Article

# Exploring the effort-reward structure of university work focusing on perceived overall stress, self-reported health, and musculoskeletal disorders

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## Abstract

*Background*: The effort-reward imbalance (ERI) model by Siegrist encouraged numerous scientific investigations that reported particular ties between psychosocial risks and poor self-reported health (SRH), while psychosocial work-related stress has also been linked to musculoskeletal disorders (MSDs). The aim of this study was to examine the health status and the perceived levels of occupational stress of university employees and to analyse the findings according to the employees' effort and reward structure of work, perceived overall stress, SRH and the presence of MSDs.

*Design and methods*: 398 employees – including healthcare professionals, academic personnel and workers with administrative or other jobs – employed at the University of Szeged, Faculty of Medicine were investigated with a self-administered questionnaire including the Effort-Reward Imbalance Questionnaire (ERI-Q) and Perceived Stress Scale 4 (PSS-4).

*Results*: More than half of the investigated subjects (54.8%) reported some forms of MSDs. Low self-reported health (P<0.001) and presence of MSDs (P=0.015) were significantly associated with the level of perceived stress and effort-reward imbalance (ERI), moreover increased level of perceived stress was independently associated with the likelihood of MSDs (AOR=1.13) and low self-reported health (AOR=1.30). ERI well predicted low self-reported health (AOR=2.05) as well. Increased level of perceived stress positively correlated with high work-related effort (r=0.247, P<0.001) and over-commitment (r=0.387, P<0.001) while with work-related reward (r=−0.181, P=0.011) perceived stress showed a negative connection.

*Conclusion*: Our results suggest that addressing the burden of effort-reward imbalance and MSDs would likely lessen employees' perceived level of overall stress and affect their self-reported overall state of health.

## Introduction

Health is not only central to human well-being, it is also an essential social capital:[1] in healthy populations people live longer, the onsets of disabilities are delayed[2] and both absenteeism and economic cost of treatment is lower among healthy employees.[3] Therefore, addressing the social determinants of health is crucial in supporting a healthy, productive society.[1]

As one of the social and economic determinants of health, healthcare professionals are key to improve the quality of health services. However, they generally suffer from high levels of work-related stress that likely hinders their motivation.[4] Occupational stress is also a significant predictor of burnout; and higher burnout levels are in turn associated with diminished job performance and more absences[5] – particularly due to mental health issues, that are among the leading causes of absenteeism and early retirement everywhere in Europe.[6] Also there are substantial scientific evidence linking psychosocial work-related stress to cardiovascular diseases, affective disorders and musculoskeletal disorders (MSDs).[7]

This group of painful disorders of muscles, tendons, joints and nerves (*i.e.* MSDs) are the most prevalent health problem associated with work in Europe.[8,9] MSDs concern workers in all occupations[8] and generally several risk factors of MSDs are present.[9] Roughly three out of five workers in the EU-28 report MSD complaints.[8] Among them, healthcare workers have one of the highest self-reported MSD prevalence due to patient handling tasks,[9] while academic employees' prolonged sitting position – especially with frequent computer use – is a major contributor in MSD development as well.[10]

The complex relationship between psychosocial factors and MSDs is also well established.[7,11,12] The effort-reward imbalance (ERI) model by Siegrist[13] – which theorizes that high efforts spent and low rewards received is likely to elicit negative emotions and sustained stress[14] – encouraged numerous scientific investigations, that reported particular ties between psychosocial risks and cardiovascular diseases[7] as well as a significant association between effort-reward imbalance and poor self-reported health.[15]

Aside from having legal responsibilities to ensure a safe and healthy workplace, it is in the healthcare providers' best interest to create a health-promoting, ergonomic work environment for employee well-being, increased productivity and efficient management.[6,16]

**Significance for public health**

*In a university hospital setting, numerous areas of academic and healthcare work are strongly interlaced. For that reason, healthcare workers, academics, and employees with various other job roles all share the work-related psychosocial and health risks that originate from the same organizational setting. As work-related stress, poor self-reported health, and musculoskeletal disorders (MSDs) are all closely linked to effort-reward imbalance (ERI), exploring the effort and reward structure of university work could provide valuable insight in the possible role of the ERI model to guide interventions in this particular setting. Our results suggest that addressing university employees' ERI, their burden of MSD, or possibly both, would likely affect employees' perceived level of overall stress and self-reported overall state of health.*

### Aims of present study

The aims of this study are to examine the health status and the perceived levels of occupational stress of university employees in dependence of their socio-demographic characteristics, in addition to analyse the findings in relation to the employees' effort and reward structure of work focusing on perceived overall stress, self-reported health and the presence of MSDs.

## Design and methods

### Study design, population, and data collection

Data were collected during routine occupational health check-ups for healthcare professionals, academic personnel, and employees with administrative, other (*e.g.* cleaners) or multiple job roles (e.g. both practicing and teaching physicians). Subjects were all employed by the University of Szeged, Faculty of Medicine, working at its various medical, academic or administrative sites. The survey was scheduled from November 2017 through the end of June 2019; the study included 398 respondents.

Data were collected by a self-administered questionnaire. Questions concerned participants' socio-demographic data (age, gender, marital status, levels of education, type of job) and health status (self-reported level of health, MSDs and presence of any other chronic diseases). Regarding MSDs questions concerned joint stiffness and recurring pain in neck, back (upper, lower), upper extremity (hand, elbow, shoulder) or lower extremity (foot, knee, hip) for an unspecified extensive period of time.

Overall perceived stress level for each subject was determined using the Hungarian validated four-item version of the Perceived Stress Scale (PSS-4).[17,18] Participants were asked how often they felt or thought a certain way during the last four weeks on a five-point scale. After scoring the negatively-worded items and reverse scoring the positively-worded items the PSS assesses the participant's subjective global stress where higher scores indicating higher perceived stress.[19]

The effort and reward structure of work was measured by the short (15 items) Hungarian version of the Effort-Reward Imbalance Questionnaire (ERI-Q) psychometrically validated by Salavecz *et al.*[20] The effort-reward imbalance (ERI) model was originally developed to identify conditions of failed reciprocity with a particular focus on work, and to predict reduced well-being,[21,22] increased illness susceptibility[13] and diminished job satisfaction.[23] The model is also widely regarded as a well-justified measure of work-related stress, convenient for comparative socio-epidemiologic research.[24] As part of ERI-Q, subscales measuring work-related effort, reward and over-commitment was included.[20] ERI-Q uses Likert-scales to indicate whether ERI and over-commitment are present. Higher scores in effort and over-commitment refer to more demanding aspects of the work environment while higher scores in reward postulate higher extrinsic work-related reward.[24] In essence the more dominantly work-related effort is perceived over reward, the higher the ERI value is for that participant.

The effort–reward ratio (*i.e.* ERI) was calculated as: ER= (e / r) × c where 'e' is the summed score of the effort scale, 'r' is the summed score of the reward scale, and 'c' defines a correction factor for different numbers of items. As the short version of the Hungarian validated questionnaire contains three items in the effort subscale and six items in the reward subscale the correction factor was 0.5.[20]

### Statistical analysis

IBM SPSS Statistics 24.0 was used for the data analysis.

Descriptive statistics for the participants' characteristics were determined, and Cronbach's α value was calculated for each psychometric scale to check for reliability.

As sample distributions violate the assumption of normality, one-way ANOVA on ranks (Kruskal-Wallis H test) was used with pairwise comparisons (Mann-Whitney U test) for post-hoc analysis to determine any statistically significant differences between the medians of PSS-4 value and effort-reward ratio among groups formed according to sociodemographic and health related characteristics. Separate analyses for effort, reward, and over-commitment subscales were also included. Detailed comparisons among median PSS-4 values were also made based on ERI-Q items individually using one-way ANOVA on ranks.

Univariable and multivariable logistic regressions were used to assess the effect of PSS-4 and ERI on the presence of MSD and poor or average self-reported health. The multivariable model was adjusted for possible sociodemographic (gender, age, education, marital status) and occupational (job role) confounding factors. Odds ratios (OR) were calculated with 95% confidence intervals (95% CI).

To determine the independent contribution of ERI and each subscale of ERI-Q to perceived stress covariate-adjusted Spearman's rank correlation analysis was performed with the use of probability-scale residuals.[25]

During the analyses missing values were excluded. Statistical significance was set at $P<0.05$ (two-tailed).

## Results

Overall characteristics of the sample are summarized in Table 1.

Out of 398 university employees the majority were females. The median age of the participants was 38 years [interquartile range (IQR)=18.0] and university degree was the most common educational qualification. 45.6% of subjects were healthcare professionals (physicians, surgeons, nurses, midwives) and 13.2% were academics (professors of various ranks, lecturers, and/or researchers including PhD students). A sum of 82 employees (20.6%) involved in administrative and various other activities (cleaning and catering services, economic and management activities) were classified as *other*, while 10.3% of study subjects with multiple roles were defined as *mixed*.

More than half of the investigated subjects (54.8%) reported musculoskeletal disorders and around a third of the subjects suffered from any other form of chronic disease (excluding MSDs) lasting for at least six months. Thyroid disease (25 instances) and hypertension (23 instances) were the most commonly reported chronic conditions, followed by asthma (11 cases) and carbohydrate metabolism disorders (10 cases). Nearly a quarter of the participants expressed average and poor overall state of health.

Table 2 shows the overview and descriptive statistics of perceived stress, ERI, its corresponding subscales, and Cronbach's alpha coefficients for the scales. All Cronbach's alpha coefficients were over 0.7 indicating the reliability of the scales.

The relationships between medians of PSS-4, effort-reward ratio, or any of the aforementioned subscales to sample characteristics are presented in Table 3.

The results indicate that low self-reported overall health rating ($P<0.001$) and presence of any form of MSDs ($P=0.015$) were significantly associated with overall stress perception (PSS-4).

Other chronic diseases, socio-demographic characteristics or the type of job were not connected with PSS-4 values.

Considering each of the effort, reward and over-commitment subscales, the type of job affected all three. Post-hoc tests revealed that subjects having more than one role (*i.e.* mixed job) reported statistically significantly greater work-related effort and over-commitment compared to any other job role.

Female employees reported significantly lower work-related reward (P<0.001), and university graduates presented significantly higher perceived effort (P=0.021) and over-commitment (P=0.006). Aside from job role and gender, married or otherwise committed employees reported higher work-related effort compared to singles with marginal significance.

MSDs were significantly associated with all three subscales: effort and over-commitment subscales showed positive, while reward showed negative association with MSD. Suffering from any other form of chronic disease presented significant associations with perceived rewards and over-commitment but not with work-related effort. Regarding the effort-reward ratio only having any form of MSDs (P=0.011) and a low self-reported health rating (P<0.001) had a positive significant association. Poor self-reported health was found to be significantly connected with higher perceived overall stress and all ERI-Q subscales as well.

Univariable (*i.e.* unadjusted) logistic regression analysis showed that increased level of perceived stress and ERI were positively associated with the likelihood of suffering from any form of MSD (OR=1.10 / OR=1.56) and low (*i.e.* average or poor) self-reported health rating (OR=1.24 / OR=1.90) (Table 4). After adjusting for potential confounding factors (gender, age, education, marital status and job role), the adjusted odds ratios showed that the independent association between predictors and the outcomes are even more likely to be present; every one unit of increase of ERI doubles the likelihood for low self-reported health rating and with increasing levels of perceived stress the likelihood of MSD and low self-reported health grows 13% and 30% respectively with each increasing unit of measure. However, the independent association between MSD and ERI showed only marginal significance (P=0.056).

According to the results of the itemized analysis of variance on ranks among PSS-4 values, subjects indicating constant time pressure (P<0.001), many interruptions (P=0.002) and those who described their work increasingly more demanding (P<0.001) reported significantly higher perceived overall stress. Similarly, those with high values regarding all six items measuring over-commitment scored significantly higher PSS-4 values (P<0.001). Accordingly, employees reporting adequate job promotion prospects (P=0.004/P=0.008) and better employment security (P=0.003) showed significantly lower perceived stress. Likewise, receiving the well-deserved respect and prestige (P=0.058), and not expecting or experiencing undesirable change in work situations (P=0.044) yielded lower perceived stress scores with marginal significance. Inadequate payment proved to be less determinative (P=0.192) of perceived stress.

As effort-reward imbalance and all three subscales of ERI-Q showed monotonic relationship with PSS-4 values, covariate-

**Table 1. Respondent characteristics (n=398).**

| Characteristic | Number | % |
|---|---|---|
| Gender | | |
| Female | 315 | 79.1 |
| Male | 83 | 20.9 |
| Age | | |
| 18-35 | 174 | 43.7 |
| 36-55 | 194 | 48.8 |
| 56-65 | 30 | 7.5 |
| Marital status | | |
| Single | 90 | 22.6 |
| Married or common-low relationship | 259 | 65.1 |
| Divorced or widowed | 49 | 12.3 |
| Education | | |
| Primary or secondary school | 84 | 21.1 |
| University | 314 | 78.9 |
| Type of job | | |
| Healthcare professional | 181 | 45.6 |
| Academic personnel | 53 | 13.2 |
| Other | 82 | 20.6 |
| Mixed (*i.e.* multiple job roles) | 41 | 10.3 |
| Missing | 41 | 10.3 |
| Musculoskeletal disorder | | |
| Yes | 218 | 54.8 |
| No | 175 | 43.9 |
| Missing | 5 | 1.3 |
| Chronic disease | | |
| Yes | 119 | 29.9 |
| No | 277 | 69.6 |
| Missing | 2 | 0.5 |
| Self-reported health | | |
| Very poor | 0 | 0.0 |
| Poor | 3 | 0.8 |
| Average | 90 | 22.6 |
| Good | 234 | 58.7 |
| Very good | 68 | 17.1 |
| Missing | 3 | 0.8 |

**Table 2. Overview of PSS-4 scale, effort, reward, over-commitment subscales of ERI-Q and effort–reward imbalance based on ERI-Q.**

| Scales | Scores | Questionnaire attributes | | |
|---|---|---|---|---|
| | Mean (SD) | Number of items | Total range of scores | Cronbach's alpha |
| PSS-4 scale | 4.68 (2.65) | 4 | 0-16 | 0.78 |
| Effort subscale of ERI-Q | 8.13 (3.35) | 3 | 3-15 | 0.80 |
| Reward subscale of ERI-Q | 21.83 (5.02) | 6 | 6-30 | 0.74 |
| Over-commitment subscale of ERI-Q | 13.94 (3.48) | 6 | 6-24 | 0.81 |
| ERI based on ERI-Q responses | 0.84 (0.57) | | | |

SD, standard deviation; PSS-4, perceived stress scale four items; ERI-Q, effort-reward imbalance questionnaire.

adjusted Spearman rank-order correlation coefficient has been calculated to determine the strength and direction of each mentioned association. After adjustments for gender, age, education, marital status and job role, both work-related effort (r=0.247, P<0.001) and over-commitment (r=0.387, P<0.001) positively associated with the level of perceived stress, while work-related reward showed a negative connection (r=−0.181, P=0.011). Positive association of overall perceived stress with the effort–reward ratio was also observable (r=0.227, P<0.001). Among the possible confounders job role was the most influential (*i.e.* over 10% coefficient difference).

## Discussion

In this study the perceived stress level and the effort-reward structure of work among healthcare employees, academics and others with differing job roles were investigated. We found that low self-reported health and presence of MSD were in significant positive association with the level of perceived stress and ERI. High work-related effort and over-commitment positively correlated with increased level of perceived overall stress.

Epstein *et al.* found that, among at-risk physicians, the

**Table 3. Relationship of personal characteristics to perceived stress, effort, reward, over-commitment subscales and effort-reward imbalance (Kruskal-Wallis H test & Mann-Whitney U test for *post-hoc* pairwise comparisons).***

| Personal characteristics | PSS-4 M (range) | P | Effort M (range) | P | Reward M (range) | P | Over-commitment M (range) | P | ERI M (range) | P |
|---|---|---|---|---|---|---|---|---|---|---|
| Gender | | 0.859 | | 0.540 | | 0.001 | | 0.280 | | 0.081 |
| Female | 4 (0-13) | | 9 (3-15) | | 22 (8-30) | | 14 (6-24) | | 0.80 (0.2-3.3) | |
| Male | 5 (0-13) | | 8 (3-15) | | 24 (6-30) | | 14 (6-23) | | 0.69 (0.2-4.7) | |
| Age (years) | | 0.379 | | 0.595 | | 0.334 | | 0.809 | | 0.388 |
| 18-35 (a) | 5 (0-13) | | 8 (3-15) | | 23 (9-30) | | 14 (6-23) | | 0.75 (0.2-3.3) | |
| 36-55 (b) | 4 (0-13) | | 8.5 (3-15) | | 22 (6-30) | | 14 (7-22) | | 0.79 (0.2-4.7) | |
| 56-65 (c) | 4 (0-9) | | 7 (3-15) | | 21 (13-28) | | 13 (7-24) | | 0.67 (0.2-2.2) | |
| Marital status | | 0.952 | | 0.044* | | 0.415 | | 0.250 | | 0.134 |
| Single (a) | 4 (1-11) | | 8 (3-15) | a-b | 23 (10-30) | | 14 (7-23) | | 0.70 (0.2-2.7) | |
| Married or in relationship (b) | 5 (0-13) | | 9 (3-15) | | 22 (8-30) | | 14 (6-24) | | 0.80 (0.2-3.3) | |
| Divorced or widowed (c) | 4 (0-9) | | 7 (3-15) | | 22 (6-29) | | 14 (8-22) | | 0.67 (0.2-4.7) | |
| Education | | 0.160 | | 0.021 | | 0.042 | | 0.006 | | 0.425 |
| Primary or secondary school | 5 (0-10) | | 8 (3-15) | | 21 (6-30) | | 13 (6-24) | | 0.72 (0.2-4.7) | |
| University | 4 (0-13) | | 9 (3-15) | | 23 (8-30) | | 14 (6-23) | | 0.76 (0.2-3.3) | |
| Type of job | | 0.264 | | 0.002* | | 0.017* | | 0.009* | | 0.141 |
| Healthcare professional (a) | 4 (0-13) | | 8 (3-15) | a-db-dc-d | 22 (8-30) | | 14 (6-21) | a-db-dc-d | 0.78 (0.2-3.3) | |
| Academic personnel (b) | 5 (1-11) | | 7 (3-13) | | 24.5 (10-30) | | 14 (6-19) | | 0.65 (0.2-2.2) | |
| Other (c) | 5 (1-11) | | 7.5 (3-15) | | 22 (8-30) | | 13 (7-24) | | 0.72 (0.2-3.3) | |
| Mixed (d) | 4 (0-13) | | 10 (3-15) | | 23.5 (11-30) | | 15 (9-23) | | 0.86 (0.2-2.7) | |
| Musculoskeletal disorder | | 0.015 | | 0.037 | | 0.001 | | 0.013 | | 0.011 |
| Yes | 5 (0-13) | | 9 (3-15) | | 21 (6-30) | | 14 (7-24) | | 0.82 (0.2-4.7) | |
| No | 4 (0-13) | | 8 (3-15) | | 24 (9-30) | | 14 (6-21) | | 0.67 (0.2-3.3) | |
| Chronic disease | | 0.722 | | 0.854 | | 0.005 | | 0.045 | | 0.277 |
| Yes | 4.5 (0-11) | | 9 (3-15) | | 21 (8-30) | | 14 (7-24) | | 0.79 (0.2-3.3) | |
| No | 4 (0-13) | | 8 (3-15) | | 23 (9-30) | | 14 (6-23) | | 0.74 (0.2-3.3) | |
| Self-reported health | | 0.001* | | 0.044* | | 0.001* | | 0.043* | | 0.001* |
| Poor (a) | 7 (7-13) | a-db-dc-db-c | 9 (6-14) | b-d | 12 (10-13) | a-da-cb-cb-dc-d | 15 (15-16) | | 1.80 (0.9-2.3) | a-db-dc-d |
| Average (b) | 6 (0-12) | | 9 (3-15) | | 21 (6-29) | | 14.5 (7-23) | | 0.83 (0.2-4.7) | |
| Good (c) | 4 (0-13) | | 9 (3-15) | | 22 (9-30) | | 14 (6-21) | | 0.76 (0.2-3.3) | |
| Very good (d) | 3 (0-9) | | 6 (3-15) | | 25 (10-30) | | 13 (7-24) | | 0.49 (0.2-2.7) | |

M, median; range, minimum-maximum value; PSS-4, perceived stress scale four items; ERI, effort-reward imbalance; *pairs of personal characteristic groups (indicated with a, b, c or d) with statistically significant differences are listed under the p-values.

**Table 4. Univariable and multivariable logistic regressions predicting the likelihood of presence of musculoskeletal disorders and poor or average self-reported health rating based on PSS-4 and ERI values.**

| Outcome | Predictor variable | Univariable analysis OR | 95% CI | P | Multivariable analysis AOR | 95% CI | P |
|---|---|---|---|---|---|---|---|
| MSD present | PSS-4 | 1.10 | 1.02-1.19 | 0.017 | 1.13 | 1.03-1.23 | 0.007 |
| | ERI | 1.56 | 1.05-2.32 | 0.027 | 1.56 | 0.99-2.45 | 0.056 |
| Poor or average SRH | PSS-4 | 1.24 | 1.13-1.35 | <0.001 | 1.30 | 1.17-1.45 | 0.001 |
| | ERI | 1.90 | 1.28-2.84 | 0.002 | 2.05 | 1.27-3.31 | 0.003 |

OR, odds ratio; AOR, adjusted odds ratio; CI, confidence interval; MSD, musculoskeletal disorder; SRH, self-reported health; PSS-4, perceived stress scale four items; ERI, effort-reward imbalance.

prevalence estimates for work-related musculoskeletal pain of the neck, shoulder, back, and upper extremity were 65%, 52%, 59% and 39% respectively.[26] In the university environment, prevalence of MSDs was reported to be lower but still 59%, 53%, 47% and 30% of the total staff may experience discomfort in the same anatomical regions.[10,27] Our findings are consistent with these reports with 54.8% of the subjects reporting some form of MSD.

Milutinović's study reported significant differences in the perception of work-related stress among nurses, regarding psychological or somatic symptoms and certain diseases, indicating a close connection between work-related stress and psychosomatic health.[28] These findings are similar to our results that suggest a close relationship between high perceived stress and suffering from MSD or poor overall health. Data from four major European studies showed that ERI, work-related effort, lack of reward and over-commitment are all significant risk factors for self-reported health.[24] Our results are consistent with these findings as participants in our study with poor self-rated health can be characterized by high effort and low reward.[15,24]

Working indisposed or feeling unfit for any workplace situation could also explain a heightened level of perceived stress. However, in our study group neither prevalence of chronic diseases (excluding MSDs) exceeded the prevalence of chronic conditions among the general population reported in the European Health Interview Survey,[29] nor did self-reported overall health proved worse compared to self-reported health status of the adult Hungarian population.[30]

The connection between MSDs and ERI is less clear. Our results presented that suffering from any form of MSDs corresponds with high work-related effort and over-commitment, and with low work-related reward; likewise, having some form of MSD was found to be associated with increased ERI. A systematic review by Koch et al. concludes that on the basis of 13 studies with positive, statistically significant association, a moderate level of evidence was inferred for the association between effort-reward imbalance and musculoskeletal pain.[31] However, without additional longitudinal studies with standardised methods no reliable conclusion can be drawn of any association between the psychosocial factors using the ERI model and musculoskeletal complaints.[31]

Available research on connection of subscales of ERI model and gender is scarce. Satoh et al. proposed a link between ERI and emotional commitment to occupation,[23] while Kong et al. highlighted ERI's connection with empathy.[32] As the reward subscale of ERI-Q focuses more on work-related extrinsic reward rather than intrinsic reward,[24] perhaps a gender difference in occupational commitment, empathy or self-advocacy might explain our results which showed that female employees gain less reward. Future studies are needed in this question.

The fact that the level of education positively correlates with work-related effort, reward and over-commitment is well established since ERI-Q validation.[20] However – similarly to our findings – the effort-reward ratio is not associated with the level of education.[20]

It is well known that role accumulation can offer employees a wide range of practical and psychological benefits such as increased salary and mobility, enhanced skills, status security and prestige esteem.[33] In our study, subjects having more than one role reported greater work-related effort and over-commitment and presented greater reward suggesting a balance that was visible in the effort-reward ratio as well. Nonetheless, having multiple job roles has a clear potential for work overload and to impair the employee's well-being.[33]

The fact that thyroid diseases were the first-mentioned of chronic conditions among university employees is somewhat peculiar. There is evidence that thyroid function, particularly TSH (thyroid-stimulating hormone) level correlates with perceived overall stress,[34] however this association does not explain the high frequency of thyroid diseases in our findings, indicating a research gap for future studies to fill.

### Implication for practice

It is extensively advised in corresponding literature that, in order to enhance employee performance, service providers should aim to improve working conditions,[4,7,35] develop and maintain a healthy workforce,[28,36] and focus on job satisfaction.[37,38,39] Healthy workplaces prevent occupational diseases and accidents, promote positive lifestyle behaviours, and facilitate organizational development.[36] Addressing the high prevalence of musculoskeletal disorders (MSDs) possibly affects employees' perceived level of overall health state and occupational stress. In addition to affecting productivity and retention, job satisfaction and ideal working conditions can also influence a healthcare network's ability to achieve its patient-centered goals.[39,40]

### Limitations of the study

The data were collected from university employees in the southern region of Hungary, therefore cannot be viewed as representative of Hungarian employees. No strategies to restrict admission into the group of subjects were employed. During statistical analysis regression modelling was employed to eliminate confounding effects, however multivariable analysis does not directly identify whether a factor is a true confounder. Therefore, it is not clear whether residual confounding remains in the model.[41] Accordingly, further studies are needed in order to determine whether these findings can be generalized and to what extent. More limitations are that – in order to improve participation compliance – the abbreviated versions of PSS and ERI questionnaires were used, in addition to omitting a standardized questionnaire for estimating MSDs. Presence of MSDs and not specifically work-related MSDs were investigated, likewise the PSS-4 tool measures overall perceived stress, not occupational stress.[42] Moreover, the responses given to any self-reported questionnaire are affected by recall bias. The subjects' state of mind at the occupational health check-up, such as an overemphasis on health problems, could have influenced the results.

## Conclusions

The perceived overall stress level and the effort-reward structure of work was investigated among healthcare employees, academics and others with differing job roles at the University of Szeged, Faculty of Medicine. Low self-reported health and the presence of musculoskeletal disorder were significantly associated with the level of perceived overall stress and effort-reward imbalance. High work-related effort and over-commitment positively correlated with increased level of perceived overall stress, while greater work-related reward correlated with lower level of overall stress. Our results suggest that addressing university employees' ERI, their burden of MSD or possibly both, would likely affect employees' perceived level of overall stress and self-reported overall state of health.

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