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Association between work stress and health behaviours in Korean and Japanese ageing studies: a cross-sectional study

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ABSTRACT

Objectives Limited research has focused on the association between work stress and health behaviours in Asian countries. We aimed to explore the effect of work stress on two health behaviours among employees aged 45 years or above in two countries with ageing populations, Korea and Japan.

Design A cross-sectional study.

Setting This secondary data analysis was conducted on baseline data from the Korean Longitudinal Study of Aging (KLoSA, 2006) and the Japanese Study of Aging and Retirement (JSTAR, 2007 and 2009).

Participants Included in the analytical sample were 4982 responders without missing data aged 45 years or older who reported work positions and hours (KLoSA n=3478, JSTAR n=1504).

Main outcome measures Work stress was represented by the short version of the effort-reward imbalance (ERI) model. We used logistic regression and multinomial logistic regression to investigate the association between work stress and smoking (binary current smoking) and between work stress and drinking (categorical volume of alcohol). Socioeconomic and work-related characteristics were taken into consideration, and we examined the potential interaction between ERI and gender.

Results Work stress as measured by ERI ratio was significantly associated with both smoking and drinking in the KLoSA analysis; after the model was fully adjusted, ORs were 1.45 (95% CI 1.17 to 1.80) and 1.44 (95% CI 1.09 to 1.90), respectively. In analysis of the data from JSTAR, the ERI ratio was associated with smoking (OR 1.37, 95% CI 1.01 to 1.89) but not with drinking. No statistically significant interaction was found between ERI and gender in any model (p=0.82 in KLoSA data and p=0.19 in JSTAR data).

Conclusions Statistically significant associations were found between work stress and both smoking and drinking behaviours in Korea and between work stress and smoking in Japan. Government integration of effort-reward balance programmes and health promotion programmes could effectively promote population health in these two Asian countries.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study is the first to use the effort-reward imbalance model to analyse work-related stress and health behaviours in Korea and Japan simultaneously.
⇒ This study acquired baseline data from two reliable organisations (the Korea Employment Information Service (KEIS), Research Institute of Economy, Trade and Industry (RIETI)), which provided representative samples from Korea and Japan.
⇒ The results may be influenced by recall bias because both data sets consisted of self-reported questions.
⇒ We were not able to test the effect of residual confounding, such as drinking subcultures, on the association between work stress and health behaviours due to the data limitations of the two data sets.

INTRODUCTION

In the last few decades, many public health studies have highlighted the necessity of studying unhealthy behaviours such as smoking, drinking, poor diet and sedentary lifestyles.[1 2] Scholars have observed that smoking, binge drinking, lack of exercise and poor diet contribute significantly to high levels of morbidity and mortality in both developed and developing countries.[1 3 4] Work stress as a potential risk factor associated with unhealthy behaviours has not been studied extensively.[5 6] Moderate work stress can motivate people to become more productive; however, excessive or unmanageable work stress may increase the risk of unhealthy behaviours.[7] A theoretical framework for the association between occupational stress and health behaviours can be found in Lazarus and Folkman,[8] who found that individuals respond to threatening events via primary and secondary appraisals.[8] While individuals engage in 'primary appraisal' to evaluate potential threats, they use 'secondary appraisal' to identify opportunities to prevent or reduce the detrimental consequences of stress.[8] We sought to examine whether health behaviours play an important role in this secondary appraisal process.[8]

Two models for work stress evaluation

Work stress has been shown to result from dissatisfaction with work or from lack of reward for work effort.[7] Two models widely used in many epidemiological studies to evaluate the level of work stress are Karasek's job demand-control (JDC) model[9–11] and Siegrist's effort-reward imbalance (ERI) model.[12–15] The JDC model measures the magnitude of work-related stress from job demand and job control dimensions.[16] The model postulates that the most stressed people are those with high job demands combined with low work control.[17 18] In contrast, the core of the ERI model is the principle of the work contract and social reciprocity.[15] This model predicts that the combination of high effort and low reward significantly increases negative emotions and may lead to a high level of work stress.[19]

Reasons for studying the association between work stress and health behaviours in Korea and Japan

Most studies that examined the association between job stress and health behaviours have focused on European and North American countries, and only a few have focused on East Asian countries.[1 5] For example, a study from Finland adopted the ERI model to examine the relationship between work stress and smoking and found that highly stressed people were more likely to smoke.[2] A study from the USA, using the job strain model, produced a similar result and concluded that high-stress jobs were positively associated with smoking intensity.[17] In terms of drinking, Siegrist and Rödel, in their meta-analysis of 18 articles, investigated from the perspective of a Western lifestyle the association between work-related stress and alcohol consumption.[6] They indicated that most of the articles used the JDC model to evaluate work stress, while few articles used the ERI model.[6] Although a study from Norway failed to determine the association between work-related stress and drinking,[20] some European studies found that work-related stress contributed to chronic heavy drinking and alcohol addiction.[18 21 22]

Nevertheless, middle-aged and older workers in Asia have been shown to be particularly vulnerable to work-related stress.[23 24] Further, Korea, Japan and other East Asian countries have longer working hours than Western countries.[23] In 2007, the average working hours in Korea exceeded 2300, which is the highest among Organisation for Economic Co-operation and Development member countries.[25] Japan has a similar situation, and Okamoto[26] mentioned that approximately 30% of male and 10% of female Japanese workers had long working hours in 2015.[26] Although the governmental minister in Japan has introduced a criterion to limit overtime work, no consequences have been established for overworking situations.[26] Based on these facts and the lack of relevant policies and welfare systems guaranteeing the rights of employees in Asia, it is predicted that work-related stress might have a more serious impact on employees in East Asian countries than in Western countries.[23 24]

It has been postulated that East Asian people of various countries may have similar patterns of coping with stress.[24] We know that two developed countries with similar economic development patterns, Japan and Korea, have witnessed an increased rate of work-related deaths in the last three decades.[27 28] Since the early 1990s, sudden deaths due to heavy workloads have become common in both countries.[23] Thus, investigating the factors associated with health behaviours and work stress in Korea and Japan may provide valuable information for designing appropriate public health strategies. Further, this work may offer helpful experience for other countries that also face increasing problems related to work stress.

In Korea and Japan, evidence from the analysis of the relationships between work-related stress and health behaviours is limited.[29 30] Kawakami and Haratani pointed out that compared with some European countries, Japanese people felt less satisfied with their jobs, thereby making them vulnerable to work-related stress.[31] In a Korean cohort study, job security was negatively associated with smoking status among people aged 20–59.[32] Similarly, in a cross-sectional study conducted in Japan, a considerable number of nurses with high job strains depended on heavy smoking.[30]

Despite these similarities when exploring the association between work stress and healthy behaviour in Korea and Japan, no literature has compared the two countries directly. Several Japanese and Korean studies found that a gender difference might exist in the association between work stress and various health outcomes.[2 29 31 33] Lack of intrinsic work rewards and uncertainty about the future contributed to unhealthy behaviours more seriously in males than in females.[33 34] Moreover, previous studies also found that age, gender, education level, marital status, occupational grade, socioeconomic status and working time might be covariates that need to be controlled for when studying the relationship between work-related stress and health behaviours in Korea and Japan.[2 31 32 35]

Research gaps in work stress and health behaviours

In summary, past Japanese and Korean work stress research focused on the relationship between work-related stress and individual health behaviours in some specific occupations, but not in general population samples.[2 30 31] Thus, this paper focuses on the association between work stress and two unhealthy behaviours, current smoking status and heavy alcohol consumption, in Korea and Japan by using two well-known ageing data sets, the Korean Longitudinal Study of Aging (KLoSA) and the Japanese Study of Aging and Retirement (JSTAR).[6 36] To focus on a potentially vulnerable population, the target population of this research is middle-aged and older workers, aged 45 years and above, in Korea and Japan.[37] The short form of ERI used in the KLoSA and JSTAR data sets, previously used and partially validated by Siegrist *et al*, will be used to measure the ERI model.[13 37 38]

The study has three objectives: (1) to examine the association between ERI and health behaviours in KLoSA

and JSTAR, (2) to investigate the potential interactions between ERI and gender, and (3) to compare results from Korea and Japan and to identify any potential differences in findings.

METHODS

Study design

The KLoSA and JSTAR databases are public data with open access.[36 39] The KLoSA study was based on the random selection of men and women aged 45–98 in South Korea, excluding Jeju Island. The baseline data were obtained in 2006, and computer-assisted personal interviewing was employed to ask questions related to work stress and health behaviours. Because of the large number of missing outcome variables in the follow-up waves, we decided to focus our study on cross-sectional analysis using 2006 data (wave 1).

The JSTAR survey was conducted by the Research Institute of Economy, Trade and Industry (RIETI), Hitotsubashi University and the University of Tokyo.[36] This survey focused on men and women aged 50–78 in 2007. According to the JSTAR first results report, the data quality was evaluated by comparing the JSTAR database with the 2005 Japanese census data. JSTAR has a high response rate in terms of the Japanese standard; however, JSTAR data sets have various limitations, such as changing the questionnaire between waves.[36] Because of this, some variables are missing in different waves. Siegrist *et al* pointed out that JSTAR data were not of sufficient quality for the longitudinal analysis of work stress, as many people dropped out in later waves.[13] Hence, our project uses the baseline JSTAR data to perform cross-sectional analyses. The baseline data from five cities (Adachi, Kanazawa, Shirakawa, Sendai and Takikawa) were collected in 2007, with an additional two cities (Tosi and Naha) obtained in 2009.

Because KLoSA is a much larger study and past literature suggests that it is of better quality than JSTAR,[36 39] the present study will focus mainly on Korean results. The Japanese results will then be compared with the Korean results.

Study sample

Figures 1 and 2 present the analytical sample selection in this study. Responders in wave 1 of KLoSA (n=3478) and JSTAR (n=1504) who reported a working position and working hours and were not missing data were included in the analytical sample. A total of 482 participants were excluded from the analysis due to missing data, which accounted for 12.2% of the total workers in the Korean baseline sample. According to the same inclusion and exclusion criteria, approximately 53.5% (n=1504) of responders could be used from a Japanese sample. In summary, nearly 87.8% of the eligible Korean sample was analysed, while only approximately half of the eligible Japanese sample was included in the analysis. To test whether the potential bias caused by the missing values would influence the results, this study applied the multiple imputation method for both data sets. The samples after imputation accounted for 91.24% of KLoSA (n=3613) and 81.59% of JSTAR (n=2292).

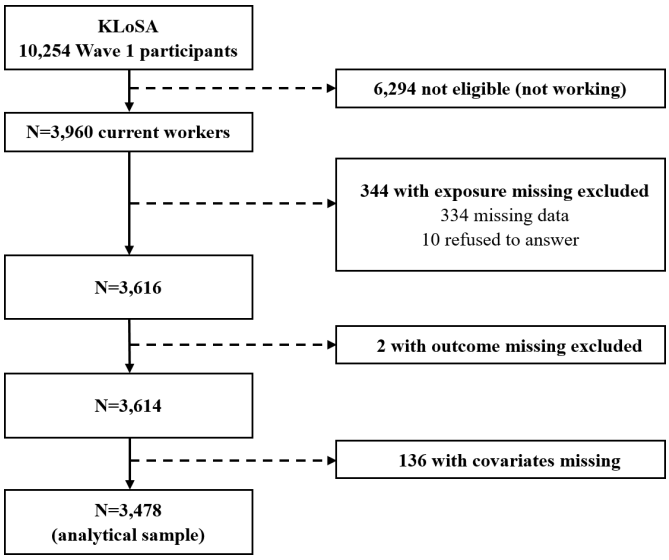

Figure 1 Flow chart of the Korean cross-sectional study sample selection. KLoSA, Korean Longitudinal Study of Aging.

Patient and public involvement

No patients were involved in this study that used deidentified data.

Measurement

ERI evaluation

ERI, the measure of work stress in this project, was measured with three questions in KLoSA and six questions in JSTAR. The ERI questionnaire used in those reports consisted of 17 items; six of the items measure 'efforts'

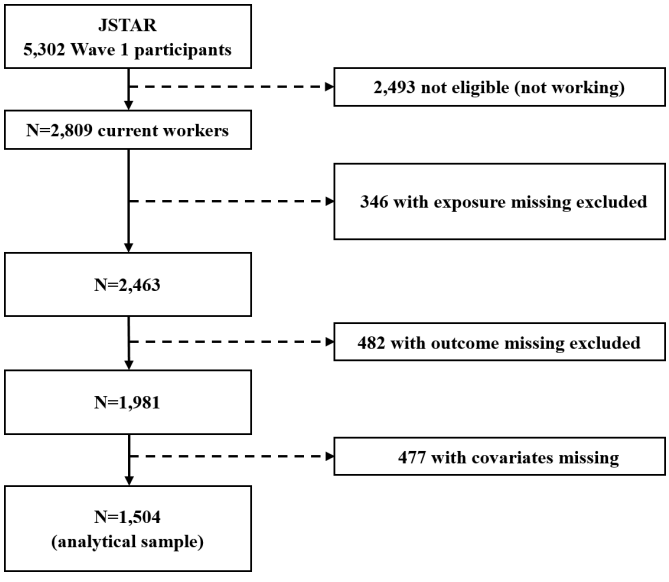

Figure 2 Flow chart of the Japanese cross-sectional study sample selection. JSTAR, Japanese Study of Aging and Retirement.

Table 1 Questions related to ERI measurement

	KLoSA	JSTAR
Effort	My job requires lots of physical effort.*	My current job involves physical labour.*
	N/A	I have a lot of work and always feel time pressure.*
Reward	I feel my job is secure.*	Do you think it is likely that you could lose your current job for a reason other than retirement?
	I am satisfied with current wage.*	Considering the effort I put in and the results I produce, I am satisfied with my current pay.*
	N/A	I receive appropriate evaluation on my work from coworkers.*
	N/A	When I have problems doing my work, colleagues give me advice and help me.*

*Reverse coding.
ERI, effort-reward imbalance; JSTAR, Japanese Study of Aging and Retirement; KLoSA, Korean Longitudinal Study of Aging.

and the remainder measure 'rewards'.[19] Because of limitations in the existing data from Korea, only one item was available for evaluating the effort dimension, while two items were available for assessing the reward dimension ('ERI [1+2]'). In data from Japan, two and four questions were used to measure 'efforts' and 'rewards' ('ERI [2+4]'), respectively. In 2012, Siegrist *et al* demonstrated that the short and long versions of the ERI model had similar properties.[13] Hence, the results from the analysis using the ERI (1+2) model will be directly comparable between KLoSA and JSTAR samples. Further, we used the ERI (2+4) model in a Japanese sample to carry out the sensitivity analysis.[40]

Responses to each item in the model used a 4-point Likert scale. A higher level of stress is indicated by higher scores on the effort scale and by lower scores on the reward scale.[40] The ERI ratio is calculated by adding the score of the effort and then dividing the value by the total score of reward, adjusted for the different number of items (correction factor), which is 0.5 in the three-item ERI model and six-item ERI model. Then, the categorical ERI is obtained by dividing the continuous ERI into tertiles.[13] Individual questions available in both data sets are shown in table 1, with questions requiring reverse scoring marked with an asterisk.

Health behaviours

The main health behaviours focused on this report are current smoking and drinking status. Measured as a binary outcome in the data from Korea, smoking was assessed by the question 'Do you smoke cigarettes now?' Participants who answered 'yes' were classified as current smokers, and those whose response was 'No' were considered non-smokers. The questionnaire in Japan asked, 'Do you regularly use tobacco, or did you use it in the past?' Participants were given three options: (1) Yes, I smoke now; (2) I smoked in the past, but I have quit; and (3) No, I have never smoked regularly. To ensure comparability between the two countries and considering that this paper mainly examines the current smoking variable, participants in Japan who chose option (1) were regarded as current smokers, and those who selected (2) or (3) were classified as current non-smokers.

Drinking was measured as a categorical outcome in the analysis. First, weekly alcohol consumption was calculated by multiplying the weekly drinking frequency of different drinks by their alcohol content. Next, according to the criteria of different drinking levels among men and women, we classified individuals in Korea and Japan into three groups: non-drinkers, moderate drinkers and heavy drinkers.[31] Males who drank between 0 and 210 g of alcohol per week (g/week) were considered moderate drinkers, and those who consumed more than 210 g/week were regarded as heavy drinkers. Similarly, females who drank approximately 0–140 g/week and more than 140 g/week were considered moderate drinkers and heavy drinkers, respectively.[41]

Covariates

All available covariates were categorised as demographic, social and socioeconomic, and work-related characteristics. Demographic variables included age and sex. Age was divided into 5-year age groups. Social variables included education and marital status. In each country, education was classified into four categories. Marital status was classified into five categories (married, separated, divorced, widowed and never married) in Korea but was available in only two categories (married/not married) in Japan. The work-related variables refer to working position and weekly working hours. In both countries, the working position was classified as non-supervisor, supervisor and self-employed. Participants were asked 'How many hours do you work per week on average?' to estimate weekly working hours.

Analytical strategy

This study employed the number (%) and mean (SD) for all variables of interest to describe the characteristics of the analytical sample. The associations between exposure (categorical ERI ratio) and outcomes (smoking and drinking) were examined in both countries separately. Given that smoking is a binary variable, logistic regression

was used to explore the relationship between ERI and the prevalence of smoking, and ORs were estimated. Multinomial logistic regression was used to evaluate the association between ERI and drinking. In both analyses, the associations between ERI and two outcomes were analysed in the same order of adjustment. For all the analyses, four adjusted models were fitted: (model 1) adjusted for age; (model 2) model 1+gender; (model 3) model 2+education, marital status; and (model 4) model 3+working position, working hours. Moreover, on the basis of model 4, we used the samples after imputation for the additional analysis and presented the results in model 5.

To compare the KLoSA and JSTAR data sets, our analytical process of JSTAR data used the same sequence of adjustments of the covariates as used for KLoSA data. As more ERI-related questions were available in JSTAR, we used a shorter version (ERI 1+2, same as in Korea) to make available comparisons and a longer version of the ERI model (2+4) to perform the sensitivity analysis. Additionally, we used ERI as a continuous variable in the sensitivity analysis since the arbitrariness of setting thresholds might exist in the categorical ERI variable.

Considering that differences might be observed in the healthy behaviours of men and women, likelihood-ratio tests were performed to examine the interactions between ERI and gender. The goodness-of-fit indices of the regression models, including and excluding the corresponding interaction terms, were compared (online supplemental tables 1 and 2).

All the analyses mentioned above were conducted in STATA MP V.16.

RESULTS

Characteristics of samples in Korea and Japan

Table 2 describes both analytical samples. The mean age of respondents in the Korean sample was 55.6 years (SD=8.3 years), while that of the Japanese sample was 59.2 years (SD=6.1 years). More than half of the participants had at least a high school education in both Korea (53.3%) and Japan (70.1%). A large proportion of subjects (Korea 88.6%, Japan 83.4%) were married. In both samples, the proportion of respondents in supervisory working positions was larger for men (Korea 15.6%, Japan 8.8%) than women (Korea 3.0%, Japan 2.9%).

The prevalence of smoking was 32.2% in Korea and 30.7% in Japan. In both countries, the prevalence of smoking was higher among men (Korea 44.5%, Japan 39.9%) than among women (Korea 3.6%, Japan 13.7%). The prevalence of male heavy drinkers was 21.1% in Korea and 43.0% in Japan; the prevalence of female heavy drinkers was 3.2% in Korea and 12.9% in Japan.

Evaluation of potential gender effect modification

In terms of the association between ERI and smoking, no statistically significant interactions by gender were found after adjusting for age, education, marital status, work position and weekly working hours (p>0.05). The p values

Table 2 Characteristics of the cross-sectional sample in Korea and Japan

Variables	Korea n (%)	Japan n (%)
Sample	3478	1504
Age		
Years, mean (SD)	55.6 (8.3)	59.2 (6.1)
45–49 years	1055 (30.3)	N/A
50–54 years	787 (22.6)	392 (26.1)
55–59 years	596 (17.1)	513 (34.1)
60–64 years	444 (12.8)	296 (19.7)
65–69 years	358 (10.3)	191 (12.7)
>70 years	238 (6.8)	112 (7.5)
Gender		
Male	2431 (69.9)	977 (65.0)
Female	1047 (30.1)	527 (35.0)
Education		
Elementary	988 (28.4)	330 (21.9)
Middle	635 (18.3)	
Vocational school	N/A	120 (8.0)
High	1281 (36.8)	715 (47.5)
College/university	574 (16.5)	339 (22.5)
Marital status		
Married	3080 (88.6)	1255 (83.4)
Separated	36 (1.0)	N/A
Divorced	90 (2.6)	N/A
Widowed	238 (6.8)	N/A
Never married	34 (1.00)	N/A
Not married	N/A	249 (16.6)
Working position		
Non-supervisor	1366 (39.3)	994 (66.1)
Supervisor	409 (11.8)	101 (6.7)
Self-employed	1703 (49.0)	409 (27.2)
Working hour		
Hours/week (SD)	48.5 (18.3)	41.7 (16.4)
Location		
Seoul	536 (15.4)	N/A
Other places	2942 (84.6)	N/A
ERI (1+2)	3478	1504
Lowest tertile	1611 (46.3)	543 (36.1)
Middle tertile	1001 (28.8)	579 (38.5)
Upper tertile (ERI)	866 (24.9)	382 (25.4)
ERI (2+4)	N/A	1504
Lowest tertile	N/A	559 (37.2)
Middle tertile	N/A	447 (29.7)
Upper tertile (ERI)	N/A	498 (33.1)
Smoking		

Continued

Table 2 Continued

Variables	Korea n (%)	Japan n (%)
No	2359 (67.8)	1042 (69.3)
Yes	1119 (32.2)	462 (30.7)
Drinking		
g/week (SD)	201.7 (289.2)	169.7 (242.5)
Never	1490 (42.8)	553 (36.8)
Moderate	1441 (41.4)	460 (30.6)
Heavy	547 (15.7)	491 (32.7)

ERI, effort-reward imbalance.

for the likelihood-ratio tests were 0.20 and 0.82 in Korea and Japan, respectively. After adjusting for all the covariates, no statistically significant interaction was found; the p value was 0.82 in Korea and 0.19 in Japan. The complete results of gender-specific analyses are shown in online supplemental tables 1 and 2. Although there was no statistically significant gender interaction, the results were different between men and women; for example, in Korea, the associations between work stress and health behaviours were much stronger in males than females.

ERI and health behaviours in Korea

Based on the KLoSA data set (2007), the results of different adjusted models for smoking and drinking are presented in table 3.

Smoking

As shown in table 3, all the results were statistically significant (p<0.05) among people who experienced the highest level of work stress (T3—high effort and low reward) compared with T1. After adjusting for age (model 1), the OR represents the ERI effect estimates on smoking behaviour, where the OR of upper ERI was 1.45 (95% CI 1.22 to 1.73). A considerable change in the effect estimates of the upper ERI group was observed after adjusting for gender (model 2), and the OR was 1.81 (95% CI 1.49 to 2.20). Further adjustment for social and work-related covariates reduced the effects of work stress but remained statistically significant (models 3 and 4).

Drinking

The effect estimates of ERI on drinking are presented in the bottom part of table 3. When comparing moderate alcohol consumers to non-alcohol consumers, the OR of upper ERI compared with low ERI was 1.15 (95% CI 0.93 to 1.42) in fully adjusted model 4, although this association was not statistically significant (p>0.05). Statistically significant results were obtained when examining the association between the upper tertile of ERI and heavy drinking. The OR in model 4 was 1.44 (95% CI 1.09 to 1.90). Additionally, gender accounted for the largest change in ORs in model 2.

In addition, place of residence was taken into consideration. In the data from Korea, participants were classified as living in the capital Seoul or elsewhere. The effect estimates of ERI did not change when the residence variable was added into the regression models. The result of the likelihood-ratio test showed that residence did not play a role in the association between ERI and smoking or between ERI and drinking when comparing the model with and without residence variable, as the p values were 0.30 in Korea and 0.87 in Japan, respectively.

In model 5, after missing values were imputed, the association between work stress and health behaviours presented similar results to the model that dropped missing values. In Korea, ERI was significantly associated with current smoking and heavy drinking behaviours, with ORs of 1.51 (95% CI 1.22 to 1.86) and 1.29 (95% CI 1.05 to 1.59), respectively.

ERI and health behaviours in Japan

In the data from Japan, using the ERI (1+2) model, the higher ERI group had a higher proportion of smoking individuals. Compared with the lowest tertile ERI group, the proportion of heavy drinkers in the upper tertile ERI group (31.1%) was slightly lower than that in the lowest tertile ERI group (35.3%).

Smoking

Table 4 shows the relationship between ERI and current smoking and alcohol drinking behaviours in Japan. To compare the results from Japan and Korea, the results also used the ERI (1+2) evaluation. The OR of smoking was 1.50 (95% CI 1.13 to 2.00) when adjusted for age (model 1) and was 1.56 (95% CI 1.16 to 2.10) when additionally adjusted for sex (model 2). The magnitude and strength of the association decreased when additionally adjusted for education and marital status. ERI in JSTAR remained associated with smoking in a similar way as in KLoSA. Moreover, the imputed Japanese sample presents a stronger association between job stress and smoking after adjusting for all the covariates in model 5.

Drinking

According to table 4, the relationship between the ERI categorised into tertiles and drinking in Japan was different from the trend seen in Korea. When comparing people in different ERI groups, people with higher work stress were less likely to drink. Moreover, when adjusted for additional covariates, work stress was not statistically associated with heavy drinking behaviour, and the effect estimates of ERI on drinking did not change much (model 3 and model 4), even when the imputed data sample was used (model 5).

Sensitivity analysis

The results of the sensitivity analysis are shown in tables 5 and 6. In table 5, using the ERI (2+4) model, the prevalence of smoking was the highest in the middle tertile. No statistically significant differences between the top and bottom ERI tertiles were found when the ERI (2+4) was

Table 3 ORs (95% CI) of the association between ERI (1+2) and current smoking and alcohol drinking in Korea

Korea	Model 1		Model 2		Model 3		Model 4		Model 5	
ERI (tertiles)	**OR (95% CI)**	**P value**	**OR (95% CI)**	**P value**	**OR (95% CI)**	**P value**	**OR (95% CI)**	**P value**	**OR (95% CI)**	**P value**
Smoking										
T1 (reference)	1.00		1.00		1.00		1.00		1.00	
T2 (middle)	1.07 (0.90 to 1.27)	0.42	1.38 (1.14 to 1.67)	0.001	1.23 (1.01 to 1.50)	0.04	1.21 (0.99 to 1.48)	0.06	1.25 (1.02 to 1.52)	0.03
T3 (upper ERI)	1.45 (1.22 to 1.73)	<0.001	1.81 (1.49 to 2.20)	<0.001	1.48 (1.20 to 1.83)	<0.001	1.45 (1.17 to 1.80)	0.001	1.51 (1.22 to 1.86)	<0.001
P for linear trend		<0.001		<0.001		<0.001		0.001		<0.001
Drinking										
Non-drinker	1.00		1.00		1.00		1.00		1.00	
Moderate drinker										
T1 (reference)	1.00		1.00		1.00		1.00		1.00	
T2 (middle)	0.83 (0.70 to 0.99)	0.04	0.99 (0.82 to 1.19)	0.88	0.99 (0.81 to 1.19)	0.88	1.00 (0.83 to 1.22)	0.98	1.26 (0.87 to 1.83)	0.23
T3 (upper ERI)	0.96 (0.80 to 1.16)	0.69	1.11 (0.91 to 1.36)	0.29	1.11 (0.90 to 1.37)	0.32	1.15 (0.93 to 1.42)	0.21	1.20 (0.80 to 1.81)	0.38
P for linear trend		0.45		0.34		0.36		0.24		0.34
Heavy drinker										
T1 (reference)	1.00		1.00		1.00		1.00		1.00	
T2 (middle)	0.81 (0.63 to 1.03)	0.08	1.01 (0.78 to 1.31)	0.92	0.96 (0.73 to 1.25)	0.75	0.94 (0.72 to 1.23)	0.66	0.97 (0.80 to 1.18)	0.79
T3 (upper ERI)	1.32 (1.04 to 1.67)	0.02	1.60 (1.24 to 2.07)	<0.001	1.45 (1.10 to 1.91)	0.008	1.44 (1.09 to 1.90)	0.01	1.29 (1.05 to 1.59)	0.02
P for linear trend		0.07		0.001		0.01		0.02		0.03
n	3478		3478		3478		3478		3613	

Model 1: adjusted for age.
Model 2: model 1+gender.
Model 3: model 2+education, marital status.
Model 4: model 3+working position, working hours.
Model 5: fully adjusted model (after MI).
ERI, effort-reward imbalance; MI, multiple imputation.

Table 4 ORs (95% CI) of the association between ERI (1+2) and current smoking and alcohol drinking in Japan

Japan	Model 1		Model 2		Model 3		Model 4		Model 5	
ERI (tertiles)	**OR (95% CI)**	**P value**	**OR (95%CI)**	**P value**	**OR (95% CI)**	**P value**	**OR (95% CI)**	**P value**	**OR (95% CI)**	**P value**
Smoking (1+2)										
T1 (reference)	1.00		1.00		1.00		1.00		1.00	
T2 (middle)	1.31 (1.01 to 1.70)	0.05	1.42 (1.08 to 1.87)	0.01	1.33 (1.01 to 1.75)	0.04	1.32 (1.00 to 1.75)	0.05	1.27 (1.00 to 1.61)	0.05
T3 (upper ERI)	1.50 (1.13 to 2.00)	0.005	1.56 (1.16 to 2.10)	0.004	1.36 (1.00 to 1.85)	0.05	1.37 (1.01 to 1.89)	0.05	1.41 (1.09 to 1.82)	0.01
P for linear trend		0.004		0.003		0.04		0.04		0.01
Drinking (1+2)										
Non-drinker	1.00		1.00		1.00		1.00		1.00	
Moderate drinker										
T1 (reference)	1.00		1.00		1.00		1.00		1.00	
T2 (middle)	0.74 (0.55 to 0.99)	0.04	0.74 (0.55 to 1.00)	0.05	0.77 (0.56 to 1.04)	0.09	0.76 (0.56 to 1.04)	0.08	0.87 (0.68 to 1.12)	0.29
T3 (upper ERI)	0.90 (0.65 to 1.24)	0.50	0.85 (0.61 to 1.18)	0.33	0.92 (0.65 to 1.30)	0.63	0.91 (0.64 to 1.29)	0.59	1.02 (0.78 to 1.34)	0.89
P for linear trend		0.40		0.26		0.53		0.50		0.93
Heavy drinker										
T1 (reference)	1.00		1.00		1.00		1.00		1.00	
T2 (middle)	0.71 (0.54 to 0.94)	0.02	0.71 (0.52 to 0.97)	0.03	0.71 (0.52 to 0.97)	0.03	0.71 (0.52 to 0.97)	0.03	0.79 (0.61 to 1.03)	0.08
T3 (upper ERI)	0.78 (0.57 to 1.07)	0.12	0.72 (0.51 to 1.02)	0.07	0.71 (0.49 to 1.01)	0.06	0.71 (0.50 to 1.02)	0.07	0.76 (0.57 to 1.02)	0.07
P for linear trend		0.08		0.05		0.04		0.05		0.06
n	1504		1504		1504		1504		2292	

Model 1: adjusted for age.
Model 2: model 1+gender.
Model 3: model 2+education, marital status.
Model 4: model 3+working position, working hours.
Model 5: fully adjusted model (after MI).
ERI, effort-reward imbalance; MI, multiple imputation.

Table 5 ORs (95% CI) of the association between ERI (2+4) and current smoking and alcohol drinking in Japan

Japan	Model 1		Model 2		Model 3		Model 4		Model 5	
ERI (tertiles)	**OR (95% CI)**	**P value**	**OR (95% CI)**	**P value**	**OR (95% CI)**	**P value**	**OR (95% CI)**	**P value**	**OR (95% CI)**	**P value**
Smoking (2+4)										
T1 (reference)	1.00		1.00		1.00		1.00		1.00	
T2 (middle)	1.49 (1.13 to 1.96)	0.004	1.71 (1.28 to 2.28)	<0.001	1.62 (1.21 to 2.17)	0.001	1.59 (1.18 to 2.14)	0.002	1.33 (1.05 to 1.68)	0.02
T3 (upper ERI)	1.30 (0.99 to 1.70)	0.05	1.31 (0.99 to 1.73)	0.06	1.21 (0.91 to 1.61)	0.19	1.17 (0.87 to 1.58)	0.29	1.40 (1.08 to 1.82)	0.01
P for linear trend		0.05		0.05		0.19		0.29		0.01
Drinking (2+4)										
Moderate drinker										
T1 (reference)	1.00		1.00		1.00		1.00		1.00	
T2 (middle)	0.79 (0.58 to 1.07)	0.13	0.83 (0.60 to 1.14)	0.26	0.84 (0.60 to 1.16)	0.28	0.85 (0.61 to 1.17)	0.32	1.02 (0.80 to 1.31)	0.86
T3 (upper ERI)	0.89 (0.66 to 1.20)	0.45	0.84 (0.62 to 1.15)	0.28	0.87 (0.64 to 1.20)	0.41	0.89 (0.64 to 1.23)	0.47	0.99 (0.75 to 1.31)	0.94
P for linear trend		0.44		0.27		0.40		0.47		0.96
Heavy drinker										
T1 (reference)	1.00		1.00		1.00		1.00		1.00	
T2 (middle)	0.75 (0.56 to 1.02)	0.07	0.82 (0.59 to 1.14)	0.24	0.80 (0.57 to 1.11)	0.18	0.80 (0.57 to 1.12)	0.19	0.85 (0.66 to 1.10)	0.23
T3 (upper ERI)	0.78 (0.58 to 1.05)	0.10	0.72 (0.52 to 0.99)	0.05	0.71 (0.51 to 0.97)	0.04	0.71 (0.51 to 0.99)	0.04	0.72 (0.53 to 0.97)	0.03
P for linear trend		0.09		0.04		0.04		0.04		0.03
n	1504		1504		1504		1504		2292	

Model 1: adjusted for age.
Model 2: model 1+gender.
Model 3: model 2+education, marital status.
Model 4: model 3+working position, working hours.
Model 5: fully adjusted model (after MI).
ERI, effort-reward imbalance; MI, multiple imputation.

Table 6 ORs (95% CI) of the association between ERI (continuous) and current smoking and alcohol drinking

	Model 1		Model 2		Model 3		Model 4	
ERI (continuous)	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
Korea								
Smoking	1.23 (1.12 to 1.35)	<0.001	1.40 (1.26 to 1.56)	<0.001	1.26 (1.12 to 1.41)	<0.001	1.24 (1.11 to 1.39)	<0.001
Drinking								
Moderate drinker	0.94 (0.77 to 1.16)	0.57	1.05 (0.85 to 1.30)	0.64	0.99 (0.79 to 1.24)	0.92	1.00 (0.80 to 1.25)	0.98
Heavy drinker	1.00 (0.91 to 1.11)	0.92	1.11 (0.99 to 1.24)	0.07	1.07 (0.96 to 1.21)	0.22	1.10 (0.98 to 1.23)	0.12
Japan (1+2)								
Smoking	1.32 (1.12 to 1.54)	0.001	1.32 (1.12 to 1.56)	0.001	1.21 (1.03 to 1.45)	0.03	1.23 (1.03 to 1.46)	0.02
Drinking								
Moderate drinker	1.05 (0.88 to 1.25)	0.58	1.01 (0.84 to 1.21)	0.91	1.06 (0.88 to 1.28)	0.55	1.05 (0.87 to 1.27)	0.60
Heavy drinker	0.92 (0.76 to 1.11)	0.38	0.87 (0.72 to 1.07)	0.19	0.86 (0.70 to 1.06)	0.17	0.87 (0.71 to 1.08)	0.21

Model 1: adjusted for age.
Model 2: model 1+gender.
Model 3: model 2+education, marital status.
Model 4: model 3+working position, working hours.
ERI, effort-reward imbalance.

used (model 4). However, the association between ERI (2+4) and smoking was found in the data imputed model 5, which was consistent with the results of the ERI (1+2) model. The OR of smoking was significantly increased in the middle ERI ratio group (models 1–4).

In terms of drinking, the results of ERI (1+2) and ERI (2+4) evaluation presented a similar trend among moderate drinkers. Additionally, the ERI ratios of the upper tertile (T3) in both ERI measurements had the widest range from 1.14 to 4 and from 0.93 to 3.20, respectively. The characteristics of drinking prevalence in the ERI (2+4) version were similar to those in the ERI (1+2) version. Meanwhile, when comparing the imputed (model 5) and unimputed (model 4) models, the associations between ERI and heavy drinking behaviours were consistent. Because the female data from Japan might not be reliable, this study also tested the gender-specific association between ERI and health behaviours (online supplemental tables 1 and 2).[19]

In table 6, when considering ERI as a continuous variable, similar results were found. There was a statistically significant association between stress and smoking in both countries. No association was found between job stress and drinking in Japan.

DISCUSSION

Main findings and comparison with previous studies

Our results indicate that a higher ERI level was positively associated with a higher prevalence of smoking and heavy drinking among Korean workers and positively associated with a higher prevalence of smoking among Japanese workers. ERI was, however, negatively associated with the prevalence of drinking in Japan. The Japanese results for alcohol consumption contradict some previous studies.[42–45] This finding might be due to report bias and selection bias. Nonetheless, the effect estimates and direction of the ERI were consistent with results from previous research in non-Asian regions.[46 47] Moreover, the results from Japan also provide some evidence for the validity of the short version of the ERI. In both analyses of JSTAR, the results using ERI (1+2) and ERI (2+4) are mostly but not entirely similar.

This study also used the likelihood-ratio test to explore the potential interaction between ERI and gender factors. No gender interaction was found in Korea or Japan. However, the associations between ERI and health behaviours were significant only among men. Although this finding may be because few women in both data sets were smokers or heavy drinkers, the result is consistent with a previous US study showing that gender was not an effect modifier in the relationship between work-related stress and health behaviours,[48] a finding contrary to most previous observational and experimental studies conducted in Western countries.[12] Our study found that work-related stress might be a protective factor against heavy drinking among Japanese workers and that this type of stress was not statistically significantly associated with outcomes among Japanese females. People with the

highest ERI levels had low odds (OR <1) of becoming heavy drinkers in Japan. Moreover, no significant association existed between work stress and drinking by comparing moderate drinkers to non-drinkers in Japan.

Thus, in Japan and Korea the association between work-related stress and drinking was dissimilar. The following explanations may account for the different results in Japan. First, an occupational drinking subculture could contribute to job stress. The purposes of socialisation and career development could also make individuals more or less prone to heavy drinking.[49] In several Asian countries, such as Japan, drinking alcohol is considered an essential way of engaging in social interactions.[45 50 51]

Differences in drinking patterns in Japan and Korea account for the disparity in the results. Most drinkers in Japan are moderate drinkers, while those in Korea are more likely to binge drink.[52–54] Hence, in Japan, the influence of drinking culture tends to be greater than the impact of work-related stress. Nevertheless, subculture and cultural norms are difficult elements to control in the analysis.[49] With a sample size of 26 946 people, one US study detected a statistically significant association between stress and drinking even though work-related stress had a much larger effect on male versus female drinking behaviours.[48]

Strengths and limitations of this study

This study used the ERI model to evaluate work stress levels and used two national-based data sets to examine the association between work stress and health behaviours in Korea and Japan. Compared with the JDC model, the ERI model concentrated on the personal component rather than the job dimension.[55] In previous research, only a few studies have applied the ERI model to explore the association between work stress and health behaviours.[19] Of those few studies, only a small percentage focused on Asian countries. Acquired from two reliable organisations (the Korea Employment Information Service (KEIS), Research Institute of Economy, Trade and Industry (RIETI)), the baseline data of this study were collected nationally. These data provided a representative sample in Korea and a male sample group in Japan. Although the representation of Japanese females was not ideal, it has been previously stated that JSTAR provides more useful information than other existing female-based studies because the latter were based on only a limited geographical area or a specific occupation or age group.[54 56–58]

This study fills research gaps regarding the association between Asian workers' stress and health behaviours. Moreover, the study sample in this project comprised middle-aged and older adults, 45 years of age and above, who may be more sensitive to the experience of work-related stress than younger people.[59] Multinomial logistic regression was applied in this project to explore the association between work stress and health behaviours, thereby providing a better way to control various potential confounders simultaneously.

However, the results of this study have several limitations. One limitation is the small sample size of JSTAR after the selection process with the inclusion and exclusion criteria; and, due to data limitation, sampling weights were not calculated in our study. From a methodological standpoint, the nature of the self-reported questions may influence the results through reporting/recall bias.[60] Recall bias indicates that variation in personal response tendencies existed but was difficult to control.[61] Apart from possibly causing outcome misclassification, it is highly likely that the effect estimates of work-related stress on smoking and drinking are underestimated.[62 63]

A third limitation is that the effect of residual confounding from other risk factors, for example, drinking subcultures, was not taken into account because of data limitations of the two data sets.[43] Residual confounding might influence the association between stress and health behaviours, leading to underestimation or overestimation of the ORs of the association.[46 64 65] Moreover, due to the cross-sectional nature of the study design, the question of causality between work stress and health behaviours is not addressed at this time.

Suggestions for further research

In future research, it will be pertinent to identify other data sets in Korea and Japan to evaluate associations and determine whether the results are consistent within national boundaries, and to investigate whether any study has better data on drinking patterns to test the ERI-drinking association.

Furthermore, longitudinal studies based on a larger sample size are recommended to control for more possible confounders, to explore causality and to clarify the relationship between work-related stress and health behaviours.

CONCLUSION

Overall, after accounting for available covariates, our study found that higher work stress expressed by the ERI (1+2) version was positively associated with a higher prevalence of smoking and heavy drinking among senior workers 45 years of age and above in Korea, positively associated with a higher prevalence of smoking in Japan, but negatively associated with the prevalence of heavy drinking in Japan. The results indicated that the effects of work stress were not significantly modified by gender. The ERI-smoking association was similar in Korea and Japan. The ERI-drinking association, however, was different in these two countries. This discrepancy may be due to the action of work stress as a risk factor in Korea but as a protective factor in Japan. Based on these findings, we recommend that governments enhance the balance between extrinsic efforts and work rewards in Asian countries. Doing so may improve health behaviours, particularly smoking behaviour, of workers and accelerate social and economic development.

Contributors TC and HP designed this study. JG and HP drafted the statistical analysis plan. TC wrote the first draft of the manuscript, prepared the analysis and interpreted the data. JG and BZ helped with the data management and HP helped with the analysis. JG is responsible for the overall content as guarantor. All authors were involved in writing the manuscript, gave critical comments on multiple versions and approved its final version.

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Patient consent for publication Not applicable.

Ethics approval The Korean Longitudinal Study of Aging (KLoSA) received approval from the National Statistical Office (approval number: 33602) and the Institutional Review Board (IRB) of the Korea National Institute for Ethics Policy. The JSTAR survey was conducted by the Research Institute of Economy, Trade and Industry (RIETI), the Hitotsubashi University and the University of Tokyo, Japan. Data from KLoSA and JSTAR are publicly available with all data anonymised. This study also received approval for the secondary use of the KLoSA and JSTAR data. All methods in this study were carried out in accordance with the relevant guidelines and regulations. Since the KLoSA and JSTAR databases have been released to the public for scientific use and no experimental treatment was conducted on either human or animal subjects in this study, ethical approval was not required for the study. KLoSA and JSTAR were approved by relevant ethical committees in their respective countries, and all participants signed informed consent for participation in the study.

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Supplementary Information

Additional file 1：

Supplemental Table 1. ORs (95% CI) of the association between Effort-reward Imbalance and current smokers by gender

	Model1				Model2				Model3			
	male		female		male		female		male		female	
ERI(tertiles)	OR(95%CI)	p-value	OR(95%CI)	p-value	OR(95%CI)	p-value	OR(95%CI)	p-value	OR(95%CI)	p-value	OR(95%CI)	p-value
Korea												
T1(reference)	1.00		1.00		1.00		1.00		1.00		1.00	
T2(middle)	1.45(1.20,1.76)	<0.001	0.65(0.28,1.50)	0.31	1.26(1.03,1.55)	0.03	0.63(0.26,1.55)	0.32	1.29(1.05,1.58)	0.01	0.70(0.29,1.71)	0.44
T3(upper-ERI)	1.84(1.50,2.25)	<0.001	1.27(0.59,2.73)	0.54	1.49(1.19,1.85)	<0.001	1.03(0.44,2.42)	0.95	1.54(1.24,1.91)	<0.001	1.15(0.50,2.64)	0.75
p for linear trend		<0.001		0.64		<0.001		0.96		<0.001		0.75
N	2431		1047		2431		1047		2509		1104	
Japan(1+2)												
T1(reference)	1.00		1.00		1.00		1.00		1.00		1.00	
T2(middle)	1.44(1.0451.94)	0.02	1.34(0.73,2.46)	0.34	1.37(1.00,1.87)	0.05	1.23(0.65,2.30)	0.52	1.36(1.03,1.79)	0.03	1.07(0.66,1.73)	0.80
T3(upper-ERI)	1.62(1.16,2.27)	0.004	1.32(0.66,2.62)	0.43	1.52(1.06,2.17)	0.02	1.14(0.56,2.34)	0.72	1.58(1.17,2.14)	0.003	1.05(0.62,1.78)	0.85
p for linear trend		0.003		0.41		0.02		0.71		0.002		0.85
Japan(2+4)												
T1(reference)	1.00		1.00		1.00		1.00		1.00		1.00	
T2(middle)	1.49(1.10,2.01)	0.01	1.59(0.86.2,96)	0.14	1.41(1.03,1.93)	0.03	1.53(0.81,2.89)	0.19	1.33(1.02,1.74)	0.04	1.35(0.84,2.18)	0.21
T3(upper-ERI)	1.48(1.06,2.08)	0.02	1.33(0.69,2.55)	0.40	1.40(0.98,2.02)	0.07	1.13(0.58,2.21)	0.72	1.47(1.09,1.99)	0.01	1.32(0.76,2.28)	0.32
p for linear trend		0.01		0.39		0.05		0.73		0.01		0.29
N	977		527		977		527		1388		904	

Model1:Adjusted for age

Model2:Model1+ education, marital status, working position, working hours

Model3:Model1+ education, marital status, working position, working hours (after MI)

Supplemental Table 2. ORs (95% CI) of the association between Effort-reward Imbalance and drinking levels by gender

	Model1				Model2				Model3			
	male		female		male		female		male		female	
ERI(tertiles)	OR(95%CI)	p-value	OR(95%CI)	p-value	OR(95%CI)	p-value	OR(95%CI)	p-value	OR(95%CI)	p-value	OR(95%CI)	p-value
Korea												
nondrinker(baseoutcome)	1.00		1.00		1.00		1.00		1.00		1.00	
moderate drinker												
T1(reference)	1.00		1.00		1.00		1.00		1.00		1.00	
T2(middle)	0.95(0.76,1.19)	0.66	1.06(0.76,1.47)	0.75	1.00(0.79,1.26)	0.98	1.05(0.74,1.50)	0.77	1.36(0.90,2.05)	0.14	1.00(0.33,3.06)	1.00
T3(upper-ERI)	1.09(0.86,1.38)	0.47	1.22(0.85,1.75)	0.29	1.20(0.92,1.55)	0.17	1.19(0.81,1.75)	0.39	1.26(0.80,2.00)	0.32	1.36(0.44,4.24)	0.59
p for linear trend		0.57		0.31		0.21		0.40		0.27		0.60
heavy drinker												
T1(reference)	1.00		1.00		1.00		1.00		1.00		1.00	
T2(middle)	0.99(0.75,1.32)	0.97	0.97(0.43,2.18)	0.94	0.94(0.70,1.26)	0.68	1.01(0.43,2.39)	0.98	1.96(0.83,1.36)	0.62	0.89(0.64,1.23)	0.48
T3(upper-ERI)	1.63(1.23,2.16)	0.001	1.05(0.43,2.58)	0.92	1.53(1.13,2.08)	0.006	1.05(0.39,2.79)	0.92	1.42(1.09,1.86)	0.01	1.22(0.86,1.73)	0.26
p for linear trend		0.001		0.93		0.01		0.92		0.01		0.31
N	2431		1047		2431		1047		2509		1104	
Japan(1+2)												
moderate drinker												
T1(reference)	1.00		1.00		1.00		1.00		1.00		1.00	
T2(middle)	0.63(0.42,0.94)	0.03	0.89(0.55,1.45)	0.65	0.66(0.44,1.00)	0.05	0.92(0.56,1.49)	0.72	0.73(0.52,1.01)	0.06	1.07(0.72,1.60)	0.75
T3(upper-ERI)	0.63(0.40,0.97)	0.04	1.33(0.76,2.22)	0.34	0.66(0.41,1.05)	0.08	1.37(0.79,2.39)	0.27	0.89(0.62,1.27)	0.51	1.16(0.75,1.80)	0.51
p for linear trend		0.03		0.39		0.08		0.31		0.51		0.51
heavy drinker												
T1(reference)	1.00		1.00		1.00		1.00		1.00		1.00	
T2(middle)	0.61(0.41,0.89)	0.01	0.94(0.51,1.73)	0.85	0.61(0.41,0.91)	0.02	0.97(0.52,1.82)	0.92	0.68(0.50,0.93)	0.02	1.12(0.65,1.94)	0.69
T3(upper-ERI)	0.56(0.36,0.85)	0.007	1.09(0.54,2.21)	0.82	0.54(0.35,0.85)	0.008	1.17(0.56,2.44)	0.68	0.68(0.48,0.96)	0.03	1.04(0.56,1.93)	0.91
p for linear trend		0.005		0.84		0.006		0.71		0.03		0.89

Japan(2+4)												
moderate drinker												
T1(reference)	1.00		1.00		1.00		1.00		1.00		1.00	
T2(middle)	0.80(0.54,1.20)	0.29	1.00(0.61,1.65)	0.99	0.84(0.55,1.27)	0.40	0.99(0.60,1.65)	0.97	0.95(0.69,1.31)	0.75	1.16(0.79,1.72)	0.45
T3(upper-ERI)	0.58(0.37,0.90)	0.02	1.23(0.74,2.03)	0.43	0.59(0.37,0.95)	0.03	1.32(0.78,2.22)	0.30	0.85(0.59,1.22)	0.37	1.22(0.77,1.93)	0.40
p for linear trend		0.02		0.43		0.03		0.31		0.37		0.37
heavy drinker												
T1(reference)	1.00				1.00				1.00		1.00	
T2(middle)	0.79(0.54,1.15)	0.22	0.89(0.48,1.65)	0.70	0.78(0.53,1.17)	0.23	0.89(0.48,1.68)	0.73	0.86(0.63,1.17)	0.34	0.78(0.46,1.32)	0.36
T3(upper-ERI)	0.56(0.37,0.85)	0.007	0.74(0.38,1.44)	0.38	0.54(0.35,0.85)	0.007	0.78(0.39,1.54)	0.47	0.66(0.47,0.94)	0.02	0.83(0.45,1.55)	0.57
p for linear trend		0.007		0.38		0.007		0.47		0.02		0.49
N	977		527		977		527		1388		904	

Model1:Adjusted for age

Model2:Model1+ education, marital status, working position, working hours

Model3:Model1+ education, marital status, working position, working hours (after MI)