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Stress, strain, and health outcomes of occupational drivers: An application of the effort reward imbalance model on Taiwanese public transport drivers

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ABSTRACT

Stress is the primary cause of strain and health problems for occupational drivers whose jobs directly relate to public safety. Although several stress theories and scales have been proposed, the method of adequately measuring the stress of occupational drivers remains unclear. We investigated the reliability and validity of the effort–reward imbalance (ERI) model and the generic 23-item ERI scale and its association to strain and health problems in occupational drivers. A total of 927 Taiwanese public transport drivers were recruited. Parallel confirmatory factor analyses (CFAs) were applied to evaluate the validity of the ERI components. Their association with burnout levels, cardiovascular disease (CVD) symptoms, and self-rated health was examined using regression methods. The CFA results showed satisfactory psychometric properties of the ERI components. Physical demands, overtime, and stress-induced sleep problems were the primary stressors in occupational drivers. The regression results showed that an imbalance between effort and reward and overcommitment levels were strong and independent predictors of strain and health outcomes. We extend the application of the ERI model to measure the stress of Taiwanese public transport drivers; its correlation with strain and health outcomes shows that the ERI scale is a reliable tool for identifying strained or unhealthy drivers.

1. Introduction

Driver health is critical to public transport. Unhealthy public transport drivers may jeopardize their own safety and that of passengers. Unhealthy public transport drivers also pose a threat to the health of companies through increasing absenteeism or turnover. Among the risk factors that affect driver health, stress plays a crucial role. Prior studies have shown that prolonged stress is associated with various health problems, such as heart diseases, strokes, and gastrointestinal diseases (Black & Garbutt, 2002; Delongis, Folkman, & Lazarus, 1988; Kivimaki et al., 2002; Quick, 1998; Tse, Flin, & Mearns, 2006). If they present when driving, these health problems, such as cardiovascular disease (CVD), may immediately affect the driver's control of the vehicle, and contribute to the likelihood of traffic accidents. Although these health issues may not occur when driving, several studies have indicated that stressors intrinsic to the work environment can cause individual or organizational costs (Kenny, 2000; Tse et al., 2006). The importance of stress is also recognized by drivers. In a study of numerous

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health and wellness issues impacting US commercial drivers, stress was reported to be one of the top health risk factors (Krueger, Brewster, Dick, Inderbitzen, & Staplin, 2007).

Although the adverse effects of stress-induced health problems have been recognized, the method of adequately measuring occupational stress in public transport drivers is unclear. Unlike the body mass index (BMI) or blood pressure (BP), which can be measured objectively, the effect of stressful events is partially determined by people's perceptions of their own stressfulness (Cohen, Kamarck, & Mermelstein, 1983). Researchers have diverse views on the aetiology of occupational stress. Early occupational stress theories (e.g., the Work Adjustment theory) were developed in the medical and psychological fields, which emphasized individual factors and examined variables, such as personality. Sociologists subsequently addressed the critical effects of organizational factors on occupational stress, such as power structure, or the institutionalized conflicts of interest between safety and productivity. Systematic and transactional theories were then developed to integrate both personal and environmental factors into a single framework (Kenny, 2000; Kenny & Cooper, 2003).

In addition to evolving occupational stress theories, numerous scales have been proposed. Various theories have posited various scales; one theory can result in various scales. A number of scales gauge stress levels with generic items, and can be applied across various professions [e.g., the Siegrist 23-item ERI scale (1996)], whereas other scales use job-specific items, and are designed for specific jobs [e.g., the Gray-Toft & Anderson Nursing Stress Scale (1981)]. The scales can be simple and straightforward, and use a single item (''Is your job stressful?''), or thorough and comprehensive using lengthy lists of items to evaluate stressful events from every possible aspect, such as the 120-item pressure management indicator (Williams & Cooper, 1998). The purposes of measurement diversify the development of scales. Numerous scales were designed to examine the observed variations in stress levels [e.g., the job-effort scale by Tse, Flin, and Mearns (2007)]; other scales were designed to predict strain or health problems (e.g., the ERI scale for CVD prediction). Selecting occupational-stress scales for public transport drivers is challenging because of the numerous theories and scales that are available.

In the transportation field, the driver stress inventory (DSI) may be the most frequently used scale to measure driver stress (Matthews, Desmond, Joyner, Carcary, & Gilliland, 1997; Rowden, Matthews, Watson, & Biggs, 2011; Öz, Özkan, & Lajunen, 2010). The DSI is based on a transactional model of stress, that is, the cognitive stress process is influenced by environmental (e.g., the complexity of traffic) and personality factors, which can contribute to subjective (e.g., anger) or performance outcomes (e.g., reckless driving). Although the DSI was not designed to measure occupational stress, because the jobs of occupational drivers include driving, a significant correlation may exist between driver stress and occupational stress for occupational drivers. However, the connection between the DSI and health problems is unclear. Therefore, we did not use DSI.

The effort–reward imbalance (ERI) model and job demand–control (JDC) model (Karasek, 1979) are occupational stress models that have been widely used in the past two decades (Bosma, Peter, Siegrist, & Marmot, 1998; de Jonge, Bosma, Peter, & Siegrist, 2000). Although the ERI model is relatively new, this study selected ERI instead of the JDC model for the following reasons: first, the ERI model covers a broader range of stressful work experience because it includes more distant macroeconomic labor market aspects, such as job security, whereas the JDC model focuses on the characteristics of the job. This feature makes ERI more attractive than JDC because the recent economic downturn has disturbed job markets; second, the ERI model considers additional personal characteristics, whereas the JDC model focuses only on situational aspects (de Jonge et al., 2000). Applying ERI reduces the burden of exploring an additional scale to measure personality, which is a crucial factor and moderator, in examining the effects of stress on strain and health outcomes (Tse et al., 2006).

We show that the ERI model and the 23-item ERI scale (Siegrist, 1996) are appropriate for measuring the stress of occupational drivers; the reliable connections of the ERI components with strain or health problems enables the scale to be a useful tool in identifying strained or unhealthy drivers. In particular, we improve the understanding of the ERI model in the following aspects: first, we extend the application of the ERI model by measuring the stress of occupational drivers in an Asian society opposed to most prior studies, which were conducted in Western countries (Aust, Peter, & Siegrist, 1997; Peter, Geißler, & Siegrist, 1998; Tse et al., 2007). Second, we simultaneously evaluate the internal and external validity of ERI components opposed to prior studies where either internal or external validity were examined; this enhances the robustness of the ERI model and scale in measuring occupational stress. Third, we show the feasibility of using an odd-numbered Likert scale in measuring the overcommitment (OC) component in the ERI model that allows respondents to select an intermediate category if they are *neutral* or *impartial* to the item content.

The remainder of this paper is organized as follows: Section 2 presents reviews of the ERI model; Section 3 presents the methodology used in this study, including measurements, data collection, and analysis procedures. Section 4 presents analysis results; Section 5 provides discussions and policy implications; and finally, we present our concluding remarks in Section 6.

2. Effort–reward imbalance model

The assessment of occupational stress typically contains three basic components: job stressors, strains, and health outcomes (Hurrell, Nelson, & Simmons, 1998). The term ''job stressors'' refers to work-related environmental conditions that may affect the health and well-being of workers. The ERI model is rooted in social reciprocity theory, and postulates that job stressors originate from an imbalance between efforts and rewards; the lack of reciprocity between costs and gains (i.e., high effort and low reward conditions) may cause strain reactions that can contribute to negative health outcomes. The ERI model assumes that "Effort at work is spent as part of a contract based on the norm of social reciprocity, where rewards are provided regarding money, esteem, and career opportunities, including job security (Siegrist et al., 2004)." The ERI model further assumes the existence of intrinsic effort, which represents a specific pattern of coping with job demands and eliciting rewards. This coping pattern defines a set of attitudes, behaviors, and emotions that reflect excessive striving combined with a strong desire for approval and esteem. People characterized by a high level of intrinsic effort tend to exaggerate their efforts.

Strains include physiological and psychological reactions to these conditions. Two stress axes are specified in ERI-related literature: the sympathetic-adrenomedullary (SAM) and the hypothalamus–pituitary–adrenal (HPA) system (Bellingrath & Kudielka, 2008). Burnout is a frequent job strain that has been related to ERI stress in various professions, including nurses and teachers (Bakker, Killmer, Siegrist, & Schaufeli, 2000; Unterbrink et al., 2007). The sustained strain reactions over a certain period may cause health problems by evoking negative emotions and activating specific stress axes.

Health outcomes refer to enduring negative health states resulting from exposure to job stressors. The original purpose of the ERI model was to predict and explain the onset of cardiovascular-related health issues. Numerous studies have confirmed this connection (Aust et al., 1997; Peter et al., 1998; Siegrist et al., 2004; Tse et al., 2007; van Vegchel, de Jonge, Bosma, & Schaufeli, 2005). Recently, other studies have also shown that ERI can be linked to psychological and behavioral outcomes, such as vital exhaustion or addictive behaviors (Siegrist et al., 2004).

Fig. 1 shows the fundamental theoretical structure of ERI. The ERI model contains three components: effort, reward, and OC. The effort component contains six items, including physical load, time pressure, interruptions, responsibilities, working overtime, and increasing demands. The reward component, defined by 11 items, consists of three latent factors, (a) financial, (b) esteem, and (c) promotion and job security. The OC component comprises the inability to withdraw from work (five items), and disproportionate irritability (one item). Although effort represents extrinsic efforts, primarily demands and obligations from work, OC represents intrinsic efforts, which imply a "need for control," and can be treated as a work-related reformulation of the Type A concept.

The ERI structure implies the three hypotheses below.

H1 The extrinsic ERIhypothesis: An imbalance between strong extrinsic effort and low reward increases the risk of poor health.
H2 The intrinsic OC hypothesis(OVC): A high level of OC, which may result in continued exaggerated efforts combined with disappointing rewards, increases the risk of poor health.
H3 The interactionhypothesis: An extrinsic ERI combined with a high level of OC increases the risk of poor health.

This study tested the three ERI hypotheses with three strain and health outcomes, namely burnout levels, CVD symptoms, and global self-ratings of health. Burnout levels are regarded as a crucial psychological stress-induced strain (Bakker et al., 2000; Rubino, Luksyte, Perry, & Volpone, 2009; Unterbrink et al., 2007), which affects job performance, and increases turnover rates (Wright & Cropanzano, 1998). CVD symptoms were selected because of their influence on public transport drivers both on and off duty. Global self-ratings of health were selected to reflect the effect of occupational stress on overall health.

3. Methodology

3.1. ERI measurement

The effort and reward items were addressed in two steps. Initially, the participants responded to whether the item content described a typical experience in their work conditions. For those who agreed, a following question asked the extent to which they feel distressed by this typical experience. If the item content did not apply, it was coded as 1. If the item content applied, and participants felt that they were not *distressed*, *somewhat distressed*, *distressed*, or *very distressed*, it was coded

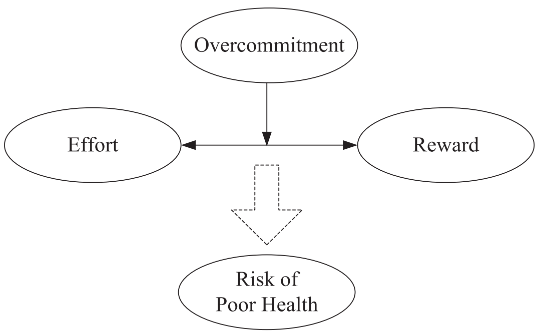

Fig. 1. Theoretical model of ERI.

with values from 2 to 5, respectively. Therefore, a total score based on the six items of effort (i.e., ERI 1–ERI 6) varied between 6 and 30, and this was based on the 11 items of reward (i.e., ERI 7–ERI 17), which varied from 11 to 55. A higher score showed an increased likelihood of a participant feeling distressed because of an experience specified by the item content.

The six items for OC were measured using a 5-point Likert scale, and were coded from 1 to 5. Consequently, a total score based on the six items varied between 6 and 30. A higher score showed an increased likelihood of a participant experiencing OC at work. The adopted Taiwanese-version ERI scale was developed by Tseng and Cheng (2002).

3.2. Other measurements

3.2.1. Burnout levels

Burnout level was measured using the Kristensen, Borritz, Villadsen, and Christensen (2005) Copenhagen Burnout Inventory (CBI). The inventory (Chang et al., 2007; Yeh, Cheng, Chen, Hu, & Kristensen, 2007) consisted of 19 items. Seven items were specifically for work-related burnout, which is the focus of this study. Each item was recorded on a 5-point Likert scale, with responses ranging from *always* (score 100) to *never* (0), or *very seriously* (100) to *very slightly* (0). The average of these seven items provided the global score of work-related burnout levels.

3.2.2. CVD symptoms

We used a self-reported CVD symptoms measurement. This variable was coded as 1 if respondents experienced any CVD symptoms in the previous year. Reported CVD symptoms included symptoms diagnosed by medical specialists, and general discomfort and pain.

3.2.3. Global self-ratings of health

We measured perceived health or self-rated health by asking participants to rate their overall health. Although health self-rating provides a simple global assessment, previous studies have shown that this measure is an inclusive and accurate measure of health status and health risk factors in judging trends and current levels of health (Idler & Benyamini, 1997). Self-rated health is a reliable predictor of mortality, highly associated with changes in functional ability (e.g., perceived control over driving), and has satisfactory validity and reliability (Chung & Wong, 2012; Idler & Benyamini, 1997; Idler & Kasl, 1995; Kaplan & Camacho, 1983; Windsor, Anstey, & Walker, 2008). Therefore, we used perceived health to investigate the health of public transport drivers.

We asked public transport drivers to compare their health to that of others of the same age to dismiss aging-related conditions. The question was stated as: "How is your health compared with others your age? Better, Same, or Worse?" Other studies have also used similar questions (e.g., Ho, 1991; Jagger & Clarke, 1988).

3.3. Data collection

The data set in this study was obtained from a government project, which was a preliminary study that explored the relationships between health conditions of professional drivers and their driving safety in Taiwan (Wong, 2009). The survey was conducted from October, 2009 to November, 2009. The participants were randomly chosen from driver lists acquired from the government, and were questioned on their health conditions, physical and psychological statuses, sociodemographic conditions, driving experience, and work environment. The response rate was approximately 86.5%.

3.4. Analysis procedure

The analysis procedure consisted of two stages. In the first stage, the CFA method was applied to examine the factorial structure of effort, reward, and OC. Siegrist et al. (2004) stated that the effort and OC components are unidimensional, whereas the reward component contains multiple latent factors, such as esteem, job promotion, and job security. This study used the suggestions of Siegrist et al. (2004) to formulate the initial structure, and subsequently, examined and modified the structure with CFA goodness of fit and modification indices. In the second stage, various regression methods were applied to examine the extrinsic ERI, the OVC, and the interaction hypotheses.

4. Results

4.1. Participants and ERI characteristics

This study recruited 927 participants. Approximately 63% of participants reported their perceived health as being similar to that of others their age, whereas 31% of participants reported better health, and 6% reported poorer health. Table 1 shows the basic characteristics of these drivers. The average *age* of the respondents was 39.97 years, with approximately 9 years of driving experience. On average, drivers were employed with their current company for 6 years. Their standard deviations were relatively high, indicating the widespread coverage of the participants, that is, young and older, and novice and

Table 1
Participant characteristics ($N = 927$).

Variable (unit)	Mean	S.D.
Age (years)	39.97	9.46
Body mass index (kg/m^2)	25.21	5.95
Company service year (years)	6.43	6.54
Driving experience (years)	8.97	8.38
Daily driving time (h)	8.90	3.96
Daily working time (h)	10.72	6.12

experienced. The majority of current public transport drivers in Taiwan are men, which is reflected by the sampled male percentage (96.21%). The average participants had a *BMI* of approximately 25, which is slightly higher than the normal threshold suggested by the Department of Health in Taiwan. The daily average *driving time* was approximately 9 h, with two additional hours for other tasks, such as cleaning the vehicle and standbys.

Table 2 shows the mean and standard deviations of ERI questionnaire items. Among the effort components, ERI 3 has the highest mean, indicating that responsibility is the most demanding item. The second most demanding item is time pressure. Conversely, interruptions and disturbances contributed relatively less to the effort component.

Compared to the effort component, the reward component has a relatively even distribution of item means. Item ERI 11 has the highest mean, which indicates that poor job promotion prospects contributed the most distress to the participants. The second highest mean was ERI 17, suggesting that inadequate salary is another primary concern for public transport drivers. In contrast, respect from colleagues (ERI 8) contributed relatively less to the distress in the reward component.

Among OC components, OC 6 had the highest mean, suggesting that sleep problems caused by job postponement is the most typically encountered OC situation for the participants. OC 1 had the lowest mean, indicating that the participants were not frequently overwhelmed because of time pressures at work.

4.2. Factorial structure of ERI

Table 3 shows the CFA modeling results of the three components of ERI (effort, reward, and OC). The analysis results showed that although the factorial structure of the effort component was the same as that proposed by Siegrist et al. (2004), one item must be excluded from the reward (ERI 15) and OC (OC 3) components to achieve satisfactory goodness of fit.

Table 2
Effort–reward imbalance questionnaire items.

Effort		Mean	S.D.
ERI 1	I have constant time pressure due to a heavy work load	1.99	1.20
ERI 2	I have many interruptions and disturbances in my job	1.41	0.86
ERI 3	I have a lot of responsibility in my job	2.36	1.23
ERI 4	I am often pressured to work overtime	1.78	1.13
ERI 5	Over the past few years, my job has become more and more demanding	1.92	1.07
ERI 6	My job is physically demanding	1.81	1.21
Reward		Mean	S.D.
ERI 7	I receive the respect I deserve from my superiors	1.46	1.00
ERI 8	I receive the respect I deserve from my colleagues	1.24	0.66
ERI 9	I experience adequate support in difficult situations	1.43	0.91
ERI 10	I am treated unfairly at work	1.47	0.99
ERI 11	My job promotion prospects are poor	1.86	1.28
ERI 12	I have experienced or I expect to experience an undesirable change in my work situation	1.75	1.15
ERI 13	My job security is poor	1.78	1.25
ERI 14	My current occupational position adequately reflects my education and training	1.34	0.82
ERI 15	Considering all my efforts and achievements, I receive the respect and prestige I deserve at work	1.47	0.97
ERI 16	Considering all my efforts and achievements, my work prospects are adequate	1.60	1.05
ERI 17	Considering all my efforts and achievements, my salary/income is adequate	1.85	1.35
Overcommitment		Mean	S.D.
OC 1	I get easily overwhelmed by time pressures at work	2.47	1.03
OC 2	As soon as I get up in the morning I start thinking about work problems	2.97	1.09
OC 3[a]	When I get home, I can easily relax and 'switch off' work	2.51	1.01
OC 4	People close to me say I sacrifice too much for my job	2.94	1.11
OC 5	Work rarely lets me go, it is still on my mind when I go to bed	2.60	1.03
OC 6	If I postpone something that I was supposed to do today I'll have trouble sleeping at night	3.11	1.12

[a] OC 3 is a reverse question. The score has been transformed; a higher score refers to a higher level of overcommitment.

Table 3
Internal consistency and goodness of fit of effort, reward, and overcommitment.

	Effort	Reward		Overcommitment	
		Initial	Final[a]	Initial	Final[b]
χ^2 (p)	38.33 (0.000)	417.42 (0.000)	146.94 (0.000)	71.52 (0.000)	22.41 (0.000)
χ^2/df	4.26	10.18	4.59	7.95	4.48
SRMR	0.023	0.050	0.037	0.037	0.022
RMSEA	0.059	0.100	0.062	0.087	0.061
NNFI	0.976	0.895	0.958	0.933	0.977
CFI	0.986	0.921	0.970	0.960	0.988
AIC	62.334	467.422	192.935	95.524	42.411
BIC	120.318	588.221	304.070	153.508	90.731
Cronbach's α	**0.85**	Esteem: 0.82 Job promotion: 0.83 Job security: 0.68 Whole: 0.90	Esteem: 0.79 Job promotion: 0.83 Job security: 0.68 Whole: **0.88**	0.74	**0.82**

[a] ERI 15 was dropped.
[b] OC 3 was dropped.

All p values of the chi-square in Table 3 are significant, which is partially attributed to the large sample size ($n = 927$). The relative chi-square (i.e., χ^2/df), also called the normed chi-squared values, are between four and five. Although these values are satisfactory by a loose threshold of five (Carmines & McIver, 1981), a relative chi-square value approaching 5 was also observed in other ERI studies (Siegrist et al., 2004). The standardized root mean square residuals (SRMR) were below the threshold of 0.05, suggesting a good fit for the models (i.e., a small difference between the observed correlation and the predicted correlation). The root mean square errors of approximation (RMSEA) were below the threshold of 0.08, implying a small discrepancy per degree of freedom (DOF) between these models and their saturated models. The non-normed fit index (NNFI) and comparative fit index (CFI) were both above 0.95, indicating good fit of the model. In brief, all the goodness of fit indices of the three models (i.e., effort, reward, and OC) were satisfactory.

The internal consistency of effort, reward, and OC was examined using the Cronbach's α. Table 3 shows that the Cronbach's α values for most components and subcomponents were above 0.7, indicating satisfactory reliability. The job security factor, a subscale of the reward component, had a slightly lower Cronbach's α value of 0.68, which may result from its small number of items.

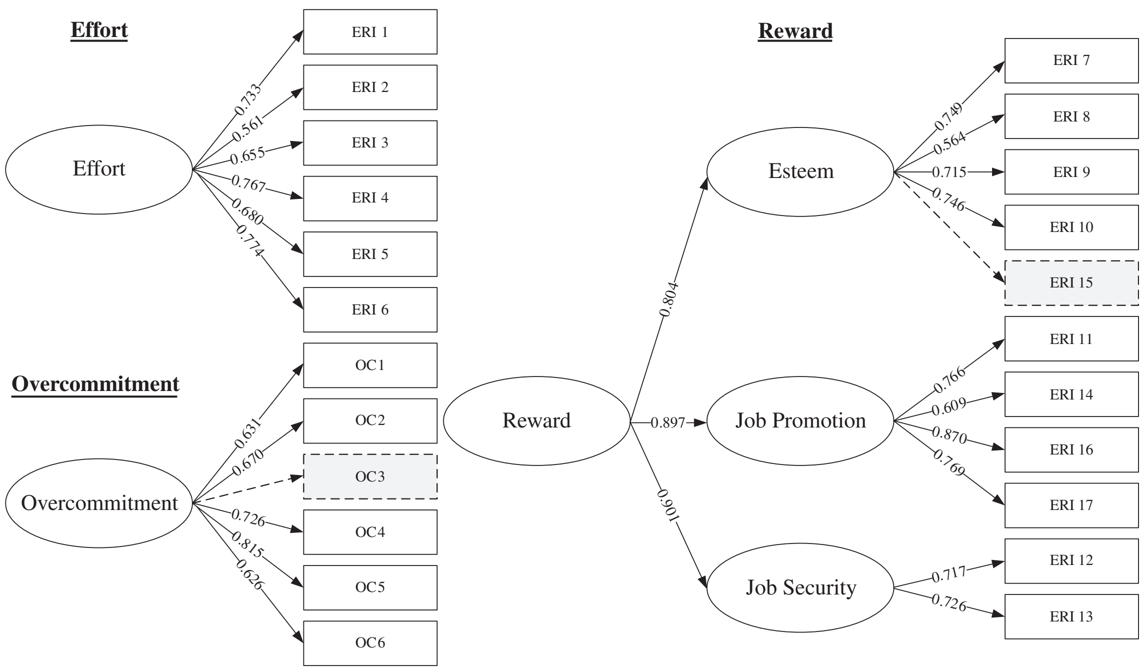

Fig. 2. Factorial structure of effort, reward, and overcommitment.

The factorial structure and the standardized loading are shown in Fig. 2; the shaded squares with dotted lines refer to items excluded from the final model. The estimated standardized loadings ranged between 0.56 and 0.90, indicating a medium to high correlation between the items and their associated latent factors. This range is similar to that presented in other studies (Siegrist et al., 2004).

In summary, nearly all of the fit indices were satisfactory. The single scales (i.e., effort, reward, or OC), and the composite measure (i.e., the effort–reward ratio) were subsequently used to examine the ERI hypotheses.

4.3. ERI hypotheses testing

Three variables were created to test the ERI hypotheses. The effort reward (ER) variable was defined as the ER ratio of $e/(r \times c)$ where e is the sum score of the effort scale, r is sum score of the reward scale,[2] and c defines a correction factor for various numbers of items in the numerator and denominator; the *OC* variable is the sum of the OC item values[3]; and the *interaction* variable is the product of the previous two variables. All continuous explanatory variables, including *ER*, *OC*, *interaction*, *age*, *BMI*, and *average daily working hours*, were mean-centered to aid interpretation. The coefficient significance was not affected by mean subtraction.

To determine the unique contribution of the ERI variables, this study presents three models for each outcome variable: the extrinsic ERI hypothesis was tested with the *ER* variable, whereas *age*, *BMI*, and *average working hours* were controlled; the *ER* variable was replaced with the *OC* variable when the OVC hypothesis was tested; and finally, all variables, including the *interaction* variable, were included in a model to test the interaction hypothesis. The variables of *driving experience* and *daily driving hours* were highly correlated with *age* and *daily working hours*, respectively, and were ignored.

4.3.1. Burnout levels

Burnout levels are a continuous variable bounded between 0 and 100. We applied multiple regression to estimate the relationship between ERI and *burnout levels*. Robust standard errors were used because of the significant heteroscedasticity of *burnout levels* (tested using the Breusch–Pagan/Cook–Weisberg test).

Table 4 shows that the extrinsic ERI and OVC hypotheses were supported, whereas the interaction hypothesis was not supported, as shown by the significantly positive coefficients of *ER* and *OC* and the nonsignificant coefficient of *interaction* (ER $\times$ OC). Among the other variables, *age* was the only variable with a significant coefficient; this implies that younger public transport drivers tend to experience higher burnout levels.

Model B1 shows that for an average female public transport driver, that is, with an *age* 39.97, *BMI* of 25.21, and *average daily working hours* of 10.72 (Table 1), a one unit increase of the *ER* variable (i.e., the ER ratio) was associated with a 30.454-unit increase of the *burnout level*. Similarly, the B2 model showed that a one unit increase of the *OC* for an average female public transport driver was associated with a 2.105-unit increase of the *burnout level*.

For the B3 model, the coefficient of ER implied a 27.358-unit increase of *burnout levels* resulting from a one unit increase in ER ratio for an average driver with an average OC level. Similarly, the coefficient of OC suggested a 1.126-unit increase of burnout levels because of a one unit increase in the OC level for an average driver with an average ER ratio.

4.3.2. CVD symptoms

This study surveyed the CVD symptoms using the self-reported questionnaire item, "whether any CVD symptoms were exhibited in the previous year." This was a yes/no question that was modeled using logit regression. Logit regression is a nonlinear regression model that requires the output variable to be either 0 or 1. For an explanation of logit regression readers can refer to Al-Ghamdi (2002) for an introduction and to Agresti (2002) for technical details. Table 4 shows, that similar to *burnout levels*, the extrinsic ERI and the OVC hypotheses were supported, but the interaction hypothesis was not, which is shown by the significantly positive ER and OC coefficients in Models C1 and C2 and the nonsignificant *interaction* variable in Model C3. Therefore, drivers who are more imbalanced in efforts and rewards or have a higher level of OC are more likely to experience CVD symptoms. Among the other variables, the variable *BMI* is the only significant variable; its positive coefficient suggests that drivers with a higher *BMI* value are more likely to experience CVD symptoms.

4.3.3. Global self-ratings of health

We measured health by asking the participants to rate their overall health as *better*, *same*, or *worse* (coded as 1, 2, and 3, respectively), compared to the health conditions of others of the same age. Because the health measure is a variable with an ordinal scale, ordered logit regression was applied. Table 4 shows that the extrinsic ERI and OVC hypotheses are supported but the interaction hypothesis is not. The positive coefficients of *ER* and *OC* in Models H1 and H2 suggest that strong efforts combined with low rewards and a high level of OC increase the probability of perceiving a lower level of self-rated health. Conversely, the significantly negative coefficient of the *interaction* variable contradicted our expectations.

[2] ERI 15 was dropped.
[3] OC 3 was dropped.

Table 4
Estimation results of regression models for the burnout levels, CVD symptoms, and global self-ratings of health.

	Burnout levels models			CVD symptoms models			Health models		
	B1 (extrinsic ERI)	B2 (OVC)	B3 (interaction)	C1 (extrinsic ERI)	C2 (OVC)	C3 (interaction)	H1 (extrinsic ERI)	H2 (OVC)	H3 (interaction)
Independent variables									
ER	30.454***		27.358***	1.508***		1.330***	1.457***		1.586***
OC		2.105***	1.126***		0.151***	0.075		0.084***	0.033
Interaction (ER × OC)			−0.822			−0.015			−0.094*
Age	−0.177***	−0.229***	−0.200***	0.035	0.031	0.033	−0.036***	−0.038***	−0.038***
Gender (male = 1)	−2.549	−3.858	−2.158	1.745	2.170	1.700	−0.429	−0.474	−0.384
BMI (body mass index)	0.021	0.068	0.015	0.042*	0.048*	0.040*	0.014	0.016	0.014
Ave. daily working hours	−0.009	0.101	−0.125	0.010	0.007	0.008	0.041***	0.041***	0.040***
Constant	32.454***	33.588***	34.965***	−7.739***	−8.095**	−7.603***			
Cut point 1							−1.945***	−1.977***	−2.045***
Cut point 2							1.947***	1.793***	1.862***
Statistics									
AIC	5982.486	6131.005	5891.946	249.960	258.778	252.117	1267.424	1288.576	1263.418
BIC	6010.142	6158.661	5928.821	278.038	286.855	289.554	1300.311	1321.464	1305.702
Likelihood	−2985.243	−3059.502	−2937.973	−118.980	−123.389	−118.059	−626.712	−637.288	−622.709

* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

Among other variables, the *age* and *average daily working hour* variables had significant coefficients. Younger public transport drivers tended to perceive poor health conditions than older drivers. Drivers working longer hours also tended to perceive a poor health level.

5. Discussion

5.1. Psychometric properties and factorial structure of ERI

Although the empirical factorial structure of ERI obtained in this study was generally consistent with the theoretical structure proposed by Siegrist et al. (2004), the ERI 15 and OC 3 items must be withdrawn from the reward and OC components, respectively, to enhance model fits. The ERI 15 reward item was expected to measure the latent factor “esteem,” but was found to be highly correlated with the other latent factor “job promotion.” This violates the theoretical structure and the assumption of structural equation modeling (SEM) that one item correlates with only one latent factor, and jeopardizes the model performance. This result partially indicates that it is occasionally difficult to disentangle financial aspects (i.e., job promotion) from career-related aspects (e.g., esteem) (Siegrist et al., 2004).

For the “OC” subscale, OC 3 was nearly irrelevant to the latent factor; its standardized coefficient in the CFA was 0.06. Unlike the other OC items, OC 3 was designed as a reverse question, which increases the difficulty in answering this question, and may cause confusion in the respondents, thus resulting in irrelevance. A low correlation was also located in other studies using the Taiwanese version 23-item ERI scale in other professions (e.g., Li, Yang, Cheng, Siegrist, & Cho, 2005). An ERI study conducted in the Netherlands (de Jonge, van der Linden, Schaufeli, Peter, & Siegrist, 2008) also found a relatively low correlation in OC 3. This suggests a re-examination of the design of OC 3 as a reverse question, particularly in the Taiwanese version.

The other item is ERI 6: “My job is physically demanding.” Siegrist et al. (2004) recommended that ERI 6 be included only when the prevalence of the physical workload is part of the typical task profile for the studied occupational groups. Numerous surveys showed that occupational drivers considered their jobs physically light (e.g., Tse et al., 2006); however, certain other studies regarded occupational driving as a physically demanding job characterized by continuous whole-body vibration and lengthy driving time (e.g., Krueger et al., 2007); the job tasks of occupational drivers may involve a significant amount of physical activity, such as loading and unloading their trucks or buses (Krueger & Van Hemel, 2001). Our analysis results show a relatively high standardized coefficient of 0.774 for ERI 6, suggesting that physical loading is one of the main sources of job demands for public transport drivers in Taiwan.

In addition to ERI 6, time pressure (ERI 1) and work overtime (ERI 4) exhibited relatively high standardized coefficients compared to other effort items. Unlike non-occupational driving, in which driving is a self-paced task, occupational driving requires following timetables, which makes driving a less self-regulated task (Krueger et al., 2007). Moreover, driving time is easily affected by traffic congestion, particularly in urban areas in Taiwan. Therefore, time pressure is one of the primary sources of distress to Taiwanese public transport drivers. The *average working hours* in our cohort was 10.7, higher than the typical 8 h-of-service standard in Taiwan. The lengthy driving hours and high correlation between *work overtime* (ERI 4) and perceived job demand (i.e., the effort component) indicate the importance of developing countermeasures to reduce or improve the management of the hours of service of Taiwanese public transport drivers.

The satisfactory psychometric properties of the OC subscale show the justifiability of using a 5-point Likert scale. In our empirical data, approximately one-third of the respondents selected the intermediate category, which suggests that a number of the respondents were neutral or impartial to the item contents. The related literature varies on the use of a Likert scale with and without a midpoint (Garland, 1991; Kulas & Stachowski, 2009; Raaijmakers, van Hoof, Hart, Verbogt, & Vollebergh, 2000; Weijters, Cabooter, & Schillewaert, 2010). Although this study provides positive evidence of using a 5-point Likert scale, further studies are required to determine the Likert type that can reveal the underlying response distributions of OC items.

5.2. Association with strain and health outcomes

We evaluated three strain and health outcomes: burnout levels, CVD symptoms, and global self-rated health levels. The results of these analyses were consistent: the extrinsic effort and the intrinsic OVC hypotheses were supported, although sociodemographic variables, driving experience, and work-related variables were jointly modeled. In contrast, none of the analysis results supported the interaction hypothesis. These findings can also be located in studies, in which the ERI models were applied to various professions and countries (see, for example, Table 2 of the review study by van Vegchel et al. (2005)). Therefore, we concluded that high effort combined with low reward and a high level of OC (independent of an ERI situation) are reliable indictors of higher burnout levels, CVD symptoms, and poor health in Taiwanese public transport drivers.

The interaction hypothesis in our empirical study was not supported when the outcome variable was *burnout levels* or *CVD symptoms*, and contradicted our expectation when the outcome variable was *self-rated health levels*. This unexpected result may be partly attributed to numerous methodological issues. We developed a series of moderated regression models to examine the interaction hypothesis; the effect of *OC levels* on the relationship between the ER, and strain or health outcomes was modeled using a product term of ER $\times$ OC. Numerous challenges in testing the interaction effects have been addressed in related literature (Whisman & McClelland, 2005), and were also encountered in this study. First, the reliability of the product term of two mean-deviated variables with uncorrelated true scores is the product of the reliabilities of the two variables (Cohen, Cohen, West, & Aiken, 2003). Consequently, the OC component in the current study had a reliability of 0.61 ($= 0.85 \times 0.88 \times 0.82$) only. To reduce this concern, the reliability for each ERI component must be improved to ensure satisfactory reliability for their products. The other issue that hindered our test of the interaction hypothesis was the sample size. The few observations of low *OC level* in the ER-greater-than-one region may be unable to represent the population, but can significantly affect the estimation result. To reduce the concerns of small sample sizes on extreme values, the overall sample size can be increased to increase the number of observations on extreme values. Another approach to reduce this concern is using regression models that are less influenced by extreme values, such as quantile regression models.

Although this study demonstrates considerable evidence of associating ERI components with strain and health outcomes, the use of generic effort items may limit the exploration of the source of distress events to public transport drivers. In their study investigating the occupational stress of bus drivers, Tse et al. (2007) used the ERI model and developed 39 job-specific effort items to replace the original six generic effort items. These job-specific effort items can account for more variance than that explained by generic effort items. However, measures of response to specific stressors may not be a better predictor of health problems than measures of response to generic stressors because an illness process may be affected by the global stress levels of people, not only by their response to particular events (Cohen et al., 1983). Tse et al. (2007) also showed that most facets of job-specific effort items did not exhibit a significant connection with the health problems of bus drivers. Therefore, generic effort items are suggested if the purpose of ERI applications is to associate with strain or health outcomes, as we have shown in this study.

6. Concluding remarks

Although numerous stress theories and scales have been developed, it is difficult to determine a theory or scale that can appropriately measure the stress of occupational drivers, and be a reliable indicator to their strain and health. This study showed that the model of ERI and the generic 23-item ERI scale measures the stress levels of Taiwanese public transport drivers appropriately, particularly when the purpose of the measurements is to associate with strain or health outcomes. ER ratio and OC levels are two ERI components that exhibit reliable and robust connections with strain and health outcomes; they elucidate variations that are unique to critical variables, such as *age*, *BMI*, or *driving time*. Therefore, we suggest these variables are used to identify strained or unhealthy drivers, who must be focused onto prevent possible undesired events.

We also demonstrated the feasibility of using a 5-point Likert scale for the OC component of ERI. The psychometric properties of the OC component and its association with strain and health outcomes are satisfactory and significant with this measurement change. Although numerous participants chose the intermediate category, further studies must examine the discrepancy of response distributions between 4- and 5-point Likert scales.

We were constrained by the reduced reliability of interaction variables and sparse observations on the extremes of the ER ratio; therefore, the interaction effect of ERI combined with a high level of OC was inconclusive. The methodological issues presented previously may provide a partial explanation for why only a few studies reported a significant interaction effect in the ERI model. Increasing the total sample size, oversampling observations on the extremes, and enhancing the reliability of individual ERI components require further research to thoroughly test the interaction hypothesis of the ERI model.

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