A Cross-Sectional Study of the Impact of Pain Severity on Absenteeism and Presenteeism Among Japanese Full-Time Workers

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ABSTRACT

Introduction: Pain is known to have a high impact on work performance, but there are several confounding factors, such as stress and mental issues. Little is known about the impact of pain severity on work performance when adjusted for such confounding factors. The aim of this study was to identify the effect of pain severity on absence from work (absenteeism) and reduced performance (presenteeism).

Methods: A cross-sectional study was conducted among full-time workers at an industrial manufacturing company in Japan. Participants were assessed using a self-reported questionnaire, including work performance evaluations, pain characteristics, pain-related fear, psychological distress, stress at the workplace and home, workaholism, and self-awareness. Principal component analysis was utilized to decrease the dimensions of the measures, and orthogonal rotation was performed on identified components with an eigenvalue > 1.0. Multivariable logistic regression analyses were performed to determine the association between pain severity and absenteeism and presenteeism, and were adjusted for confounding factors. We also analyzed the association between pain intensity and presenteeism using multivariable logistic regression analyses.

Results: A total of 349 workers participated in the study. Six principal components were identified as confounding factors: work stress, regulation, mental instability, less support, home stress, and life dissatisfaction. Multivariable logistic regression analyses showed significant associations of moderate to severe pain with absenteeism (p = 0.02) and low and high presenteeism (p = 0.004 and 0.009, respectively), adjusted for age, sex, body mass index, short sleep, and the six principal components. Pain intensity was also significantly associated with low and high presenteeism (p = 0.002 and 0.014, respectively) in people with pain.
Conclusions: Pain severity is a risk factor for absenteeism and presenteeism, even if workers have comorbid psychological stress or mental health problems.

Keywords: Absenteeism; Pain; Presenteeism; Principal component analysis; Stress; Work performance

Key Summary Points

Why carry out this study?

- Pain is a high-impact health problem in terms of both absenteeism and presenteeism.
- There are several confounding factors, such as stress and mental health problems, between occupational pain and work performance.
- Little is known about the impact of pain severity on absenteeism and presenteeism when adjusted for confounding factors.

What was learned from the study?

- Six principal components were identified as confounding factors between work performance and occupational pain.
- Pain severity is a risk factor for absenteeism and presenteeism, even if the workers are comorbid with psychological stress or mental health problems.
- In those participants with pain, pain intensity and headache were significant risk factors for presenteeism.

INTRODUCTION

In an aging society with a declining birthrate, the sustainability of stable labor productivity is an urgent issue. The performance of individual workers plays a significant role in maintaining and improving productivity. Employees’ work performance is impaired by multidimensional factors, including physical and psychological problems such as pain, stress, work environment, and lifestyle. Pain is the most prevalent symptom that occurs frequently in daily life. The results of a national survey carried out in Japan indicated that back pain, headaches, neck and shoulder pain, and joint pain are among the most common subjective symptoms [1].

Although such pain symptoms may not be life-threatening, they physically interfere with the ability of a person to work and maintain a well-balanced mental state. Several studies have suggested that people with pain are more prone to negative emotions, such as anxiety, fear, and depression [2, 3]. Studies estimating the economic loss due to absence from work have reported that neck and back disabilities are the most critical factors and result in financial loss [4, 5]. Thus, pain is an important health issue that impairs a person’s physical and mental quality of life and economic productivity.

Presenteeism and absenteeism are known indicators of work performance. Presenteeism refers to the act of showing up at work but not functioning effectively due to ill health. Such workers are physically present at their workplace and superficially appear to function normally. However, they are not able to perform their duties adequately, and their potential performance loss is likely to be prolonged. Presenteeism is considered a more substantial problem than absenteeism, which is being absent from work due to illness or other reasons. For example, Wada et al. showed that the estimated wage loss due to presenteeism was at least twice that due to absenteeism in individuals aged < 50 years who experienced back or neck disorders or who had migraines or chronic headaches [6]. Presenteeism represents a significant economic loss.

Risk factors affecting pain and productivity are diverse and often overlap, and include work-related stress and mental health. A systematic review and meta-analysis suggested that high workload, low job control, and low social support are key risks for chronic low back pain [7]. These measures of workplace stress also impair work performance. In addition, stress at home could be associated with work performance loss from the viewpoint of work-family conflict.
Depression and other mental disorders can enhance pain through neural mechanisms of the brain reward system and descending pathway of pain modulation [8]. Also, presenteeism in individuals with pain is associated with pain-related fear, resulting in a strong belief to avoid physical activity [9]. In contrast, the degree of interoceptive awareness may be linked to both pain and performance [10, 11].

Thus, there are several confounding factors in the relationship between pain and performance which should be adjusted for to investigate the impact of pain on work performance. In this study, we conducted a cross-sectional survey of the status of presenteeism and absenteeism among Japanese workers and the risk factors for performance decline. This study aimed to identify the effect of pain severity on absence from work (absenteeism) and reduced performance (presenteeism) while making a comprehensive adjustment for multiple aspects of confounding factors.

METHODS

Study Design

A cross-sectional complete case survey was conducted in a branch office located in the suburbs of Tokyo, Japan. The office is a technology development division of an industrial manufacturing company, where most employees are desk workers. Data were collected by responses to questionnaires and extracted from the annual health check data. Responses were anonymized and aggregated for analysis. The company’s health care administration team distributed the questionnaire to all full-time employees on 19 July 2018, and the deadline for collecting the completed survey forms was set at 10 August 2018. All procedures were approved by the Keio University School of Medicine Ethics Committee (approval number 20170069) and the Safety and Health Committee of the company. The study was conducted in accordance with the Helsinki Declaration of 1994 and subsequent amendments, and participation was voluntary.

Participants

Full-time employees of the participating company were asked to participate in the survey. The purpose of the study and the research procedures were provided through the company’s intranet and a document attached to the questionnaire. Participants were asked to respond to a questionnaire and to agree to provide data from their annual physical examinations. They were informed that participation in the study was completely voluntary, and that by responding to the questionnaire, they were indicating their willingness to participate in the study.

Measures

Demographic and Lifestyle-Related Measures

Information on participants’ sociodemographic and health-related characteristics were extracted from data provided on annual health examinations. Specifically, the following data were provided: age, sex, body mass index (BMI, kg/m²), highest educational level achieved (high school graduate or junior college graduate, Bachelor’s degree, Master’s degree, or PhD), sleep duration (hours: < 5, 5, 6, 7, 8, or ≥ 9), and smoking status (current smoker or non-smoker). We defined < 6 h of sleep duration as short sleep, with 7–9 h of sleep considered to be adequate for a healthy adult [12].

Absenteeism and Presenteeism

The Japanese version of the World Health Organization Health and Work Performance Questionnaire (HPQ) Short Form was used to assess participants’ absenteeism and presenteeism [13, 14]. The HPQ asks participants about the number of full- and partial-day sick leaves they had taken due to physical or mental health problems in the past 4 weeks; these days away from the workplace were categorized as absenteeism. Presenteeism was measured using the following question: “On a scale from 0 to 10, where 0 is no impairment and 10 is full impairment of job performance, how would you rate the effect of your health problem on your overall job performance on the days you
worked during the past seven days?” A high presenteeism score indicates a low level of performance. Participants with presenteeism were divided into three groups by tertile values: no presenteeism (0), low level (1–2), and high level (3–10).

**Pain Characteristics**
Participants reported the presence and intensity of pain in the past 4 weeks using the numeric rating scale (NRS), where “0” corresponds to no pain and “10” indicates the worst imaginable pain [15]. Mild pain was defined as an NRS score of ≤ 3, and moderate to severe pain was defined as an NRS score of ≥ 4. Pain duration was assessed by a single question asking whether pain persisted for ≥ 3 months, corresponding to the definition of “chronic pain” by the International Association for the Study of Pain [16]. Participants were asked to mark body parts where they felt pain on a figure of the body, as shown previously [17]. Four major locations of pain were identified corresponding to the marked body parts: 1, headache; 6 and/or 7, neck and shoulder pain; 13, low back pain; and 16, knee pain.

**Pain-related Fear**
Fear of movement is frequently observed in individuals with pain and significantly increases with pain intensity [18]. We used the Japanese short version of the Tampa Scale of Kinesiophobia (TSK), which is associated with work performance [9], to assess pain-related fear. The TSK comprises 11 items on a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree) with sufficient internal consistency (Cronbach’s α = 0.92). The total score was obtained by summing the scores for the 11 items and ranged from 11 to 44. Higher scores indicate a greater fear of movement within the participants [19, 20].

**Psychological Distress**
Participants’ psychological distress was assessed using the Kessler Psychological Distress Scale (K6). Participants rated their psychological distress during the past 30 days on six items (e.g., nervousness and worthlessness) on a 5-point scale ranging from 0 (never) to 4 (always). A higher total score indicates more severe psychological distress. The K6 Japanese version was previously validated with a Cronbach’s α of 0.85 [21].

**Work-home Demands**
The degree of demands on work was evaluated separately for work overload and work emotional demands. Work overload was evaluated by four questions (Cronbach’s α = 0.88), consisting of workload demands (e.g., job quantity) and pressure on the job (e.g., time pressure) [22]. The degree of work emotional demands was represented by the frequency of emotionally challenging events in a person’s work environment and was assessed by six questions (Cronbach’s α = 0.86) [23]. Both work overload and work emotional demands were rated on a 5-point scale from 1 (never) to 5 (always). Higher total scores indicate greater work demands. With reference to the evaluation procedure of work demands, a participant’s home demands were evaluated with a six-item questionnaire with a 5-point scale referring to home overload (e.g., “Do you find that you are busy at home?”) and home emotional demands (e.g. “How often do emotional issues arise at home?”). Higher total scores indicate greater home demands. Cronbach’s α of the home overload scale and home emotional demands scale were 0.80 and 0.76, respectively [24].

**Work-home Resources**
We used the Brief Job Stress Questionnaire (BJSQ) to assess the available work-related resources for individuals [25]. The BJSQ is a questionnaire widely used in Japan to assess psychosocial stress in the workplace. Work-related resources were assessed by social support and task controllability at work. The social support subscale evaluates supports from a person’s supervisors, co-workers, and family using three questions (e.g., “How reliable are the following people when you are troubled?”). Task controllability at work was measured using four questions (e.g., “I can choose how and in what order to do my work”). Each item was measured on a 4-point Likert scale ranging from 1
Higher total scores indicate worse social support and controllability at work.

**Work-home Dissatisfaction**

Dissatisfaction represents an imbalance between rewards and effort in life. We assessed dissatisfaction at work and at home using a subscale of the BJSQ, comprising a 4-point scale ranging from 1 (satisfied) to 4 (unsatisfied). A higher score indicates greater dissatisfaction.

**Workaholism**

Workaholism, an addictive attitude toward work, is also known as a relevant factor in work performance [26]. We used the Dutch Work Addiction Scale (DUWAS), in which Cronbach’s $\alpha$ was 0.82 [27], to evaluate participants’ tendencies towards workaholism. The DUWAS includes two trends of cognitive bias: working excessiveness and working compulsiveness ($\alpha = 0.70$ and 0.70, respectively). Each subscale consists of five items rated on a 4-point Likert scale ranging from 1 (totally disagree) to 4 (totally agree). A higher score indicates a higher tendency towards workaholism.

**Self-awareness**

Participants’ level of self-awareness was measured using subscales of the Multidimensional Assessment of Interoceptive Awareness (MAIA), a self-report questionnaire assessing interoceptive perception [28]. In this study, we assessed five out of eight dimensions, 20 items in all, in the MAIA: not-distracting, not-worrying, attention regulation, self-regulation, and trusting. These five dimensions were previously shown to be associated with stress, depression, anxiety, and pain in people with low back pain [11]. The average score of the items was used to estimate the level of each dimension. The reliability and validity of the Japanese version of MAIA (MAIA-J) was previously validated [29]. The number of items and internal consistency of the subscales were: not-distracting (3 items, $\alpha = 0.66$), not-worrying (3 items, $\alpha = 0.67$), attention regulation (7 items, $\alpha = 0.87$), self-regulation (4 items, $\alpha = 0.83$), body listening (3 items, $\alpha = 0.82$), and trusting (3 items, $\alpha = 0.79$).

**Statistical Analyses**

First, participants were categorized into three groups according to the severity of their pain: no pain, mild pain (NRS score of $\leq 3$), and moderate to severe pain (NRS score of $\geq 4$). Then, background sociodemographic factors were compared among the three groups. One-way analysis of variance (ANOVA) and the Kruskal–Wallis tests were performed for parametric and nonparametric data, respectively. The Chi-square test was used for categorical data.

To accurately assess the impact of a wide range of domain variables, principal component analysis was used to decrease the dimensions of the measures, including those of TSK, K6, work- and home-related stress (overload, emotional demand, and control, respectively), the social support provided by supervisors, co-workers, and family, and MAIA (not-distracting, not-worrying, attention regulation, self-regulation, and trusting). Principal component analysis is an unsupervised machine learning algorithm commonly used for dimensionality reduction by projecting each data point onto first few principal components. The first principal component is computed on a direction that maximizes the variance of the projected data. The second one is generated as a direction orthogonal to the first one that maximizes the variance. We identified principal components using a cutoff eigenvalue of 1.0, and variables of the principal components were generated using Varimax (orthogonal) rotation.

Next, we performed a multivariable logistic regression analysis to identify the association between absenteeism and pain severity and the principal components adjusted for age, sex, and BMI. Likewise, odds ratios (OR) of pain severity and the principal components in participants with each level of presenteeism were identified using the multivariable logistic analysis compared to participants with no presenteeism.

Finally, we performed multivariable logistic regression analyses in participants with pain to identify associations between pain intensity and chronicity of pain (> 3 months) with each level of presenteeism.
All statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) V.25.0 software package (IBM Corp., Armonk, NY, USA). Statistical significance was determined using two-tailed $p$ values < 0.05.

RESULTS

All 545 employees in the industrial manufacturing company’s branch office were invited to participate in the study (Fig. 1). Of these, 354 employees responded to the questionnaire (65% response rate). Five responses with incomplete data were excluded, and 349 participants were included in the analyses. The average age of the participants was 40.9 years, ranging from 18 to 68 years, and the number of men was 292 (83.7%).

Table 1 shows the demographic characteristics of participants without pain ($n = 128$, 36.7%), those with mild pain ($n = 104$, 29.8%), and those with moderate to severe pain ($n = 117$, 33.5%). The number of men was the smallest among participants with moderate to severe pain, although there were no significant differences among the groups in terms of age, BMI, number of participants with Bachelor’s degree or lower, short sleep, or smoking habits. The prevalence of neck and shoulder pain, knee pain, and chronic pain were greater in the moderate-to-severe pain group than in the mild pain group. Participants with absenteeism and low and high levels of presenteeism significantly increased with pain severity ($p < 0.01$ and $< 0.001$, respectively), whereas pain location and chronicity showed no statistically significant associations with absenteeism nor presenteeism in participants with pain (see Electronic Supplementary Material [ESM] Table 1). Participants with pain showed a tendency toward greater work overload and compulsiveness in measures of work-related stress. The average of the trusting, not-distracting, and not-worrying dimensions in the MAIA decreased with pain severity, whereas the K6 and TSK scores increased concomitant with pain severity. Participants with pain also showed greater home demand (overload and emotional demands).

We identified six principal components with eigenvalues $> 1.0$, namely work stress, regulation, mental instability, less support, home stress, and life dissatisfaction (Fig. 2; ESM Table 2). Each principal component was represented by the most relevant measures with a high loading, which was $> 0.5$ of the absolute value; for example, the third principal component was mainly generated from lower values of “not-distracting” and “not-worrying” as well as values of the K6 and the TSK, suggesting that higher “mental instability” represents more psychological vulnerability in the individuals.

As shown in Table 2, absenteeism was significantly associated with mental instability (OR 1.49, 95% confidence intervals [CI] 1.10–2.03) and moderate to severe pain (OR 2.49, 95% CI 1.14–5.43). Conversely, low and high levels of presenteeism were significantly associated with mental instability (OR 1.65, 95% CI 1.18–2.32 and OR 3.07, 95% CI 2.03–4.63, respectively) and moderate-to-severe pain (OR 2.99, 95% CI 1.43–6.28 and OR 3.50, 95% CI 1.36–9.00, respectively), as well as work stress (OR 1.59, 95% CI 1.14–2.21 and OR 2.03, 95% CI 1.37–3.03, respectively) and home stress (OR 1.72, 95% CI 1.25–2.39 and OR 1.71, 95% CI 1.19–2.48, respectively) (Table 3). The ORs for work stress and mental instability increased with the severity of presenteeism.

In participants with pain, mental instability (OR 1.72, 95% CI 1.08–2.75), home stress (OR 1.93, 95% CI 1.23–3.04), pain severity
Table 1 Demographic characteristics of people with and without pain (*N* = 349)

| Demographic characteristics          | No pain (N = 128) | Mild pain (NRS: 1–3)*a (N = 104) | Moderate to severe pain (NRS: 4–10)*a (N = 117) | p value |
|--------------------------------------|-------------------|----------------------------------|-----------------------------------------------|---------|
| **n**                                | 128               | 104                              | 117                                           |         |
| Age (years), mean (SEM)              | 40.2 (1.0)        | 42.1 (11.2)                      | 40.7 (10.8)                                   | 0.438   |
| Male, n (%)                          | 111 (87%)         | 93 (89%)                         | 88 (75%)                                      | 0.016*  |
| BMI (kg/m²), mean (SEM)              | 22.6 (3.1)        | 23.1 (2.8)                       | 23.5 (4.2)                                    | 0.143   |
| Bachelor’s degree or lower, n (%)    | 19 (15%)          | 13 (13%)                         | 22 (19%)                                      | 0.433   |
| Short sleep (< 6 h), n (%)           | 22 (17%)          | 12 (12%)                         | 7 (6%)                                        | 0.074   |
| Current smoker, n (%)                | 14 (11%)          | 26 (25%)                         | 34 (29%)                                      | 0.228   |
| Neck and shoulder pain, n (%)        | –                 | 47 (45.2)                        | 76 (65.0)                                     | 0.003*  |
| Low back pain, n (%)                 | –                 | 31 (29.8)                        | 49 (41.9)                                     | 0.062   |
| Knee pain, n (%)                     | –                 | 12 (11.5)                        | 30 (25.6)                                     | 0.007*  |
| Headache, n (%)                      | –                 | 12 (11.5)                        | 14 (12.0)                                     | 0.922   |
| Chronic Pain, n (%)                  | –                 | 64 (62%)                         | 91 (78%)                                      | 0.008   |
| Absenteism, n (%)                    | 12 (9%)           | 15 (14%)                         | 31 (26%)                                      | 0.002*  |

**Presenteeism, n (%)**

|          | No pain | Mild pain | Moderate to severe pain | p value |
|----------|---------|-----------|-------------------------|---------|
| 0        | 53 (41.4) | 39 (37.5) | 17 (14.5) | < 0.001*** |
| 1–2      | 47 (36.7) | 39 (37.5) | 50 (42.7) |         |
| 3–10     | 28 (21.9) | 26 (25.0) | 50 (42.7) |         |

**Work stress, mean (SEM)**

|          | No pain | Mild pain | Moderate to severe pain | p value |
|----------|---------|-----------|-------------------------|---------|
| Overload | 11.5 (3.9) | 12.2 (3.5) | 12.7 (3.7) | 0.028* |
| Emotional demand | 12.5 (4.8) | 12.4 (4.2) | 13.3 (5.3) | 0.291 |
| Control  | 6.0 (1.8)  | 6.0 (1.8)  | 6.2 (1.7)  | 0.694 |
| Excessive| 10.8 (3.6) | 11.8 (3.4) | 11.5 (3.6) | 0.082 |
| Compulsive | 9.1 (2.8)  | 9.7 (2.9)  | 10.2 (3.5) | 0.025* |

**MAIA, mean (SEM)**

|          | No pain | Mild pain | Moderate to severe pain | p value |
|----------|---------|-----------|-------------------------|---------|
| Attention regulation | 3.0 (1.0) | 3.0 (0.9) | 2.8 (1.0) | 0.106 |
| Self-regulation | 2.9 (0.9) | 2.8 (1.0) | 2.7 (1.1) | 0.088 |
| Trusting  | 3.1 (1.1) | 2.7 (1.0) | 2.7 (1.2) | 0.007** |
| Not-distracting | 3.4 (1.3) | 3.1 (1.2) | 2.7 (1.3) | < 0.001*** |
| Not-worrying | 3.0 (1.0) | 2.9 (0.9) | 2.7 (1.0) | 0.023* |
| K6, mean (SEM) | 4.4 (4.9) | 5.1 (4.5) | 5.8 (5.1) | 0.065 |
| TSK, mean (SEM) | 21.4 (5.1) | 22.8 (4.1) | 24.3 (5.2) | < 0.001*** |

**Less support, mean (SEM)**
Table 1 continued

| Demographic characteristics | No pain (NRS: 1–3)a | Mild pain (NRS: 4–10)a | Moderate to severe pain (NRS: 4–10)a | p value |
|----------------------------|---------------------|------------------------|--------------------------------------|---------|
| Boss                       | 6.8 (2.2)           | 6.7 (2.1)              | 6.7 (2.2)                            | 0.885   |
| Colleague                  | 6.4 (2.1)           | 6.7 (1.8)              | 6.7 (2.1)                            | 0.474   |
| Family                     | 5.1 (2.2)           | 5.0 (2.0)              | 5.2 (2.3)                            | 0.809   |

**Home stress, mean (SEM)**

|                           | No pain (NRS: 1–3)a | Mild pain (NRS: 4–10)a | Moderate to severe pain (NRS: 4–10)a |
|---------------------------|---------------------|------------------------|--------------------------------------|
| Overload                  | 11.0 (2.5)          | 12.3 (3.5)             | 12.2 (3.2)                            | 0.001** |
| Emotional demand          | 5.7 (2.3)           | 5.9 (2.3)              | 6.4 (2.6)                            | 0.048*  |
| Control                   | 13.9 (3.5)          | 14.1 (3.6)             | 14.5 (3.5)                           | 0.468   |

**Dissatisfaction, mean (SEM)**

|               | No pain (NRS: 1–3)a | Mild pain (NRS: 4–10)a | Moderate to severe pain (NRS: 4–10)a |
|---------------|---------------------|------------------------|--------------------------------------|
| Work          | 2.1 (0.8)           | 2.3 (0.7)              | 2.2 (0.7)                            | 0.177   |
| Home          | 1.9 (0.9)           | 2.0 (0.8)              | 2.0 (0.8)                            | 0.685   |

One-way analysis of variance (ANOVA) and Kruskal–Wallis test were performed for parametric and nonparametric data, respectively. Chi-square test was performed for categorical data.

SEM Standard error of the mean, BMI body mass index, MAIA Multidimensional Assessment of Interoceptive Awareness, K6 Kessler Psychological Distress Scale, TSK Tampa Scale for Kinesiophobia

*, **, *** Indicates significant difference at *p < 0.05, **p < 0.01, ***p < 0.001

aPeople with pain were divided into two groups using the numerical rating scale (NRS)

(OR 1.42, 95% CI 1.13–1.79), and presence of headache (OR 5.78, 95% CI 1.14–29.44) were associated with a low level of presenteeism, whereas work stress was not significantly associated with a low level of presenteeism (Table 4). Also, a high level of presenteeism was associated with work stress (OR 2.11, 95% CI 1.13–1.79), mental instability (OR 1.42, 95% CI 1.13–1.79), home stress (OR 1.42, 95% CI 1.17–3.81), pain intensity (OR 1.36, 95% CI 1.06–1.75), and presence of headache (OR 6.90, 95% CI 1.37–34.76). The ORs for work stress and mental instability increased with the severity of presenteeism.

**DISCUSSION**

The present study is a cross-sectional investigation of individual performance and risk factors among Japanese workers. The results showed that pain intensity was an independent risk factor for performance loss, even after comprehensive adjustment for novel risk factors, including interoceptive awareness and home stress. In addition, the subdivided risk factors for performance loss were decomposed into six main components, and the main domains were identified. Multivariate logistic regression analysis adjusted for the six principal components showed a direct association between moderate to severe pain, absenteeism, and presenteeism. Furthermore, we found that in those participants with pain, pain intensity and headache were significant risk factors for presenteeism. To obtain a sufficient sample size for statistical analyses, we did not stratify participants by the location of pain in this study. Instead, four major locations of pain were included as independent variables. The results of the multivariable regression analyses suggest that treatment of headache may be an effective strategy to...
improve work performance for the participated company.

A unique feature of the present results is that 85.4% of participants with moderate to severe pain reported presenteeism, while only 24.2% reported absenteeism. This dissociation suggests that few individuals are so physically disabled that they cannot work, even when in pain. Pain is likely associated with mental health problems, such as catastrophic thinking and depression, leading to decreased performance. Recently, it has also been suggested that the neurobiological mechanism by which pain causes decreased performance is the suppression of reward and motivational processes in the brain’s dopamine system [8]. In addition, pain...
has been shown to discount future subjective values in relation to pain intensity, suggesting that physical pain may not only directly cause physical disability but may do so indirectly as well. Still, pain may also indirectly affect cognition and emotion, resulting in lower performance.

The present study also showed that moderate to severe pain significantly reduced work performance compared to mild pain, indicating that reducing individuals’ degree of pain may increase their work performance. Similarly, Wada et al. reported that pain intensity is most associated with wage loss due to presenteeism and absenteeism caused by back and neck disorders [6]. Many individuals with pain receive medical treatment, but a national survey showed that 70.7% of these patients are not satisfied with their treatment, limiting the effectiveness of medical therapies [30]. To reduce the number of individuals with moderate to severe pain, psychosocial interventions, such as improving the workplace environment and providing care programs for employees with pain (such as sit-to-stand [22] and yoga [10]), are effective, and the workplace as a whole should work to employees’ improve pain.

However, given that pain directly affects work performance, it is necessary to intervene before the pain worsens. Mild pain is clinically more likely to respond to treatment than severe and chronic pain, and should be seen as a signal before it escalates into severe pain. Even for those individuals whose pain is already being treated, it is crucial to encourage them to adjust environmental factors and improve self-care to prevent worsening of their pain. To maintain the productivity of the entire enterprise, health literacy for pain management must be improved from a comprehensive perspective. Follow-up studies using longitudinal research are required to determine the subsequent course of people with mild pain and those undergoing pain treatment.

One of the novelties of this study is the inclusion of interoceptive awareness as an adjusted risk factor. Interoceptive awareness is a measure of the attitude of consciously perceiving sensations from inside the body and being aware of and accepting the body’s physiological state. In the present study, all five subscales of interoceptive awareness were examined as adjustment factors. Interestingly, three of the domains, “attention regulation,” “self-regulation,” and “trusting,” were integrated into the second principal component, namely, “regulation,” whereas the other two domains, “not-distracting” and “not-worrying,” comprised the third component, “mental instability,” with K6 and TSK. Although “trusting the body,” one of the subscales of interoceptive awareness, was significantly associated with overall work performance [10], presenteeism due to health problems was not associated with “regulation,” including an element of “trusting.” As interoceptive awareness is a personal trait rather than

| Variables            | Absenteeism | OR 95% CI (LL, UL) | p value |
|----------------------|-------------|--------------------|---------|
| Work stress          | 0.98        | (0.73, 1.32)       | 0.920   |
| Regulation           | 0.80        | (0.59, 1.08)       | 0.147   |
| Mental instability   | 1.49        | (1.10, 2.03)       | 0.011*  |
| Less support         | 1.22        | (0.91, 1.63)       | 0.193   |
| Home Stress          | 1.19        | (0.89, 1.59)       | 0.247   |
| Life dissatisfaction | 1.24        | (0.91, 1.68)       | 0.175   |
| Mild pain            | 1.43        | (0.62, 3.30)       | 0.773   |
| Moderate to severe   | 2.49        | (1.14, 5.43)       | 0.021*  |

Odds ratios (ORs) of the identified six principal components and pain severity were computed using a multivariable logistic regression analysis, adjusted for age, sex, BMI, and short sleep. Mild pain and moderate to severe pain were defined as scores 1–3 and 4–10 in the NRS

OR odds ratio, CI confidence interval, LL lower limit, UL upper limit

*Indicates significant difference at *p < 0.05
a health indicator [31], it was not directly associated with health-related performance but with overall performance instead.

Another novelty of the study is that we examined stress at home regarding work-family conflict, which has recently received attention. Given that work-family conflict is associated with pain [32], home stress is also a risk factor for pain, as we previously reported that individuals with pain showed greater home demands [10]. However, very few studies have adjusted for the effect of home stress as a confounding factor between pain and work performance. In this study, home stress was included in the regression analysis as an adjustment variable.

This study has several limitations. First, the study was conducted at a single workplace in which most employees are male desk workers; thus, the generalizability of the findings is limited. However, the association between pain and performance loss was consistent with the findings of previous studies. Our findings reinforce the value of taking six principal components into account as confounding factors. Second, self-reported measures were used in this study to assess work performance; thus, participants' exact productivity loss due to pain is unclear. However, one study has shown that subjective work performance was significantly correlated with objective work performance [33], suggesting that our findings are acceptable as scientific results. Third, this was a cross-sectional study, which did not include employees who were on leave when the survey was distributed. There is a potential limitation to the impact of pain on absenteeism in this study, as workers who were out on leave for pain- or recovery-related reasons (e.g., childbirth or surgery) did not have the opportunity to respond to the questionnaire. Further longitudinal studies are required to determine the exact impact of pain on absenteeism.
CONCLUSIONS

In conclusion, pain severity itself is an independent risk factor for absenteeism and presenteeism, even if the workers have comorbid psychological stress or mental health problems. Adequate health literacy may help to improve work performance by lowering the overall pain levels of individuals in the workplace.

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Table 4 Associations of the principal components and pain properties to the presence of mild and severe presenteeism in individuals with pain (N = 221)

| Presenteeism | NRS: 0 (n = 56) | NRS: 1–2 (n = 89) | NRS: 3–10 (n = 76) |
|--------------|----------------|-----------------|-------------------|
|              | OR             | 95% CI (LL, UL) | p value           | OR             | 95% CI (LL, UL) | p value           |
| Work stress  | 1              | 1.64 (0.99, 2.71) | 0.054             | 2.32          | (1.21, 4.46)   | 0.012*             |
| Regulation   | 1              | 1.13 (0.73, 1.72) | 0.587             | 0.73          | (0.45, 1.19)   | 0.203              |
| Mental instability | 1 | 1.92 (1.18, 3.12) | 0.009**          | 2.65          | (1.45, 4.82)   | 0.002**            |
| Less support | 1              | 0.98 (0.63, 1.52) | 0.921             | 1.16          | (0.70, 1.93)   | 0.560              |
| Home stress  | 1              | 2.06 (1.27, 3.32) | 0.003**          | 2.12          | (1.24, 3.63)   | 0.006**            |
| Life dissatisfaction | 1 | 0.85 (0.56, 1.30) | 0.450             | 1.08          | (0.63, 1.84)   | 0.778              |
| Pain intensity | 1             | 1.46 (1.14, 1.87) | 0.003**          | 1.61          | (1.18, 2.20)   | 0.003**            |
| Chronic pain (duration > 3 mo) | 1 | 0.94 (0.41, 2.15) | 0.892             | 1.58          | (0.56, 4.47)   | 0.387              |
| Neck and shoulder pain | 1 | 1.68 (0.73, 3.86) | 0.218             | 0.41          | (0.14, 1.21)   | 0.107              |
| Low back pain | 1              | 1.06 (0.45, 2.48) | 0.891             | 0.94          | (0.34, 2.59)   | 0.902              |
| Knee pain    | 1              | 1.13 (0.39, 3.29) | 0.822             | 0.79          | (0.16, 3.85)   | 0.768              |
| Headache     | 1              | 5.78 (1.14, 29.44) | 0.035*           | 6.90          | (1.37, 34.76)  | 0.019*             |

ORs of the identified six principal components, pain intensity, and chronic pain (duration ≥ 3 months) were computed in each category of presenteeism using multivariable logistic regression analyses compared to individuals without presenteeism, adjusted for age, sex, BMI, and short sleep.

*, **Indicates significant difference at *p < 0.05, **p < 0.01
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**Compliance with Ethics Guidelines.** All procedures were approved by the Keio University School of Medicine Ethics Committee (approval number 20170069) and the Safety and Health Committee of the company. The study was conducted in accordance with the Helsinki Declaration of 1994 and subsequent amendments, and participation was voluntary.

**Data Availability.** Data are available upon reasonable request. The data analyzed in this study are available with the permission of the Institutional Review Board of Keio University School of Medicine, corresponding to each request (https://www.ctr.med.keio.ac.jp/rinri/).

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