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**Title:**

# Factors associated with disabling low back pain among nursing personnel in Japan: A cross-sectional survey.

Takahiko Yoshimoto[1,2*], Hiroyuki Oka[2], Shuhei Ishikawa[3], Akatsuki Kokaze[1], Shingo Muranaga[3], Ko Matsudaira[2]

[1] Department of Hygiene, Public Health and Preventive Medicine, Showa University School of Medicine, Tokyo, Japan

[2] Department of Medical Research and Management for Musculoskeletal Pain, 22nd Century Medical & Research Center, Faculty of Medicine, The University of Tokyo, Tokyo, Japan

[3] Department of Rehabilitation, Kameda Medical Center, Chiba, Japan

[*] **Corresponding author:**

Takahiko Yoshimoto

Department of Hygiene, Public Health and Preventive Medicine, Showa University School of Medicine, 1-5-8 Hatanodai, Shinagawa-ku, Tokyo 142-8555, Japan

Tel: +81(3)3784-8134; Fax: +81(3)3784-7733

E-mail address: yoshimotot@med.showa-u.ac.jp

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## ABSTRACT

**Objectives:** Low back pain (LBP) is a common cause of disability among nursing personnel. Although many studies regarding the risk factors for LBP among nursing staff have focused on the physical load at work, multidimensional assessments of risk factors are essential to identify appropriate preventive strategies. We aimed to investigate the association of multidimensional factors (individual, physical, psychological, and occupational) with disabling LBP among nursing personnel in Japan.

**Design:** Observational study with cross-sectional design.

**Setting:** Data was collected using the self-administered questionnaire at a tertiary medical center.

**Participants:** After excluding participants with missing variables, 718 nursing personnel were included in the analysis.

**Outcome measures:** A self-administered questionnaire assessed individual characteristics, rotating night shift data, severity of LBP, previous episode of LBP, sleep problem, kinesiophobia (Tampa Scale for Kinesiophobia), depressive condition (K6), physical flexibility, and frequency of lifting at work. A logistic regression model was used to evaluate the factors associated with disabling LBP (LBP interfering with work) among nursing personnel.

**Results:** Of all participants, 110 (15.3%) reported having disabling LBP. The multivariable logistic regression analysis after adjustment for several confounding factors showed that kinesiophobia (highest tertile, adjusted odds ratio [aOR]: 6.13, 95% confidence interval [CI]: 3.34-11.27), previous episode of LBP (aOR: 4.33, 95% CI: 1.50-12.41), and insomnia (aOR: 1.66, 95% CI: 1.05-2.62) were significantly associated with disabling LBP.

**Conclusions:** The present study indicated that kinesiophobia, a previous episode of LBP, and sleep problems were associated with disabling LBP among nursing personnel. In the future, workplace interventions considering assessments of these factors may reduce the incidence of disabling LBP in nursing staff, although further prospective studies are needed.

**Strengths and limitations of this study**

- This study was designed to assess simultaneously the multidimensional aspects (individual, physical, psychological, and occupational) of disabling low back pain among nursing personnel in Japan.
- This paper provides results that will be useful in understanding the complexity of low back pain and developing appropriate strategies for reducing the incidence of occupational low back pain.
- The major limitations of this study are the participants at a single center and the cross-sectional design.

## INTRODUCTION

The global burden of disease study 2017 indicated that low back pain (LBP) is one of the leading cause of disability worldwide.[1] LBP is a major public health problem with an enormous negative economic impact on individuals, industries, and societies.[2 3]

The etiology of LBP is multifactorial and includes physical factors (physical load at work,[4] physical flexibility,[5] etc.) and psychological factors (depression,[6] and fear-avoidance belief,[7] etc.). Among psychological factors, pain-related fear of movement/reinjury, which is known as kinesiophobia, has been suggested to be an important contributor for LBP.[8] LBP also recurs frequently; thus, a previous episode of LBP can be a predictor of future episodes.[9] Moreover, lifestyle factors including sleep problems can increase the risk of LBP.[10]

Several studies have shown that nursing personnel have a higher prevalence of LBP relative to the general population,[11] or other occupational groups,[12 13] which may be related to nursing work-related factors. Indeed, in addition to the above physical and psychological factors, occupation-specific factors such as frequent manual handling[14 15] and rotating night shifts[16] have been suggested to be associated with the development of LBP among nursing personnel. Because LBP could lead not only to decreased work performance, but also professional abandonment,[17] clarifying the risk factors of LBP and exploring appropriate preventive strategies is essential to reduce the incidence of LBP among nursing professionals.

Although there is ample evidence showing that physical factors, including manual handling, among nursing personnel are a significant risk factor for LBP,[14 15 17] systematic reviews of interventions for LBP in nurses have indicated that ergonomic interventions for LBP had inadequate results.[18 19] Thus, studies investigating the factors associated with LBP among nursing personnel from a multidimensional perspective including individual, physical and psychological factors are increasingly needed. Since the prevalence of disabling LBP varies across countries and occupations,[20] it may be important to investigate the factors associated with disabling LBP among nursing personnel in Japan in order to design appropriate strategies for reducing the

incidence of occupational LBP. Therefore, we aimed to perform a multidimensional assessment, including individual, physical, psychological, and occupational aspects, of disabling LBP among nursing personnel at a tertiary hospital in Japan.

## METHODS

### Study populations

This cross-sectional study was based on a survey conducted among nursing personnel at Kameda Medical Center at Chiba Prefecture, Japan during February 2017. During this period, an anonymous, self-administered questionnaire was distributed to 1,152 workers at the nursing department in the center. After the workers answered the questionnaires, they put them in sealed envelopes. Then, occupational health staff collected and sent the envelopes to the authors. Staff other than the authors were not allowed to open the sealed envelopes. Written informed consent was obtained from each participant. All procedures were approved by the Research Ethics Committee of Kameda Medical Center (Approval No. 16-159) and carried out according to the Declaration of Helsinki.

### Study measures

The following items were assessed using the self-administered questionnaire: age, sex, height, weight, occupation type (registered nurse, assistant nurse, midwife, or nursing aid), rotating night shift (frequency of shift work per month), severity of LBP, previous episode of LBP, sleep problem, fear-avoidance (kinesiophobia), depressive condition, physical flexibility, and lifting at work. Body mass index (BMI) was calculated as weight (kg) divided by the square of height (m).

The severity of LBP, evaluated by respondents, was classified into four grades: grade 0 (no LBP), grade 1 (LBP that did not interfere with work), grade 2 (LBP that interfered with work), and grade 3 (LBP that interfered with work and required sick leave). These grades were determined with reference to Von Korff's grading method.[21] The area of LBP (between the costal

margin and inferior gluteal folds) was indicated as a diagram in the questionnaire.[22] LBP was defined as pain lasting for ≥1 day and experienced during the past one month, in accordance with the standard definition of LBP proposed by Dionne et al.[23] LBP associated with menstrual periods, pregnancy, or febrile illness was excluded. Individuals with disabling LBP were defined as those who had LBP interfering with work, irrespective of sick leave because of LBP (grade 2 or 3).[24] Past LBP history characteristics were evaluated in a question regarding the previous episode of LBP.

Sleep problems were assessed using questions about the sleep duration and sleep habits in the previous month.[25] Disability of sleep duration was defined by durations < 6 hours. Difficulty initiating sleep was defined as taking more than 30 min to fall asleep. Difficulty maintaining sleep and early morning awakening were defined by the occurrence of nocturnal awakenings or early morning awakenings three times or more per week. The presence of insomnia was defined if the participants reported at least one positive response to the three symptoms of sleep habits above.[25]

To assess fear of movement/(re)injury, we used the short version of the Tampa Scale for Kinesiophobia (TSK-11).[26] The TSK-11 consists of 11 items, each of which is scored on a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). The total scores range from 11 to 44, with higher scores indicating greater fear of movement/(re)injury. The Japanese version of TSK-11 has been translated and validated by Matsudaira et al.[27 28] Participants' scores were classified into tertiles according to their total scores.

Depressive condition was evaluated by using the Kessler 6-item psychological distress scale (K6).[29] The K6 consists of six items that assess how frequently respondents experienced symptoms of psychological distress such as nervousness, negative affect, fatigue, and worthlessness over the past 30 days. Each item was rated on a 5-point scale ranging from 0 (none of the time) to 4 (all of the time), with the total score ranging from 0 to 24. The K6 has been translated to a Japanese version, whose reliability and validity have been confirmed by Furukawa et al.[30] Individuals with a K6 score of ≥10 were defined as having a depressive condition in

accordance with a previous study.[31]

Physical flexibility was assessed by using the modified finger-to-floor distance[32] which mainly represents trunk flexibility. The grade of this item was rated on a 7-point scale: 1) fingertips cannot reach across the knees; 2) fingertips can reach across the knees but wrists not; 3) wrists can reach beyond the knees, but fingertips cannot reach the ankles; 4) fingertips can reach the ankles; 5) fingertips can touch the floor; 6) all of the fingers can touch the floor; and 7) palms can touch the floor. Flexibility was classified into two groups based on whether wrists could reach beyond the knee, but fingertips could not reach the ankles.[24]

Physical work demand was measured with a question exploring the frequency of lifting at work. The frequency of lifting was divided into 0, 1-4, 5-9, 10 times per shift, and lifting ≥5 times per shift was defined as frequent with reference to a previous study.[16]

**Statistical analysis**

Data were presented as median (25th, 75th percentile) for continuous variables or number (%) for categorical variables. Characteristics of participants were compared using the chi-squared test for categorical variables and Wilcoxon rank-sum test for continuous variables. To assess factors associated with disabling LBP, a logistic regression model was used to estimate the odds ratio (OR) and 95% confidence interval (CI) for disabling LBP. In the model, the following factors were included for adjustment: sex, age, BMI, frequency of shift work, sleep duration, insomnia, previous episode of LBP, TSK and K6 scores, flexibility, lifting at work. Multicollinearity was not suspected as all variance inflation factors (VIFs) were <2. A p-value less than 0.05 was considered to be statistically significant (two-sided). All statistical analyses were performed using JMP version 13.0 (SAS Institute Inc., Cary, NC, USA).

## RESULTS

Of all workers at the nursing department in the center, 1075 respondents provided answers in

the questionnaires. Since the present study was focused on nursing personnel who provide direct care in the center, 146 employees who were not related to direct nursing care (clerical work or providing guidance to patients, etc.) were excluded. We further excluded 211 participants with missing data for any variable. As a result, 718 nursing staff completed the questionnaire with no missing data and were included in the analysis.

The median age of participants in the present study was 31.0 years, and 79.7% of the participants were women. Of the included participants, 15.3% were reported to have disabling LBP. The characteristics of participants with or without disabling LBP are shown in Table 1. The proportions of insomnia ($p < 0.001$) and previous episode of LBP ($p < 0.001$) among participants with disabling LBP were higher relative to those observed in participants without disabling LBP. The proportions of those who had high TSK ($p < 0.001$) or K6 ($p < 0.038$) scores were higher in the disabling LBP group than in the no disabling LBP group. In contrast, the groups with and without disabling LBP showed no significant differences for physical flexibility and the frequency of lifting at work.

We calculated the crude and adjusted ORs and their 95% CIs for disabling LBP (Table 2). The non-adjusted analysis showed that insomnia, previous episode of LBP, and TSK and K6 scores were significantly associated with disabling LBP. Multivariable analysis after adjusting for sex, age, BMI, and all explanatory variables showed that insomnia (adjusted OR [aOR]: 1.66, 95% CI: 1.05-2.62), a previous episode of LBP (aOR: 4.31, 95% CI: 1.50-12.41), and TSK score (aOR: 2.08, 95% CI: 1.11-3.89 in middle, aOR: 6.13, 95% CI: 3.34-11.27 in high) remained significantly associated with disabling LBP.

Table 1. Characteristics of the study participants

| | Disabling LBP (n = 110) | No disabling LBP (n = 608) | *p*-value |
|---|---|---|---|
| Sex (women) | 79 (71.8%) | 493 (81.1%) | 0.026 |
| Age, years | 27.5 (24.0, 40.0) | 31.0 (24.0, 42.0) | 0.052 |
| Body mass index, kg/m$^2$ | 21.6 (19.8, 23.3) | 21.2 (19.5, 23.9) | 0.793 |
| Occupation type | | | |
| Registered nurse | 88 (80.0%) | 495 (81.4%) | 0.886 |
| Assistant nurse (practical nurse) | 2 (1.8%) | 16 (2.6%) | |
| Midwife | 4 (3.6%) | 18 (3.0%) | |
| Nursing aid | 16 (14.5%) | 79 (13.0%) | |
| Frequency of shift work, per month | 6.0 (2.5, 10.0) | 6.0 (0.0, 10.8) | 0.571 |
| Sleep duration | | | |
| >6 hours | 78 (70.9%) | 436 (71.7%) | 0.864 |
| <6 hours | 32 (29.1%) | 172 (28.3%) | |
| Insomnia | | | |
| Not have insomnia | 47 (42.7%) | 366 (60.2%) | < 0.001 |
| Have insomnia | 63 (57.3%) | 242 (39.8%) | |
| Previous episode of LBP | | | |
| No | 4 (3.6%) | 97 (16.0%) | < 0.001 |
| Yes | 106 (96.4%) | 511 (84.0%) | |
| TSK | | | |
| Low (≤17) | 18 (16.4%) | 252 (41.4%) | < 0.001 |
| Middle (18-23) | 32 (29.1%) | 206 (33.9%) | |
| High (≥24) | 60 (54.5%) | 150 (24.7%) | |
| K6 | | | |
| <10 | 78 (70.9%) | 485 (79.8%) | 0.038 |
| ≥10 | 32 (29.1%) | 123 (20.2%) | |
| Flexibility | | | |
| Flexible | 75 (68.2%) | 443 (72.9%) | 0.314 |
| Not flexible | 35 (31.6%) | 165 (27.1%) | |
| Lifting | | | |
| Not frequent | 45 (40.9%) | 289 (47.5%) | 0.200 |
| Frequent | 65 (59.1%) | 319 (52.5%) | |

Data are presented as number (percentage) or median (25th, 75th percentile).

LBP, Low back pain; TSK, Tampa scale for kinesiophobia

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Table 2. Association between disabling low back pain and independent variables from logistic regression models

| | Crude | | Adjusted* | |
|---|---|---|---|---|
| | OR (95% CI) | *p*-value | OR (95% CI) | *p*-value |
| Frequency of shift work, per month | 1.00 (0.97-1.04) | 0.783 | 0.98 (0.94-1.02) | 0.390 |
| Sleep duration | | | | |
| >6 hours | 1.00 | | 1.00 | |
| <6 hours | 1.04 (0.66-1.63) | 0.864 | 1.12 (0.68-1.83) | 0.659 |
| Insomnia | | | | |
| Not have insomnia | 1.00 | | 1.00 | |
| Have insomnia | 2.03 (1.34-3.06) | < 0.001 | 1.66 (1.05-2.62) | 0.029 |
| Previous episode of LBP | | | | |
| No | 1.00 | | 1.00 | |
| Yes | 5.03 (1.81-13.97) | 0.002 | 4.31 (1.50-12.41) | 0.007 |
| TSK | | | | |
| Low (≤17) | 1.00 | | 1.00 | |
| Middle (18-23) | 2.17 (1.19-3.99) | 0.012 | 2.08 (1.11-3.89) | 0.022 |
| High (≥24) | 5.60 (3.19-9.84) | < 0.001 | 6.13 (3.34-11.27) | < 0.001 |
| K6 | | | | |
| <10 | 1.00 | | 1.00 | |
| ≥10 | 1.62 (1.02-2.55) | 0.039 | 1.06 (0.64-1.75) | 0.834 |
| Flexibility | | | | |
| Flexible | 1.00 | | 1.00 | |
| Not flexible | 1.25 (0.81-1.94) | 0.314 | 0.95 (0.59-1.53) | 0.846 |
| Lifting | | | | |
| Not frequent | 1.00 | | 1.00 | |
| Frequent | 1.31 (0.87-1.98) | 0.201 | 0.99 (0.62-1.58) | 0.973 |

LBP, Low back pain; TSK, Tampa scale for kinesiophobia; OR, Odds ratio; CI, Confidence interval

*Adjusted for sex, age, body mass index, and all other variables which indicated in this table.

## DISCUSSION

The present study investigated the association of disabling LBP with related factors via a multifaceted assessment among nursing personnel at a tertiary hospital. The results of our multivariable logistic regression analysis showed that insomnia, previous episodes of LBP, and

kinesiophobia were independently associated with disabling LBP. To our knowledge, this is the first study that identified a significant association of pain-related fear and insomnia with disabling LBP among nursing personnel in Japan.

In this study, disabling LBP was set as the outcome of interest to identify risk factors for LBP among nursing personnel. In occupational fields, absence from work (absenteeism) due to LBP is often used as the outcome of disability. However, the number of individuals taking a sick leave due to LBP is considerably small. A previous international epidemiological study showed that the prevalence of absenteeism due to musculoskeletal disorders, mainly LBP, was much less common in Japan relative to that in the UK.[12] Moreover, it has been suggested that the loss of work performance due to LBP has a greater negative economic impact on individuals and workplaces in terms of healthcare costs and work productivity than sick leaves due to LBP.[33 34] Therefore, it may be appropriate to define disabling LBP as LBP interfering with work performance with or without sick leave.

Our results showed that high TSK scores were significantly associated with disabling LBP among nursing personnel after adjustment for various confounding factors (the OR [95% CI] of the highest tertile of TSK: 6.13 [3.34-11.27]). This result was similar to those obtained in our previous studies with white-collar workers[31] and workers at nursing care facilities,[35] which implies that kinesiophobia is an important factor for LBP regardless of job type. Kinesiophobia, an irrational and debilitating fear of movement/(re)injury, can cause a negative vicious cycle in the fear-avoidance model.[36] Avoidance of behavior based on kinesiophobia can cause physical inactivity, which has a negative impact on physical and psychological aspects and results in persistence of LBP. Werti et al reported that fear-avoidance beliefs were an important prognostic factor for LBP chronicity[7] and predicted poor treatment responses in subjects with LBP of less than 6 months.[37] Moreover, a recent systematic review has indicated that a greater degree of kinesiophobia at baseline predicted the progression of disability and the subsequent decline of quality of life among subjects with chronic musculoskeletal pain.[38] Therefore, our results suggest

that assessment of negative beliefs such as kinesiophobia may help prevent the chronicity of LBP in the workplace.

We found that the presence of a previous episode of LBP was a significant factor associated with disabling LBP, which is consistent with our earlier study in Japan.[24] Previous systematic reviews also showed that individuals with a history of LBP were at increased risk of future episodes.[9 39] Indeed, LBP has been suggested to be liable to recurrence. The recurrence rate of LBP within the first year after the episode has been reported to range from 24% to 50% or more.[39 40] This may be because individuals with LBP sometimes reduce their levels of physical activity, which leads to physical deconditioning, including functional changes of the trunk. A recent study indicated that trunk muscle mass was associated with LBP disability.[41] Additionally, our results may indicate that individuals with LBP continue to have the risk factors responsible for the initial occurrence of LBP. Thus, a previous episode of LBP may be an important predictor of future episodes also among nursing personnel.

In this study, sleep disturbance defined as insomnia was found to be an independent factor relevant to disabling LBP among nursing personnel. Previous studies reported that more than 50% of those who suffer from LBP have sleep problems.[42 43] Although the relationship between disturbed sleep and pain has been considered to be bidirectional, recent studies have focused on the influence of disturbed sleep on pain. Several prospective studies have indicated that sleep problems were associated with a higher risk of chronic musculoskeletal pain onset including LBP.[10 44] Our findings may be attributable to the decreased pain threshold consequent to sleep disturbance, which has been indicated by experimental studies.[45] Although the mechanism underlying the association between sleep disturbance and pain remains to be fully understood, the mesolimbic dopamine system has been suggested to play a role via an overlapping neurophysiological mechanism between sleep and pain;[46] however, because the potential mechanisms involved in these interactions are beyond the scope of our study, further studies including pathophysiological assessments are needed. Our results suggest that in the treatment of

individuals with disabling LBP, assessment and management of both sleep problems and LBP may have more positive effects on recovery relative to those achieved by targeting sleep or LBP independently.

The present study investigated the association of disabling LBP with multidimensional factors among nursing personnel, including selective variables with reference to previous findings. These factors were assessed using validated tools, which would reduce the risk of classification bias. However, the study had some limitations. First, participants were recruited from a single hospital, which might limit the generalizability of our results. Second, due to the cross-sectional design, the causality of the associations cannot be determined. Finally, our results might be affected by some potential confounding factors such as psychosocial work-related stress, other lifestyle habits, or socioeconomic status that were not considered in our study.

In conclusion, the present findings obtained with a multivariable logistic regression analysis showed that kinesiophobia, previous episodes of LBP, and insomnia were significantly associated with disabling LBP among nursing personnel. In the future, workplace interventions considering the assessment of these factors can help reduce the incidence of disabling LBP among nursing staff, although further prospective studies are needed to elucidate a causal relationship.

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**Competing interests:**

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**Authors' contributions**

TY and KM contributed to the conceptualization of this study. TY and SI contributed to the data acquisition. TY and HO analyzed and interpreted the data. SM, AK, and KM contributed to the supervision of this study. TY drafted the manuscript. All authors have read and approved the final manuscript.

**References**

1. GBD 2017 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet* 2018;392:1789–858.
2. Dagenais S, Caro J, Haldeman S. A systematic review of low back pain cost of illness studies in the United States and internationally. *Spine J* 2008;8:8–20.
3. Dieleman JL, Baral R, Birger M, et al. US Spending on Personal Health Care and Public

Health, 1996-2013. *JAMA* 2016;316:2627–46.

4. Hoogendoorn WE, van Poppel MN, Bongers PM, et al. Physical load during work and leisure time as risk factors for back pain. *Scand J Work Environ Health* 1999;25:387–403.
5. Sadler SG, Spink MJ, Ho A, et al. Restriction in lateral bending range of motion, lumbar lordosis, and hamstring flexibility predicts the development of low back pain: a systematic review of prospective cohort studies. *BMC Musculoskelet Disord* 2017;18:179.
6. Pinheiro MB, Ferreira ML, Refshauge K, et al. Symptoms of Depression and Risk of New Episodes of Low Back Pain: A Systematic Review and Meta-Analysis. *Arthritis Care Res (Hoboken)* 2015;67:1591–603.
7. Wertli MM, Rasmussen-Barr E, Weiser S, et al. The role of fear avoidance beliefs as a prognostic factor for outcome in patients with nonspecific low back pain: a systematic review. *Spine J* 2014;14:816–36 e4.
8. Crombez G, Vlaeyen JW, Heuts PH, et al. Pain-related fear is more disabling than pain itself: evidence on the role of pain-related fear in chronic back pain disability. *Pain* 1999;80:329–39.
9. Taylor JB, Goode AP, George SZ, et al. Incidence and risk factors for first-time incident low back pain: a systematic review and meta-analysis. *Spine J* 2014;14:2299–319.
10. Mork PJ, Vik KL, Moe B, et al. Sleep problems, exercise and obesity and risk of chronic musculoskeletal pain: the Norwegian HUNT study. *Eur J Public Health* 2014;24:924–9.
11. Leighton DJ, Reilly T. Epidemiological aspects of back pain: the incidence and prevalence of back pain in nurses compared to the general population. *Occup Med (Lond)* 1995;45:263–7.
12. Matsudaira K, Palmer KT, Reading I, et al. Prevalence and correlates of regional pain and associated disability in Japanese workers. *Occup Environ Med* 2011;68:191–6.
13. Hofmann F, Stossel U, Michaelis M, et al. Low back pain and lumbago-sciatica in nurses and a reference group of clerks: results of a comparative prevalence study in Germany. *Int Arch Occup Environ Health* 2002;75:484–90.

14. Smedley J, Egger P, Cooper C, et al. Prospective cohort study of predictors of incident low back pain in nurses. *BMJ* 1997;314:1225–8.

15. Yassi A, Lockhart K. Work-relatedness of low back pain in nursing personnel: a systematic review. *Int J Occup Environ Health* 2013;19:223–44.

16. Eriksen W, Bruusgaard D, Knardahl S. Work factors as predictors of intense or disabling low back pain; a prospective study of nurses' aides. *Occup Environ Med* 2004;61:398–404.

17. Schlossmacher R, Amaral FG. Low back injuries related to nursing professionals working conditions: a systematic review. *Work* 2012;41 Suppl 1:5737–8.

18. Dawson AP, McLennan SN, Schiller SD, et al. Interventions to prevent back pain and back injury in nurses: a systematic review. *Occup Environ Med* 2007;64:642–50.

19. Van Hoof W, O'Sullivan K, O'Keeffe M, et al. The efficacy of interventions for low back pain in nurses: A systematic review. *Int J Nurs Stud* 2018;77:222–31.

20. Coggon D, Ntani G, Palmer KT, et al. Drivers of international variation in prevalence of disabling low back pain: Findings from the Cultural and Psychosocial Influences on Disability study. *Eur J Pain* 2019;23:35–45.

21. Von Korff M, Ormel J, Keefe FJ, et al. Grading the severity of chronic pain. *Pain* 1992;50:133–49.

22. Kuorinka I, Jonsson B, Kilbom A, et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Appl Ergon* 1987;18:233–7.

23. Dionne CE, Dunn KM, Croft PR, et al. A consensus approach toward the standardization of back pain definitions for use in prevalence studies. *Spine (Phila Pa 1976)* 2008;33:95–103.

24. Matsudaira K, Konishi H, Miyoshi K, et al. Potential risk factors for new onset of back pain disability in Japanese workers: findings from the Japan epidemiological research of occupation-related back pain study. *Spine (Phila Pa 1976)* 2012;37:1324–33.

25. Nakata A, Ikeda T, Takahashi M, et al. Sleep-related risk of occupational injuries in Japanese small and medium-scale enterprises. *Ind Health* 2005;43:89–97.

26. Woby SR, Roach NK, Urmston M, et al. Psychometric properties of the TSK-11: a shortened version of the Tampa Scale for Kinesiophobia. *Pain* 2005;117:137–44.

27. Kikuchi N, Matsudaira K, Sawada T, et al. Psychometric properties of the Japanese version of the Tampa Scale for Kinesiophobia (TSK-J) in patients with whiplash neck injury pain and/or low back pain. *J Orthop Sci* 2015;20:985–92.

28. Matsudaira K, Inuzuka K, Kikuchi N, et al. Development of a Japanese Version of the Tampa Scale for Kinesiophobia (TSK-J): Translation and Linguistic Validation. *Rinsho Seikei Geka (Clin Orthop Surg)* 2013;48:13–9.

29. Kessler RC, Andrews G, Colpe LJ, et al. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychol Med* 2002;32:959–76.

30. Furukawa TA, Kawakami N, Saitoh M, et al. The performance of the Japanese version of the K6 and K10 in the World Mental Health Survey Japan. *Int J Methods Psychiatr Res* 2008;17:152–8.

31. Wakaizumi K, Yamada K, Oka H, et al. Fear-avoidance beliefs are independently associated with the prevalence of chronic pain in Japanese workers. *J Anesth* 2017;31:255–62.

32. Akaha H, Matsudaira K, Takeshita K, et al. Modified measurement of finger-floor distance - self-assessment bending scale-. *J Jpn Soci Lumbar Spine Disord* 2008;14:164–9.

33. Loeppke R, Taitel M, Richling D, et al. Health and productivity as a business strategy. *J Occup Environ Med* 2007;49:712–21.

34. Wada K, Arakida M, Watanabe R, et al. The economic impact of loss of performance due to absenteeism and presenteeism caused by depressive symptoms and comorbid health conditions among Japanese workers. *Ind Health* 2013;51:482–9.

35. Yoshimoto T, Oka H, Fujii K, et al. Survey on chronic disabling low back pain among care workers at nursing care facilities: a multicenter collaborative cross-sectional study. *J Pain Res* 2019;12:1025–32.

36. Leeuw M, Goossens ME, Linton SJ, et al. The fear-avoidance model of musculoskeletal pain:

current state of scientific evidence. *J Behav Med* 2007;30:77–94.

37. Wertli MM, Rasmussen-Barr E, Held U, et al. Fear-avoidance beliefs-a moderator of treatment efficacy in patients with low back pain: a systematic review. *Spine J* 2014;14:2658–78.

38. Luque-Suarez A, Martinez-Calderon J, Falla D. Role of kinesiophobia on pain, disability and quality of life in people suffering from chronic musculoskeletal pain: a systematic review. *Br J Sports Med* 2019;53:554–9.

39. Hestbaek L, Leboeuf-Yde C, Manniche C. Low back pain: what is the long-term course? A review of studies of general patient populations. *Eur Spine J* 2003;12:149–65.

40. Stanton TR, Henschke N, Maher CG, et al. After an episode of acute low back pain, recurrence is unpredictable and not as common as previously thought. *Spine (Phila Pa 1976)* 2008;33:2923–8.

41. Hori Y, Hoshino M, Inage K, et al. ISSLS PRIZE IN CLINICAL SCIENCE 2019: clinical importance of trunk muscle mass for low back pain, spinal balance, and quality of life-a multicenter cross-sectional study. *Eur Spine J* 2019;28:914–21.

42. Hagen EM, Svensen E, Eriksen HR, et al. Comorbid subjective health complaints in low back pain. *Spine (Phila Pa 1976)* 2006;31:1491–5.

43. Alsaadi SM, McAuley JH, Hush JM, et al. Prevalence of sleep disturbance in patients with low back pain. *Eur Spine J* 2011;20:737–43.

44. Canivet C, Ostergren PO, Choi B, et al. Sleeping problems as a risk factor for subsequent musculoskeletal pain and the role of job strain: results from a one-year follow-up of the Malmo Shoulder Neck Study Cohort. *Int J Behav Med* 2008;15:254–62.

45. Kundermann B, Krieg JC, Schreiber W, et al. The effect of sleep deprivation on pain. *Pain Res Manag* 2004;9:25–32.

46. Finan PH, Smith MT. The comorbidity of insomnia, chronic pain, and depression: dopamine as a putative mechanism. *Sleep Med Rev* 2013;17:173–83.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

| | Item No | Recommendation | Page No |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | P 1 |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | P 2 |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | P 4 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | P 4-5 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | P 5 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | P 5 |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants | P 5 |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | P 5-7 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | P 5-7 |
| Bias | 9 | Describe any efforts to address potential sources of bias | P 13 |
| Study size | 10 | Explain how the study size was arrived at | NA |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | P 5-7 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | P 7 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | P 7 |
| | | (*c*) Explain how missing data were addressed | P 7 |
| | | (*d*) If applicable, describe analytical methods taking account of sampling strategy | NA |
| | | (*e*) Describe any sensitivity analyses | NA |
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | P 7-8 |
| | | (b) Give reasons for non-participation at each stage | P 8 |
| | | (c) Consider use of a flow diagram | NA |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | P 7-9 |
| | | (b) Indicate number of participants with missing data for each variable of interest | NA |
| Outcome data | 15* | Report numbers of outcome events or summary measures | P 8 |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | P 8, 10 |

| | | | |
|---|---|---|---|
| | | (*b*) Report category boundaries when continuous variables were categorized | P 9-10 |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | NA |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | NA |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | P 10-11 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | P 13 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | P 11-13 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | P 13 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | P 13 |

*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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# Factors associated with disabling low back pain among nursing personnel at a medical center in Japan: A comparative cross-sectional survey

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| Secondary Subject Heading: | Epidemiology, Nursing |
| Keywords: | low back pain, nurse, kinesiophobia, sleep |
| | |

**Title:**

Factors associated with disabling low back pain among nursing personnel at a medical center in Japan: A comparative cross-sectional survey.

Takahiko Yoshimoto[1,2*], Hiroyuki Oka[2], Shuhei Ishikawa[3], Akatsuki Kokaze[1], Shingo Muranaga[3], Ko Matsudaira[2]

[1] Department of Hygiene, Public Health and Preventive Medicine, Showa University School of Medicine, Tokyo, Japan

[2] Department of Medical Research and Management for Musculoskeletal Pain, 22nd Century Medical & Research Center, Faculty of Medicine, The University of Tokyo, Tokyo, Japan

[3] Department of Rehabilitation, Kameda Medical Center, Chiba, Japan

[*] **Corresponding author:**

Takahiko Yoshimoto

Department of Hygiene, Public Health and Preventive Medicine, Showa University School of Medicine, 1-5-8 Hatanodai, Shinagawa-ku, Tokyo 142-8555, Japan

Tel: +81(3)3784-8134; Fax: +81(3)3784-7733

E-mail address: yoshimotota@gmail.com

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## ABSTRACT

**Objectives:** Low back pain (LBP) is a common cause of disability among nursing personnel. Although many studies regarding the risk factors for LBP among nursing staff have focused on the physical load at work, multidimensional assessments of risk factors are essential to identify appropriate preventive strategies. We aimed to investigate the association of multidimensional factors (individual, physical, psychological, and occupational) with disabling LBP among nursing personnel in Japan.

**Design:** Observational study with comparative cross-sectional design.

**Setting:** Data was collected using the self-administered questionnaire at a tertiary medical center.

**Participants:** After excluding participants with missing variables, 718 nursing personnel were included in the analysis.

**Outcome measures:** A self-administered questionnaire assessed individual characteristics, rotating night shift data, severity of LBP, previous episode of LBP, sleep problem, kinesiophobia (Tampa Scale for Kinesiophobia), depressive condition (K6), physical flexibility, and frequency of lifting at work. A logistic regression model was used to evaluate the factors associated with disabling LBP (LBP interfering with work) among nursing personnel.

**Results:** Of all participants, 110 (15.3%) reported having disabling LBP. The multivariable logistic regression analysis after adjustment for several confounding factors showed that kinesiophobia (highest tertile, adjusted odds ratio [aOR]: 6.13, 95% confidence interval [CI]: 3.34-11.27), previous episode of LBP (aOR: 4.33, 95% CI: 1.50-12.41), and insomnia (aOR: 1.66, 95% CI: 1.05-2.62) were significantly associated with disabling LBP.

**Conclusions:** The present study indicated that kinesiophobia, a previous episode of LBP, and sleep problems were associated with disabling LBP among nursing personnel. In the future, workplace interventions considering assessments of these factors may reduce the incidence of disabling LBP in nursing staff, although further prospective studies are needed.

**Strengths and limitations of this study**

- This study focused on disabling low back pain as the outcome of interest which was considered as a serious problem in workplace.
- This study was designed to assess simultaneously the multidimensional aspects (individual, physical, psychological, and occupational) of disabling low back pain among nursing personnel in Japan.
- This paper provides results that will be useful in understanding the complexity of low back pain and developing appropriate strategies for reducing the incidence of occupational low back pain.
- This study was conducted among participants at one medical center, which might limit the generalizability of our findings.
- The cross-sectional design of this study could not clarify a causal relationship.

## INTRODUCTION

The global burden of disease study 2017 indicated that low back pain (LBP) is one of the leading cause of disability worldwide.[1] LBP is a major public health problem with an enormous negative economic impact on individuals, industries, and societies.[2 3]

The etiology of LBP is multifactorial and includes physical factors (physical load at work,[4] physical flexibility,[5] etc.) and psychological factors (depression,[6] and fear-avoidance belief,[7] etc.). Among psychological factors, pain-related fear of movement/reinjury, which is known as kinesiophobia, has been suggested to be an important contributor for LBP.[8] LBP also recurs frequently; thus, a previous episode of LBP can be a predictor of future episodes.[9] Moreover, lifestyle factors including sleep problems can increase the risk of LBP.[10]

Several studies have shown that nursing personnel have a higher prevalence of LBP relative to the general population or other occupational groups,[11-13] which may be related to nursing work-related factors. Indeed, in addition to the above physical and psychological factors, occupation-specific factors such as manual handling[14 15] and rotating night shifts[16 17] have been suggested to be associated with the development of LBP among nursing personnel. Because LBP could lead not only to decreased work performance, but also professional abandonment,[18] clarifying the risk factors of LBP and exploring appropriate preventive strategies is essential to reduce the incidence of LBP among nursing professionals.

Although there is ample evidence showing that physical factors, including manual handling, among nursing personnel are a significant risk factor for LBP,[14 15 18] systematic reviews of interventions for LBP in nurses have indicated that ergonomic interventions for LBP had inadequate results.[19 20] Thus, studies investigating the factors associated with LBP among nursing personnel from a multidimensional perspective including individual, physical and psychological factors are increasingly needed. Since the prevalence of disabling LBP varies across countries and occupations,[21] it may be important to investigate the factors associated with disabling LBP among nursing personnel in Japan in order to design appropriate strategies for reducing the

incidence of occupational LBP. Therefore, we aimed to perform a multidimensional assessment, including individual, physical, psychological, and occupational aspects, of disabling LBP among nursing personnel at a tertiary hospital in Japan.

## METHODS

### Study populations

This comparative cross-sectional study was based on a survey conducted among nursing personnel at Kameda Medical Center at Chiba Prefecture, Japan during February 2017. During this period, an anonymous, self-administered questionnaire was distributed to 1,152 workers at the nursing department in the center. After the workers answered the questionnaires, they put them in sealed envelopes. Then, occupational health staff collected and sent the envelopes to the authors. Staff other than the authors were not allowed to open the sealed envelopes. Written informed consent was obtained from each participant. All procedures were approved by the Research Ethics Committee of Kameda Medical Center (Approval No. 16-159) and carried out according to the Declaration of Helsinki.

### Study measures

The following items were assessed using the self-administered questionnaire: age, sex, height, weight, occupation type (registered nurse, assistant nurse, midwife, or nursing aid), rotating night shift (frequency of shift work per month), severity of LBP, previous episode of LBP, sleep problem, fear-avoidance (kinesiophobia), depressive condition, physical flexibility, and lifting at work. Body mass index (BMI) was calculated as weight (kg) divided by the square of height (m).

The severity of LBP, evaluated by respondents, was classified into four grades: grade 0 (no LBP), grade 1 (LBP that did not interfere with work), grade 2 (LBP that interfered with work), and grade 3 (LBP that interfered with work and required sick leave). These grades were determined with reference to Von Korff's grading method.[22] The area of LBP (between the costal

margin and inferior gluteal folds) was indicated as a diagram in the questionnaire.[23] LBP was defined as pain lasting for ≥1 day and experienced during the past one month, in accordance with the standard definition of LBP proposed by Dionne et al.[24] LBP associated with menstrual periods, pregnancy, or febrile illness was excluded. Individuals with disabling LBP were defined as those who had LBP interfering with work, irrespective of sick leave because of LBP (grade 2 or 3).[25] Past LBP history characteristics were evaluated in a question regarding the previous episode of LBP.

Sleep problems were assessed using questions about the sleep duration and sleep habits in the previous month.[26] Disability of sleep duration was defined by durations < 6 hours. Difficulty initiating sleep was defined as taking more than 30 min to fall asleep. Difficulty maintaining sleep and early morning awakening were defined by the occurrence of nocturnal awakenings or early morning awakenings three times or more per week. The presence of insomnia was defined if the participants reported at least one positive response to the three symptoms of sleep habits above.[26]

To assess fear of movement/(re)injury, we used the short version of the Tampa Scale for Kinesiophobia (TSK-11).[27] The TSK-11 consists of 11 items, each of which is scored on a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). The total scores range from 11 to 44, with higher scores indicating greater fear of movement/(re)injury. The Japanese version of TSK-11 has been translated and validated by Matsudaira et al.[28 29] Participants' scores were classified into tertiles according to their total scores.

Depressive condition was evaluated by using the Kessler 6-item psychological distress scale (K6).[30] The K6 consists of six items that assess how frequently respondents experienced symptoms of psychological distress such as nervousness, negative affect, fatigue, and worthlessness over the past 30 days. Each item was rated on a 5-point scale ranging from 0 (none of the time) to 4 (all of the time), with the total score ranging from 0 to 24. The K6 has been translated to a Japanese version, whose reliability and validity have been confirmed by Furukawa et al.[31] Individuals with a K6 score of ≥10 were defined as having a depressive condition in

accordance with a previous study.[32]

Physical flexibility was assessed by using the modified finger-to-floor distance[33] which mainly represents trunk flexibility. The grade of this item was rated on a 7-point scale: 1) fingertips cannot reach across the knees; 2) fingertips can reach across the knees but wrists not; 3) wrists can reach beyond the knees, but fingertips cannot reach the ankles; 4) fingertips can reach the ankles; 5) fingertips can touch the floor; 6) all of the fingers can touch the floor; and 7) palms can touch the floor. Flexibility was classified into two groups based on whether wrists could reach beyond the knee, but fingertips could not reach the ankles.[25]

Physical work demand was measured with a question exploring the frequency of lifting at work. The frequency of lifting was divided into 0, 1-4, 5-9, 10 times per shift, and lifting ≥5 times per shift was defined as frequent with reference to a previous study.[16]

**Statistical analysis**

We conducted a multivariable logistic regression analysis because our dependent variable (disabling LBP) was dichotomous. One guideline has suggested that a sample size with at least 10 cases for each independent variable is required to estimate a discriminant function parameters accurately in logistic regression analysis.[34] Therefore, based on this guideline and our 11 predictor variables, we required 110 cases for our analysis. Moreover, considering the prevalence of disabling LBP and missing data, we calculated 1,000 participants to ensure the accurate estimation in the analysis.

Data were presented as median (25th, 75th percentile) for continuous variables or number (%) for categorical variables. Characteristics of participants were compared using the chi-squared test for categorical variables and Wilcoxon rank-sum test for continuous variables. To assess factors associated with disabling LBP, a logistic regression model was used to estimate the odds ratio (OR) and 95% confidence interval (CI) for disabling LBP. In the model, the following factors were included for adjustment: sex, age, BMI, frequency of shift work, sleep duration, insomnia,

previous episode of LBP, TSK and K6 scores, flexibility, lifting at work. Multicollinearity was not suspected as all variance inflation factors (VIFs) were <2. A p-value less than 0.05 was considered to be statistically significant (two-sided). All statistical analyses were performed using JMP version 13.0 (SAS Institute Inc., Cary, NC, USA).

**Patient and public involvement**

Patients and the public were not involved in the design or planning of the study.

## RESULTS

Of all workers at the nursing department in the center, 1075 respondents provided answers in the questionnaires (response rate: 93.3%). Since the present study was focused on nursing personnel who provide direct care in the center, 146 employees who were not related to direct nursing care (clerical work or providing guidance to patients, etc.) were excluded. We further excluded 211 participants with missing data for any variable. As a result, 718 nursing staff completed the questionnaire with no missing data and were included in the analysis (completion rate: 66.8%).

The median age of participants in the present study was 31.0 years, and 79.7% of the participants were female. The distribution of LBP severity according to grade was as follows: grade 0 (n = 233), grade 1 (n = 375), grade 2 (n = 104), and grade 3 (n = 6). Thus, 15.3% of the included participants were reported to have disabling LBP. The characteristics of participants with or without disabling LBP are shown in Table 1. The proportions of insomnia ($p < 0.001$) and previous episode of LBP ($p < 0.001$) among participants with disabling LBP were higher relative to those observed in participants without disabling LBP. The proportions of those who had high TSK ($p < 0.001$) or K6 ($p < 0.038$) scores were higher in the disabling LBP group than in the no disabling LBP group. In contrast, the groups with and without disabling LBP showed no significant differences for physical flexibility and the frequency of lifting at work.

We calculated the crude and adjusted ORs and their 95% CIs for disabling LBP (Table 2). The non-adjusted analysis showed that insomnia, previous episode of LBP, and TSK and K6 scores were significantly associated with disabling LBP. Multivariable analysis after adjusting for sex, age, BMI, and all explanatory variables showed that insomnia (adjusted OR [aOR]: 1.66, 95% CI: 1.05-2.62), a previous episode of LBP (aOR: 4.31, 95% CI: 1.50-12.41), and TSK score (aOR: 2.08, 95% CI: 1.11-3.89 in middle, aOR: 6.13, 95% CI: 3.34-11.27 in high) remained significantly associated with disabling LBP.

Table 1. Characteristics of the study participants

| | Disabling LBP (n = 110) | No disabling LBP (n = 608) | *p*-value |
|---|---|---|---|
| Sex | | | |
| Male | 31 (28.2%) | 115 (18.9%) | 0.026 |
| Female | 79 (71.8%) | 493 (81.1%) | |
| Age, years | 27.5 (24.0, 40.0) | 31.0 (24.0, 42.0) | 0.052 |
| Body mass index, kg/m$^2$ | 21.6 (19.8, 23.3) | 21.2 (19.5, 23.9) | 0.793 |
| Occupation type | | | |
| Registered nurse | 88 (80.0%) | 495 (81.4%) | 0.886 |
| Assistant nurse (practical nurse) | 2 (1.8%) | 16 (2.6%) | |
| Midwife | 4 (3.6%) | 18 (3.0%) | |
| Nursing aid | 16 (14.5%) | 79 (13.0%) | |
| Frequency of shift work, per month | 6.0 (2.5, 10.0) | 6.0 (0.0, 10.8) | 0.571 |
| Sleep duration | | | |
| >6 hours | 78 (70.9%) | 436 (71.7%) | 0.864 |
| <6 hours | 32 (29.1%) | 172 (28.3%) | |
| Insomnia | | | |
| Not have insomnia | 47 (42.7%) | 366 (60.2%) | < 0.001 |
| Have insomnia | 63 (57.3%) | 242 (39.8%) | |
| Previous episode of LBP | | | |
| No | 4 (3.6%) | 97 (16.0%) | < 0.001 |
| Yes | 106 (96.4%) | 511 (84.0%) | |
| TSK | | | |
| Low (≤17) | 18 (16.4%) | 252 (41.4%) | < 0.001 |
| Middle (18-23) | 32 (29.1%) | 206 (33.9%) | |
| High (≥24) | 60 (54.5%) | 150 (24.7%) | |
| K6 | | | |
| <10 | 78 (70.9%) | 485 (79.8%) | 0.038 |
| ≥10 | 32 (29.1%) | 123 (20.2%) | |
| Flexibility | | | |
| Flexible | 75 (68.2%) | 443 (72.9%) | 0.314 |
| Not flexible | 35 (31.6%) | 165 (27.1%) | |
| Lifting | | | |
| Not frequent | 45 (40.9%) | 289 (47.5%) | 0.200 |
| Frequent | 65 (59.1%) | 319 (52.5%) | |

Data are presented as number (percentage) or median (25th, 75th percentile).

LBP, Low back pain; TSK, Tampa scale for kinesiophobia

Table 2. Association between disabling low back pain and independent variables from logistic regression models

| | Crude | | Adjusted* | |
|---|---|---|---|---|
| | OR (95% CI) | *p*-value | OR (95% CI) | *p*-value |
| Frequency of shift work, per month | 1.00 (0.97-1.04) | 0.783 | 0.98 (0.94-1.02) | 0.390 |
| Sleep duration | | | | |
| >6 hours | 1.00 | | 1.00 | |
| <6 hours | 1.04 (0.66-1.63) | 0.864 | 1.12 (0.68-1.83) | 0.659 |
| Insomnia | | | | |
| Not have insomnia | 1.00 | | 1.00 | |
| Have insomnia | 2.03 (1.34-3.06) | < 0.001 | 1.66 (1.05-2.62) | 0.029 |
| Previous episode of LBP | | | | |
| No | 1.00 | | 1.00 | |
| Yes | 5.03 (1.81-13.97) | 0.002 | 4.31 (1.50-12.41) | 0.007 |
| TSK | | | | |
| Low (≤17) | 1.00 | | 1.00 | |
| Middle (18-23) | 2.17 (1.19-3.99) | 0.012 | 2.08 (1.11-3.89) | 0.022 |
| High (≥24) | 5.60 (3.19-9.84) | < 0.001 | 6.13 (3.34-11.27) | < 0.001 |
| K6 | | | | |
| <10 | 1.00 | | 1.00 | |
| ≥10 | 1.62 (1.02-2.55) | 0.039 | 1.06 (0.64-1.75) | 0.834 |
| Flexibility | | | | |
| Flexible | 1.00 | | 1.00 | |
| Not flexible | 1.25 (0.81-1.94) | 0.314 | 0.95 (0.59-1.53) | 0.846 |
| Lifting | | | | |
| Not frequent | 1.00 | | 1.00 | |
| Frequent | 1.31 (0.87-1.98) | 0.201 | 0.99 (0.62-1.58) | 0.973 |

LBP, Low back pain; TSK, Tampa scale for kinesiophobia; OR, Odds ratio; CI, Confidence interval
*Adjusted for sex, age, body mass index, and all other variables which indicated in this table.

## DISCUSSION

The present study investigated the association of disabling LBP with related factors via a multifaceted assessment among nursing personnel at a tertiary hospital. The results of our multivariable logistic regression analysis showed that insomnia, previous episodes of LBP, and

kinesiophobia were independently associated with disabling LBP. To our knowledge, this is the first study that identified a significant association of pain-related fear and insomnia with disabling LBP among nursing personnel in Japan.

In this study, disabling LBP was set as the outcome of interest to identify risk factors for LBP among nursing personnel. In occupational fields, absence from work (absenteeism) due to LBP is often used as the outcome of disability. However, the number of individuals taking a sick leave due to LBP is considerably small. A previous international epidemiological study showed that the prevalence of absenteeism due to musculoskeletal disorders, mainly LBP, was much less common in Japan relative to that in the UK.[11] Moreover, it has been suggested that the loss of work performance due to LBP has a greater negative economic impact on individuals and workplaces in terms of healthcare costs and work productivity than sick leaves due to LBP.[35 36] Therefore, it may be appropriate to define disabling LBP as LBP interfering with work performance with or without sick leave.

Our results showed that high TSK scores were significantly associated with disabling LBP among nursing personnel after adjustment for various confounding factors (the OR [95% CI] of the highest tertile of TSK: 6.13 [3.34-11.27]). This result was similar to those obtained in our previous studies with white-collar workers[32] and workers at nursing care facilities,[37] which implies that kinesiophobia is an important factor for LBP regardless of job type. Kinesiophobia, an irrational and debilitating fear of movement/(re)injury, can cause a negative vicious cycle in the fear-avoidance model.[38] Avoidance of behavior based on kinesiophobia can cause physical inactivity, which has a negative impact on physical and psychological aspects and results in persistence of LBP. Werti et al reported that fear-avoidance beliefs were an important prognostic factor for LBP chronicity[7] and predicted poor treatment responses in subjects with LBP of less than 6 months.[39] Moreover, a recent systematic review has indicated that a greater degree of kinesiophobia at baseline predicted the progression of disability and the subsequent decline of quality of life among subjects with chronic musculoskeletal pain.[40] Therefore, our results suggest

that assessment of negative beliefs such as kinesiophobia may help prevent the chronicity of LBP in the workplace.

We found that the presence of a previous episode of LBP was a significant factor associated with disabling LBP, which is consistent with our earlier study in Japan.[25] Previous systematic reviews also showed that individuals with a history of LBP were at increased risk of future episodes.[9 41] Indeed, LBP has been suggested to be liable to recurrence. The recurrence rate of LBP within the first year after the episode has been reported to range from 24% to 50% or more.[41 42] This may be because individuals with LBP sometimes reduce their levels of physical activity, which leads to physical deconditioning, including functional changes of the trunk. A recent study indicated that trunk muscle mass was associated with LBP disability.[43] Additionally, our results may indicate that individuals with LBP continue to have the risk factors responsible for the initial occurrence of LBP. Thus, a previous episode of LBP may be an important predictor of future episodes also among nursing personnel.

In this study, sleep disturbance defined as insomnia was found to be an independent factor relevant to disabling LBP among nursing personnel. Previous studies reported that more than 50% of those who suffer from LBP have sleep problems.[44 45] Although the relationship between disturbed sleep and pain has been considered to be bidirectional, recent studies have focused on the influence of disturbed sleep on pain. Several prospective studies have indicated that sleep problems were associated with a higher risk of chronic musculoskeletal pain onset including LBP.[10 46] Our findings may be attributable to the decreased pain threshold consequent to sleep disturbance, which has been indicated by experimental studies.[47] Although the mechanism underlying the association between sleep disturbance and pain remains to be fully understood, the mesolimbic dopamine system has been suggested to play a role via an overlapping neurophysiological mechanism between sleep and pain;[48] however, because the potential mechanisms involved in these interactions are beyond the scope of our study, further studies including pathophysiological assessments are needed. Our results suggest that in the treatment of

individuals with disabling LBP, assessment and management of both sleep problems and LBP may have more positive effects on recovery relative to those achieved by targeting sleep or LBP independently.

The present study investigated the association of disabling LBP with multidimensional factors among nursing personnel, including selective variables with reference to previous findings. These factors were assessed using validated tools, which would reduce the risk of classification bias. However, the study had some limitations. First, participants were recruited from a single hospital, which might limit the generalizability of our results. Second, due to the cross-sectional design, the causality of the associations cannot be determined. Finally, our results might be affected by some potential confounding factors such as psychosocial work-related stress, other lifestyle habits, or socioeconomic status that were not considered in our study.

In conclusion, the present findings obtained with a multivariable logistic regression analysis showed that kinesiophobia, previous episodes of LBP, and insomnia were significantly associated with disabling LBP among nursing personnel. In the future, workplace interventions considering the assessment of these factors can help reduce the incidence of disabling LBP among nursing staff, although further prospective studies are needed to elucidate a causal relationship.

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**Competing interests:**

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**Authors' contributions**

TY and KM contributed to the conceptualization of this study. TY and SI contributed to the data acquisition. TY and HO analyzed and interpreted the data. SM, AK, and KM contributed to the supervision of this study. TY drafted the manuscript. All authors have read and approved the final manuscript.

**Data availability statement**

The data used in the current study are available on reasonable request and only after approval by the Research Ethics Committee of Kameda Medical Center.

**References**

1. GBD 2017 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of

Disease Study 2017. *Lancet* 2018;392:1789-858.

2. Dagenais S, Caro J, Haldeman S. A systematic review of low back pain cost of illness studies in the United States and internationally. *Spine J* 2008;8:8-20.
3. Dieleman JL, Baral R, Birger M, et al. US Spending on Personal Health Care and Public Health, 1996-2013. *JAMA* 2016;316:2627-46.
4. Hoogendoorn WE, van Poppel MN, Bongers PM, et al. Physical load during work and leisure time as risk factors for back pain. *Scand J Work Environ Health* 1999;25:387-403.
5. Sadler SG, Spink MJ, Ho A, et al. Restriction in lateral bending range of motion, lumbar lordosis, and hamstring flexibility predicts the development of low back pain: a systematic review of prospective cohort studies. *BMC Musculoskelet Disord* 2017;18:179.
6. Pinheiro MB, Ferreira ML, Refshauge K, et al. Symptoms of Depression and Risk of New Episodes of Low Back Pain: A Systematic Review and Meta-Analysis. *Arthritis Care Res (Hoboken)* 2015;67:1591-603.
7. Wertli MM, Rasmussen-Barr E, Weiser S, et al. The role of fear avoidance beliefs as a prognostic factor for outcome in patients with nonspecific low back pain: a systematic review. *Spine J* 2014;14:816-36 e4.
8. Crombez G, Vlaeyen JW, Heuts PH, et al. Pain-related fear is more disabling than pain itself: evidence on the role of pain-related fear in chronic back pain disability. *Pain* 1999;80:329-39.
9. Taylor JB, Goode AP, George SZ, et al. Incidence and risk factors for first-time incident low back pain: a systematic review and meta-analysis. *Spine J* 2014;14:2299-319.
10. Mork PJ, Vik KL, Moe B, et al. Sleep problems, exercise and obesity and risk of chronic musculoskeletal pain: the Norwegian HUNT study. *Eur J Public Health* 2014;24:924-9.
11. Matsudaira K, Palmer KT, Reading I, et al. Prevalence and correlates of regional pain and associated disability in Japanese workers. *Occup Environ Med* 2011;68:191-6.
12. Leighton DJ, Reilly T. Epidemiological aspects of back pain: the incidence and prevalence of

back pain in nurses compared to the general population. *Occup Med (Lond)* 1995;45:263-7.

13. Genevay S, Cedraschi C, Courvoisier DS, et al. Work related characteristics of back and neck pain among employees of a Swiss University Hospital. *Joint Bone Spine* 2011;78:392-7.

14. Yassi A, Lockhart K. Work-relatedness of low back pain in nursing personnel: a systematic review. *Int J Occup Environ Health* 2013;19:223-44.

15. Burdorf A, Koppelaar E, Evanoff B. Assessment of the impact of lifting device use on low back pain and musculoskeletal injury claims among nurses. *Occup Environ Med* 2013;70:491-7.

16. Eriksen W, Bruusgaard D, Knardahl S. Work factors as predictors of intense or disabling low back pain; a prospective study of nurses' aides. *Occup Environ Med* 2004;61:398-404.

17. d'Ettorre G, Vullo A, Pellicani V, et al. Acute low back pain among registered nurses. Organizational implications for practice management. *Ann Ig* 2018;30:482-9.

18. Schlossmacher R, Amaral FG. Low back injuries related to nursing professionals working conditions: a systematic review. *Work* 2012;41 Suppl 1:5737-8.

19. Dawson AP, McLennan SN, Schiller SD, et al. Interventions to prevent back pain and back injury in nurses: a systematic review. *Occup Environ Med* 2007;64:642-50.

20. Van Hoof W, O'Sullivan K, O'Keeffe M, et al. The efficacy of interventions for low back pain in nurses: A systematic review. *Int J Nurs Stud* 2018;77:222-31.

21. Coggon D, Ntani G, Palmer KT, et al. Drivers of international variation in prevalence of disabling low back pain: Findings from the Cultural and Psychosocial Influences on Disability study. *Eur J Pain* 2019;23:35-45.

22. Von Korff M, Ormel J, Keefe FJ, et al. Grading the severity of chronic pain. *Pain* 1992;50:133-49.

23. Kuorinka I, Jonsson B, Kilbom A, et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Appl Ergon* 1987;18:233-7.

24. Dionne CE, Dunn KM, Croft PR, et al. A consensus approach toward the standardization of

back pain definitions for use in prevalence studies. *Spine (Phila Pa 1976)* 2008;33:95-103.

25. Matsudaira K, Konishi H, Miyoshi K, et al. Potential risk factors for new onset of back pain disability in Japanese workers: findings from the Japan epidemiological research of occupation-related back pain study. *Spine (Phila Pa 1976)* 2012;37:1324-33.
26. Nakata A, Ikeda T, Takahashi M, et al. Sleep-related risk of occupational injuries in Japanese small and medium-scale enterprises. *Ind Health* 2005;43:89-97.
27. Woby SR, Roach NK, Urmston M, et al. Psychometric properties of the TSK-11: a shortened version of the Tampa Scale for Kinesiophobia. *Pain* 2005;117:137-44.
28. Kikuchi N, Matsudaira K, Sawada T, et al. Psychometric properties of the Japanese version of the Tampa Scale for Kinesiophobia (TSK-J) in patients with whiplash neck injury pain and/or low back pain. *J Orthop Sci* 2015;20:985-92.
29. Matsudaira K, Inuzuka K, Kikuchi N, et al. Development of a Japanese Version of the Tampa Scale for Kinesiophobia (TSK-J): Translation and Linguistic Validation. *Rinsho Seikei Geka (Clin Orthop Surg)* 2013;48:13-9.
30. Kessler RC, Andrews G, Colpe LJ, et al. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychol Med* 2002;32:959-76.
31. Furukawa TA, Kawakami N, Saitoh M, et al. The performance of the Japanese version of the K6 and K10 in the World Mental Health Survey Japan. *Int J Methods Psychiatr Res* 2008;17:152-8.
32. Wakaizumi K, Yamada K, Oka H, et al. Fear-avoidance beliefs are independently associated with the prevalence of chronic pain in Japanese workers. *J Anesth* 2017;31:255-62.
33. Akaha H, Matsudaira K, Takeshita K, et al. Modified measurement of finger-floor distance - self-assessment bending scale-. *Journal of Japanese Society of Lumbar Spine Disorders* 2008;14:164-9.
34. Katz MH. Multivariable Analysis: A Practical Guide for Clinicians. 2nd edition. Cambridge: Cambridge University Press 2006.

35. Loeppke R, Taitel M, Richling D, et al. Health and productivity as a business strategy. *J Occup Environ Med* 2007;49:712-21.

36. Wada K, Arakida M, Watanabe R, et al. The economic impact of loss of performance due to absenteeism and presenteeism caused by depressive symptoms and comorbid health conditions among Japanese workers. *Ind Health* 2013;51:482-9.

37. Yoshimoto T, Oka H, Fujii K, et al. Survey on chronic disabling low back pain among care workers at nursing care facilities: a multicenter collaborative cross-sectional study. *J Pain Res* 2019;12:1025-32.

38. Leeuw M, Goossens ME, Linton SJ, et al. The fear-avoidance model of musculoskeletal pain: current state of scientific evidence. *J Behav Med* 2007;30:77-94.

39. Wertli MM, Rasmussen-Barr E, Held U, et al. Fear-avoidance beliefs-a moderator of treatment efficacy in patients with low back pain: a systematic review. *Spine J* 2014;14:2658-78.

40. Luque-Suarez A, Martinez-Calderon J, Falla D. Role of kinesiophobia on pain, disability and quality of life in people suffering from chronic musculoskeletal pain: a systematic review. *Br J Sports Med* 2019;53:554-9.

41. Hestbaek L, Leboeuf-Yde C, Manniche C. Low back pain: what is the long-term course? A review of studies of general patient populations. *Eur Spine J* 2003;12:149-65.

42. Stanton TR, Henschke N, Maher CG, et al. After an episode of acute low back pain, recurrence is unpredictable and not as common as previously thought. *Spine (Phila Pa 1976)* 2008;33:2923-8.

43. Hori Y, Hoshino M, Inage K, et al. ISSLS PRIZE IN CLINICAL SCIENCE 2019: clinical importance of trunk muscle mass for low back pain, spinal balance, and quality of life-a multicenter cross-sectional study. *Eur Spine J* 2019;28:914-21.

44. Hagen EM, Svensen E, Eriksen HR, et al. Comorbid subjective health complaints in low back pain. *Spine (Phila Pa 1976)* 2006;31:1491-5.

45. Alsaadi SM, McAuley JH, Hush JM, et al. Prevalence of sleep disturbance in patients with low back pain. *Eur Spine J* 2011;20:737-43.

46. Canivet C, Ostergren PO, Choi B, et al. Sleeping problems as a risk factor for subsequent musculoskeletal pain and the role of job strain: results from a one-year follow-up of the Malmo Shoulder Neck Study Cohort. *Int J Behav Med* 2008;15:254-62.

47. Kundermann B, Krieg JC, Schreiber W, et al. The effect of sleep deprivation on pain. *Pain Res Manag* 2004;9:25-32.

48. Finan PH, Smith MT. The comorbidity of insomnia, chronic pain, and depression: dopamine as a putative mechanism. *Sleep Med Rev* 2013;17:173-83.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

| | Item No | Recommendation | Page No |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | P 1 |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | P 2 |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | P 4 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | P 4-5 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | P 5 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | P 5 |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants | P 5 |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | P 5-7 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | P 5-7 |
| Bias | 9 | Describe any efforts to address potential sources of bias | P 13 |
| Study size | 10 | Explain how the study size was arrived at | NA |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | P 5-7 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | P 7 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | P 7 |
| | | (*c*) Explain how missing data were addressed | P 7 |
| | | (*d*) If applicable, describe analytical methods taking account of sampling strategy | NA |
| | | (*e*) Describe any sensitivity analyses | NA |
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | P 7-8 |
| | | (b) Give reasons for non-participation at each stage | P 8 |
| | | (c) Consider use of a flow diagram | NA |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | P 7-9 |
| | | (b) Indicate number of participants with missing data for each variable of interest | NA |
| Outcome data | 15* | Report numbers of outcome events or summary measures | P 8 |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | P 8, 10 |

| | | | |
|---|---|---|---|
| | | (*b*) Report category boundaries when continuous variables were categorized | P 9-10 |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | NA |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | NA |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | P 10-11 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | P 13 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | P 11-13 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | P 13 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | P 13 |

*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.