twice as high a level of effort-reward imbalance as production workers. A review of empirical studies confirmed validity of the criterion with respect to a self-reported health outcome and the responsiveness of the measures to organizational changes. Nevertheless, the low prevalence of an effort-reward imbalance (originally formulated by Siegrist's group on European samples) in Japanese employees seemed to reduce the statistical power of these tests. A subsequent change in exposure prevalence by defining the top quintile of the distribution of the logarithmic-transformed effort-reward ratio resulted in an improvement in the statistical fit. The Japanese evidence indicates promising

applicability of the effort-reward imbalance model, particularly if statistical approaches that measure the model's core notion are extended, and recommendation of repeated measures for exposure. Cross-cultural research on occupational stress is instructive in terms of health science.
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The model for effort-reward imbalance (ERI) at work, originally formulated by Siegrist's group on European samples, has been receiving considerable attention in occupational health research because of its predictive power for adverse health outcomes^{1,2}. This model defines stressful experiences at work as an imbalance between high effort expended and low reward received³. 'Effort' is evaluated by measuring work demands. Three transmitters are considered to be sources of a 'reward': money, esteem, and career opportunities. Considering current labor market developments in a global economy—fragmented job careers, job instability, redundancy, and forced occupational mobility, the importance of career opportunities is emphasized. Another unique feature of the ERI model concerns the inclusion of a personal component into an otherwise situational model of job stress. A distinct personal pattern of coping with job demands, termed 'overcommitment', in which a set of attitudes, behavior and emotions reflecting excessive endeavors combined with a strong desire for approval and esteem are defined. People characterized by overcommitment exaggerate their efforts beyond levels normally considered appropriate⁴. It has been hypothesized that not only is this coping critical enough to result in emotional exhaustion, it amplifies the ill effects of the effort-reward imbalance.

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The ERI model may provide a useful tool for studying current occupational stress in Japan, considering the work situation in the midst of a period of drastic transformation. The economic recession of the 1990s and international competition have forced organizations to restructure. The traditional Japanese system, which included lifetime employment and seniority-constrained wages and promotions, is fast disappearing. Consequently, a performance-related pay system has gradually been introduced, yielding a competitive working climate as well as a feeling of job insecurity^{5,6}. Job insecurity seems to influence middle-aged and older employees, in particular, who are likely to be targets of downsizing and have only restricted alternative job opportunities. Accordingly, the Japanese version of the ERI questionnaire has been introduced⁷. At least in test-statistical terms, the factorial structure of the ERI scales measuring the components of the theoretical concepts was replicated in a satisfactory way, and internal consistencies of the scales were appropriate^{7,8}.

Nevertheless, much effort is needed to prove whether the ERI model works cross-culturally. Confirming the discriminate validity may be a step. In Europe, several studies showed the stress levels according to different sociodemographic characteristics. The findings appeared to reflect the respective working situation, but differences in measurements preclude comparability. The WOLF study, in which those studied were representative of Swedish workers, and a German study of professional

bus drivers showed that the effort-reward imbalance level was higher in men than in women^{9,10}, whereas the Whitehall II study, in which British white-collar civil servants were investigated, showed the reverse¹¹. For socioeconomic status indicators, the effort-reward imbalance level was higher for white-collar workers and well-educated groups than their counterparts in the Swedish study. The opposite trends were observed in other studies in terms of occupational status^{10,11}, or occupation (higher in blue-collar than in white-collar), e.g., in the Kuopio Ischemic Heart Disease Risk Factor Study of a population-based male sample in eastern Finland¹². With regard to overcommitment, the Swedish study reported that the level of 'immersion' (a former term meaning one's personal coping pattern) was higher in women, white-collar employees, and the well-educated (men only) than in their counterparts. As an 'effort' component, personal measures (competitiveness, overcommitment, and hostility), but not a situation-specific effort, were included in the Whitehall II study and a broad array of work demands in the Finnish study. Low status control (poor promotion prospects and blocked careers) was the measure for low rewards in the Whitehall II study; and the investigators in the Finnish study derived an economic reward measure from actual income. In neither the Swedish WOLF study nor the study of German bus-drivers was the full version of the ERI questionnaire available so that further validation studies are necessary, using psychometrically valid, standardized instruments,

Table 1. Characteristics of the study populations

Occupation	Dental technician	Production	Production	Hospital staff	Nurse
<i>n</i> ^a	105	712	190	868	1,959
Response rate (%)	73	78	89	99	96
Gender					
% men	100	79	53	2	1
Age					
Mean years (range)	41 (22–67)	39 (19–63)	37 (20–59)	29 (20–63)	31 (20–59)
Career					
Mean years (range) ^b	20 (1–49)	9 (0–42)	13 (1–32)	7 (0–41)	9 (0–39)
Occupational status					
% manager/self-employed	53	25	14	11	11
Educational attainment					
% higher than high school	77	45	Not measured	89	100
Sector					
% public	4	0	0	0	67
Working hours					
% ≥50 h/w	74	44	Not measured	23	5
Shift work					
% yes	4	6	30	89	98

Note. ^aSample sizes noted in this table are the maximum number in the analyses. ^bYears of employment (worked less than 6 months were coded as 0).

taking into account the socioeconomic situations as well as cultural backgrounds in each country.

Outside the European society, there are no studies investigating the discriminant validity based on a large working population. Since the standardized ERI questionnaire has been applied to enormous numbers of Japanese employees, we are now able to approach the issue. Furthermore, testing the ERI model in several independent studies provided an opportunity to prove the applicability of the model to Japanese employees. The aim of this analysis was to investigate the associations of the stress indices with sociodemographic and work-related variables across some working populations. Empirical findings in the respective settings were also reviewed. Such analyses will provide further validation of the ERI model and offer a referential basis for occupational health research with this model.

Methods

This analysis was based on five databases: (1) 105 male dental technicians, (2) and (3) 712 and 190 employees of two private companies producing electrical devices and automobile parts, respectively; and the staff of several hospitals—(4) 868 from a private university hospital (predominantly nurses) and (5) 1,959 nurses from four public hospitals and another private university hospital. Some important sociodemographic and work-related profiles of the study population are summarized in Table 1. As shown, high response rates were obtained. Female employees made up more than three-quarters of the study population and the sample seemed to represent relatively young and well-educated workers.

The ERI questionnaire

The standardized self-administered questionnaire for measuring ERI^{3,9)} has been translated into Japanese by a back-translation process⁷⁾. The situation-specific component, composed of 17 items as measured by the scales for 'effort' (6 items, e.g., "I have constant time pressure due to a heavy work load") and 'reward' (11 items), composed of subscales, 'job promotion and salary' (4 items, e.g., "My job promotion prospects are poor"), 'esteem' (5 items, e.g., "I receive the respect I deserve from my superior"), and 'career opportunity' (2 items, e.g., "My job security is poor"). The person-specific component 'overcommitment' (29 items) composed of 4 uni-dimensional subscales 'need for approval' (6 items, e.g., "I usually take criticism very seriously"), 'competitiveness and latent hostility' (6 items, e.g., "Always being a little better or faster than others is sort of a game to me"), 'disproportionate irritability' (8 items, e.g., "Even the slightest interruption bothers me"), and 'inability to withdraw from work' (9 items, e.g., "Work is usually on my mind even when I go to bed"). Two summary measures were constructed to test the model:

first, a ratio of the summed items measuring 'effort' to the summed score of items measuring 'reward', according to statistical test instructions⁹⁾. In the original formula, only items with a prevalence of at least 10% were included and employees with a ratio >1.0 are expected to suffer from a critical effort-reward imbalance. For comparison, all the items were included to produce the summary measure in this analysis. The second summary measure concerned the personal component of the model, the critical pattern of coping. Employees scoring in the upper tertile of the summed score are considered to be at risk from 'overcommitment'^{3,9)}. The internal consistency and factorial validity of these scales, based on four of the current databases, have been reported elsewhere⁸⁾. Briefly, the alpha coefficient of each representative scale was .82 to .88 for effort, .80 to .91 for reward, and .60 to .76 for overcommitment. The factor structure was in line with the theoretical assumptions.

Procedure

A series of cross-tabulations of sociodemographic and work-related variables with the ERI stress measures, using the χ^2 test, was performed. Multiple logistic regression analyses were employed to see the independent associations. Categorical variables were coded by using dummy variables for logistic analyses and Odds ratios and 95% confidence intervals are displayed to indicate the relative magnitude of the association after controlling out the effect of the other variables. To avoid collinearity between age and career ($r=.782$, $p<.001$), one's career was not included in the model. Since there may be specific features due to occupation, two occupational categories were operationalized; that is workers in the production sector [database (1, 2, 3)] and in the service sector [hospital staff, database (4, 5)], and potential effect modification was investigated by stratified analyses of subgroups of data. Finally, the stress levels in the occupational groups were compared. Because women and the employees engaged in shift work were unevenly distributed among hospital staff, another logistic model was constructed by excluding these variables. It should be noted that one study population [database (3)] was excluded from the multiple logistic analyses because of the selected missing variables. For explanatory purposes, an analysis of variance was employed in which the mean effort and reward scores of the respective categories were compared controlling for each other factors. Empirical studies were also reviewed and the main results are presented. SPSS for Windows, release 6.1, was used for the statistical analyses.

Results

Associations among sociodemographic, work-related variables and the stress measures

Table 2 lists the prevalence of exposure levels for the

Table 2. Prevalence of the ERI measures (%) according to sociodemographic and work-related variables

	<i>n</i> ^a	Effort-reward imbalance	χ^2	χ^{2b}	Over- commitment	χ^2	χ^{2b}
Overall	3,834	7.3			30.2		
Gender							
Men	807	8.6	2.49		33.4	4.34*	
Women	2,998	6.9			29.5		
Age, years							
<=24	1,105	6.1	11.55**	0.24	28.1	9.19*	8.42**
25-30	1,090	9.4			28.7		
31-40	791	7.8			32.4		
>=41	819	5.5			33.7		
Career, years							
<=3	1,213	6.0	6.54†	0.54	28.4	5.82	4.65*
<=6	828	9.2			29.8		
<=14	862	7.1			29.6		
>14	889	7.1			33.5		
Occupational status							
Subordinates	3,253	7.0	2.19		29.0	13.93***	
Manager	563	9.0			37.3		
Education							
Higher than high school	3,099	7.3	0.63		30.4	0.15	
Lower	517	8.3			29.6		
Sector							
Public	1,315	6.8	1.49		27.0	8.69**	
Private	2,518	7.5			31.8		
Working hours, h/w							
<50	2,878	5.7	48.64***		28.8	10.19**	
>=50	664	14.0			35.3		
Shift work							
No	1,021	7.4	0.02		32.2	2.12	
Yes	2,798	7.3			29.6		
Occupation							
Production sector	1,007	7.0	0.22		31.3	0.70	
Service sector	2,827	7.4			29.9		

Note. ^aMaximum number; Sample sizes may differ due to missing observations. ^bTest for trend.

†*p*<.10, **p*<.05, ***p*<.01, ****p*<.001.

effort-reward imbalance and overcommitment according to the selected sociodemographic and work-related variables. The overcommitment level was higher in men than in women. The effort-reward imbalance level was highest in the 25-30 age group, and then decreased with age. The overcommitment level increased with age. One's career was highly correlated with age in this sample so that the association patterns were almost parallel to the age distribution for the stress measures. Those in managerial positions and employees in the private sector reported significantly higher levels of overcommitment than their respective counterparts. With regard to working conditions, reported working hours were strongly correlated with stress measures. No significant trends

were found that related to educational attainment, shift work, or occupations.

Table 3 displays the results of multiple logistic regression analyses. After controlling for each other variable, gender difference in the stress levels disappeared, but the age distribution for the stress measures did not change. The associations between the stress levels and the occupational status became less significant. Higher overcommitment levels in the private sector and higher stress levels in those who reported longer working hours remain significant. Stratified analyses by occupation revealed some specific findings. The prevalence of effort-reward imbalance was significantly higher in managerial nurses than in other

Table 3. Association between the ERI measures and sociodemographic and work-related variables^a

	Effort-Reward imbalance		Over-commitment	
	Odds ratio	95%CI ^b	Odds ratio	95%CI
All participants				
Women ^c	1.16	(0.67, 2.00)	1.14	(0.84, 1.53)
Age (25–30 yr) ^d	1.60	(1.11, 2.31)*	1.08	(0.89, 1.32)
Age (31–40 yr) ^d	1.20	(0.76, 1.90)	1.25	(0.99, 1.58) [†]
Age (≥41 yr) ^d	0.76	(0.43, 1.34)	1.41	(1.08, 1.84)*
Subordinates ^e	0.74	(0.46, 1.17)	0.85	(0.66, 1.09)
Lower education ^f	1.44	(0.93, 2.23)	0.80	(0.62, 1.04)
Private sector ^g	0.91	(0.64, 1.29)	1.32	(1.10, 1.58)**
Long working hour ^h	3.32	(2.36, 4.67)***	1.23	(0.99, 1.52) [†]
Shift work ⁱ	1.34	(0.77, 2.31)	0.98	(0.73, 1.30)
Production sector				
Women ^c	0.34	(0.10, 1.22) [†]	0.77	(0.46, 1.29)
Age (25–30 yr) ^d	2.85	(0.91, 8.94) [†]	1.31	(0.66, 2.62)
Age (31–40 yr) ^d	1.67	(0.52, 5.34)	2.25	(1.16, 4.34)*
Age (≥41 yr) ^d	0.65	(0.19, 2.26)	2.18	(1.13, 4.20)*
Subordinates ^e	1.81	(0.83, 3.98)	1.07	(0.71, 1.61)
Lower education ^f	2.21	(1.17, 4.15)*	0.90	(0.63, 1.27)
Private sector ^g	140.46	(0.00, 9.62E+16)	1.68	(0.17, 16.73)
Long working hour ^h	5.29	(2.52, 11.12)***	1.49	(1.03, 2.15)*
Shift work ⁱ	0.18	(0.02, 1.47)	0.39	(0.16, 0.96)*
Service sector (Hospital staff)				
Women ^c	0.62	(0.21, 1.86)	2.01	(0.88, 4.58)
Age (25–30 yr) ^d	1.46	(0.98, 2.18) [†]	1.10	(0.89, 1.36)
Age (31–40 yr) ^d	0.96	(0.56, 1.67)	1.10	(0.85, 1.44)
Age (≥41 yr) ^d	1.04	(0.54, 2.01)	1.30	(0.94, 1.79)
Subordinates ^e	0.46	(0.26, 0.82)**	0.81	(0.59, 1.12)
Lower education ^f	2.08	(1.01, 4.26)*	1.07	(0.65, 1.74)
Private sector ^g	0.92	(0.64, 1.31)	1.34	(1.11, 1.61)**
Long working hour ^h	3.10	(2.07, 4.64)***	1.02	(0.77, 1.35)
Shift work ⁱ	0.98	(0.42, 2.30)	1.10	(0.70, 1.73)

Note. ^aMultiple logistic regression analyses controlling for each other variable were employed.

^bConfidence interval. ^cReference category = Men. ^dReference category=Age≤24 yr. ^eReference category=Manager. ^fReference category=Higher than high school educational attainment. ^gReference category=Public sector. ^hReference category=Working hours<50 h/w. ⁱReference category=No shift.

[†]p<.10, *p<.05, **p<.01, ***p<.001.

nurses. The overcommitment levels were higher in the employees of private hospitals and lower in production workers with shift work than in the respective counterparts. Lower educational attainment was associated with effort-reward imbalance. The associations between working hours and the job stress indices were very robust.

After controlling for potential confounders, hospital staff were found to have almost twice as high a level of effort-reward imbalance as production workers (Odds ratio and 95% confidence interval=2.0; 1.3–3.1 for effort-

reward imbalance, and 1.2; 0.9–1.5 for overcommitment, respectively).

Criterion validity

Because of the low prevalence of the effort-reward imbalance exposure defined by the original formula, several statistical approaches were performed for each test. With a few exceptions, the associations among the outcome variables and the stress measures have been confirmed in a satisfactory way (Table 4).

Tsutsumi *et al.*⁷⁾ developed a Japanese version of the

Table 4. Review of the empirical studies: Criterion validities

Ref. No.	Study population	Outcome	Adjustment	Measure	Finding ^a
7)	105 male dental technician	Musculoskeletal symptoms ¹³⁾	Age, education, career, working hours, occupational status	ERI OC	2.0 (0.5–8.3) 4.6 (1.5–13.7)
15)	565 male employees of a production company	Psychiatric disorder ¹⁴⁾	Age, marital status, cohabitants	High effort Low reward OC	3.4 (2.3–5.0) 1.9 (1.3–2.9) 1.6 (1.1–2.4)
17)	190 employees of a production company	Depression ¹⁶⁾	Age, gender, occupational status, job type	ERI-L OC	3.8 (1.6–9.1) 3.1 (1.4–6.9)
20)	604 qualified nurses	POMS subscales ²¹⁾ High tension-anxiety Depression Fatigue Burn-out ²²⁾	Age, job demands, job control	ERI-M	4.1 (2.9–5.9) 3.9 (2.7–5.6) 4.2 (2.9–6.0) 4.9 (3.7–7.0)
24)	1,959 Nurses	Smoking prevalence Tobacco dependence ²³⁾	Age, marital status, qualification, shift work, occupational status	High effort Low reward OC High effort Low reward OC	1.1 (0.8–1.4) 1.3 (1.0–1.8) 1.1 (0.8–1.5) 2.4 (1.2–4.9) 1.8 (0.9–3.7) 0.8 (0.4–1.5)

Note. ^aOdds ratio (95% confidence interval). ERI=effort-reward imbalance: effort-reward ratio $E/(R \cdot C)$; E=sum score effort, R=reversed sum score reward, C=weight factor of number of items in the nominator divided by number of items in the denominator; ratio values >1 define exposure. OC=Sum score overcommitment, values in the upper tertile define exposure. High effort=Sum score effort, values in above median define exposure. Low reward=Sum score reward, values in below median define exposure. ERI-L=logarithmic effort-reward ratio, values in the top quintile define exposure. ERI-M=effort-reward ratio, values in above median define exposure.

ERI questionnaire and confirmed the psychometric properties for a sample of male dental technicians. A scale measuring self-reported musculoskeletal symptoms¹³⁾ was used as a reference for the test of criterion validity. After controlling for possible confounding variables, a significantly increased odds ratio of the high level of musculoskeletal symptoms in overcommitted versus non-overcommitted was found, but due to wide confidence intervals the odds ratio of the effort-reward imbalance was not significant.

Nagami and her colleagues found positive associations among the stress measures and psychiatric disorders measured by GHQ-28¹⁴⁾ in their male sample of a production company¹⁵⁾. Very recently her group found that the stress measures predicted the GHQ levels in their follow-up sample, even after controlling for the GHQ scores in the baseline (Dr. Makiko Nagami, personal communication).

Effort-reward imbalance and overcommitment were significantly associated with depressive symptomatology, defined by CES-D¹⁶⁾ for employees in a small plant¹⁷⁾. With an earlier version of the questionnaire, Miki *et al.*¹⁸⁾ found a similar association in their sample of 96 female

nurses. They also found an association between an ERI measure composed of median split measures of the components (effort and reward) and job satisfaction on the NIOSH scale¹⁹⁾.

Shimomitsu *et al.*²⁰⁾ examined the effect of the effort-reward imbalance on mental health among nurses in a university hospital. Nurses who showed an effort-reward imbalance had about a four times higher risk for three measures on the Profile of Mood States (POMS)²¹⁾: high tension-anxiety, depression, fatigue, and burnout²²⁾. With a screening questionnaire for tobacco/nicotine dependence²³⁾, Kawano²⁴⁾ found that high effort was significantly associated with tobacco dependence in smoking nurses. Also, in univariate analyses (*t*-test) on current smokers, she found higher smoking intensity (cigarettes smoked per day) in the groups with high effort and low reward than in their counterparts ($p < .01$ and $p < .05$, respectively), but she did not use the original formula for effort-reward imbalance because of the small number of cells for exposure.

Responsiveness of the stress measures

Two consecutive questionnaire surveys were conducted

for employees of a medium-sized company producing electrical devices²⁵). During the follow-up period, a series of substantial organizational restructurings occurred: i.e., the introduction of an annual salary payment plan; a voluntary retirement plan for force reduction; streamlining the production line; moving part of the engineering staff from the head office to the plant site; and sale of a factory. Analyses on 543 employees who responded to both surveys revealed that the exposure level of the effort-reward imbalance increased from 8.5 to 12.1%, which indicated reasonable responsiveness to the ERI questionnaire. The analyses also revealed that the measure of 'irritability' (a sub-scale of the overcommitment scale) significantly increased during the follow-up period.

Discussion

Because the study population was not representative of the entire Japanese working population, the following interpretations should be confined to the groups that were studied, but observed findings appear to show discriminant validity by reflecting some current working conditions in Japan. Furthermore, several independent empirical findings indicated the applicability of the ERI model with regard to various psychosomatic outcomes. The Japanese evidence provided further validation of the ERI model and some implications for future research with the model.

Sociodemographic profiles, working conditions and stress measures

After controlling for possible confounders, the stress measure levels were similar for the two genders. Many factors should be taken into account to generalize the results. For example, data exist that show gender discrimination in terms of pay or promotion (e.g., the female/male wage ratio is 63% on average²⁶) and a higher proportion of women are part-time or temporary employees, which means their pay and job security are inferior to those of regular employees⁵).

Exposure to an effort-reward imbalance was more prevalent in younger employees, whereas older employees were more overcommitted. The former finding seems to parallel the age distribution for main stressors found in a nationwide survey of 16,000 individuals from 12,000 private work sites, where peaks of the perceived stressors for the young through middle-age emerged, then declined²⁷). The under-representativeness of middle- and older- age groups and the inclusion of the public sector in our sample may explain some of the minor gaps. Additional explanatory analyses revealed that the effort level fell sharply in the oldest workers, and the reward level did not increase with age. The latter finding indicates that the age distribution for the stress measures was not necessarily linked to the

traditional Japanese lifetime employment and a seniority-constrained wage and promotion system. Rather, the item analyses revealed that middle-aged and older groups reported poor career opportunity (job insecurity) significantly more often than their younger counterparts did, which well reflects the current working situation in Japan. In the context, it is not only understandable that commitment for work is built on longer employment, but a harsh economic situation may also affect the attitude among middle-aged and older employees. Another explanation for the age trend of overcommitment is the secular trend in the Japanese attitude toward one's profession. Recent statistics have shown that younger employees put more emphasis on their family life and are less reluctant to change jobs than middle-aged and older workers^{28, 29}).

Observed difference between occupational sectors in the overcommitment level seemed due to the differences in the 'need for approval' and 'competitiveness', which may reflect the harsher working conditions (i.e., the survival race) in the private sector than in the public sector³⁰). In line with this observation, reported working hours were closely correlated with the stress measures. We expected that shift workers would have higher effort-reward imbalance³¹). Under-representativeness may explain the non-significant association. Another possibility is that the association may depend on the specific characteristics of the sample. In a study database (of a private university hospital) there was a higher level of effort-reward imbalance in the employees on shift work than in the employees on daytime work ($\chi^2=5.23$, $p<.05$).

Stratified analyses provided some additional findings. A high effort-reward imbalance for the managerial employees seemed specific to hospital staff. Managerial nurses reported lower reward levels, mainly due to low esteem reward, more specifically low support from supervisors and colleagues. They also reported poor promotion prospects. It was interesting to find that lower educational attainment was associated with higher effort-reward imbalance in the Japanese sample where relatively high homogeneity in social class and health is believed in, because exposure to effort-reward imbalance is hypothesized to be more prevalent in lower socioeconomic status²). A lower overcommitment level in production workers engaged in shift work was difficult to explain. The very small proportion who were shift worker might indicate that they were not necessarily engaged on the production line, but in surveillance or maintenance, which was not ascertained by the questionnaire.

Compared to production workers, hospital staff had a higher level of effort-reward imbalance even though the group included many female nurses in public hospitals where the job is more secure than in the private sector. Explanatory analyses revealed that hospital staff reported

significantly higher effort scores than production workers did. Although further studies are necessary, this finding is in line with a hypothetical background of frequent effort-reward imbalance experience among service occupations, in particular the ones dealing with client interaction^{2, 32}.

Criterion validity

Clearly, two common methodological weaknesses can be pointed out in the reviewed studies. The cross-sectional study design does not permit conclusions on the causal relationships between stress measures and health outcomes. In addition, both measures of stress and outcome variables were based on self-reporting, so it was possible that associations between the two were inflated from shared methods of variance and item overlap³³; or they could be spurious or driven by a "third variable" (e.g., neuroticism and negative affectivity)³⁴. In Europe, there are at least three prospective and semi-prospective studies with heart outcomes, and a number of cross-sectional and experimental studies with physiological measures, using the extrinsic and intrinsic components (or a combination of both) of the model^{1, 2}. *Hard* outcomes directly associated with physical health are needed if one wishes to provide further validation of the ERI model in Japan, but the reviewed studies at least showed non-contradictory associations of the ERI measures with each study outcome, which was guided by the theoretical hypotheses. Several recent studies also reported that the problem of shared method variance or the impact of negative affectivity should not be considered a major problem^{35–38}.

Responsiveness of the measure

Observed findings confirmed the reasonable responsiveness of the stress measures. They also indicate that some components of overcommitment may be affected by the social context (see Table 2 and the analysis on responsiveness of the measures). As Siegrist suggests, this coping pattern may be reinforced by specific circumstances in professional life². Scarce evidence calls for more research to explore the concept in relation to the social context as well as by observation throughout the professional life for the measure. These findings also imply the potentiality that intervention aimed at stress reduction at the interpersonal level will work by modifying the critical coping pattern³⁹.

So far, long-term exposure data on the ERI measures are scarce, not only in a Japanese setting but also in European research. Although the ERI model is constructed to identify chronically stressful experiences, failure to assess deterioration or fluctuations in the situation may cause imprecise evaluation. Considering the dynamic responsiveness of the ERI stress measures to organizational change, it is recommended that the

exposure level be assessed at more than one point in time so that prospective studies can measure long-term cumulative exposure or change in exposure levels.

Low prevalence of the effort-reward imbalance exposure

Finally, the low prevalence of the effort-reward imbalance exposure in Japanese employees and an example of its statistical solution should be discussed. As observed, low prevalence of the effort-reward imbalance exposure in a Japanese working population reduced the statistical power of the model. In the analyses of production employees in which the association between effort-reward imbalance and depression was examined, an alternative statistical approach was taken⁴⁰. The effort-reward ratio was estimated as a continuous measure to improve the statistical power of the construct by using a logarithmic transformation that places an inverse imbalance of the same magnitude at the same distance from 1 (when effort and reward are equal). After the participants were grouped into quintiles for an examination of the effort-reward ratio, those who fell in the top quintile were expected to suffer from a critical effort-reward imbalance. A comparison of the statistical findings was made between the original measurement of the effort-reward ratio >1.0 and the top quintile for the logarithmic ratio. After controlling for confounders, the latter procedure provided a statistically better fit (Odds ratio and 95% confidence interval=3.3; 0.6–18.1 for the former, and 3.8; 1.6–9.0 for the latter, respectively). Compared to the ratio of the ordinal data, the log-transformed procedure is advantageous in making full use of the information collected by the ERI measures, and minimizing the measurement errors.

The criterion for effort-reward imbalance exposure was established after several statistical test experiences in European settings, in which the prevalence range varied from 10 to 45% of the population studied⁴¹. A lower prevalence of the effort-reward imbalance exposure observed in the Japanese data may be partly attributable to the abovementioned Japanese traditional employment style (i.e., relatively stable job and expected salary irrespective of performance). Investigating the employees of big companies or foreign investment companies that have a performance-related pay system should show a different picture. Besides, cultural differences in the characteristics of the perception of stressors and expressions of distress between Asian and European populations should be elaborated. Alternative analytical approaches may be available, as shown above, to solve the problem of populations with a low prevalence, but there still remains the issue of international standardization of the questionnaire. Identifying differential item functioning is a key approach for this issue⁴².

Taking into consideration the under-representativeness of our study population and the weak study design used, we offer tentative conclusions and implications for future validation study:

- 1) A series of empirical findings with sociodemographic variables and psychosocial outcomes indicate that the ERI model captures stressful situations in the current Japanese working population.
- 2) The prevalence of effort-reward imbalance exposure and the associations between sociodemographic variables and the stress measures may be sample dependent. Thus more diverse sampling is necessary and comparative analyses among occupations will provide fruitful information. Also, from a cross-cultural perspective and for international comparisons, it is necessary to do item level comparisons of the response pattern in Asian and European settings.
- 3) From a methodological perspective, alternative statistical methods (i.e., cut-off point) should be available. It is certain that a prospective study design with repeated measures for exposure and intervention studies will be indispensable for confirming the usefulness of the ERI model.

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