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

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7 2 Factors associated with disabling low back pain among nursing personnel in Japan: A cross-  
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9 3 sectional survey.

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49 21  
50 22 **Word count:** 2,893 words

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5 23 **ABSTRACT**  
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7 24 **Objectives:** Low back pain (LBP) is a common cause of disability among nursing personnel.

8  
9 25 Although many studies regarding the risk factors for LBP among nursing staff have focused on  
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11 26 the physical load at work, multidimensional assessments of risk factors are essential to identify  
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13 27 appropriate preventive strategies. We aimed to investigate the association of multidimensional  
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15 28 factors (individual, physical, psychological, and occupational) with disabling LBP among nursing  
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17 29 personnel in Japan.

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20 30 **Design:** Observational study with cross-sectional design.

21  
22 31 **Setting:** Data was collected using the self-administered questionnaire at a tertiary medical center.

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24 32 **Participants:** After excluding participants with missing variables, 718 nursing personnel were  
25  
26 33 included in the analysis.

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28 34 **Outcome measures:** A self-administered questionnaire assessed individual characteristics,  
29  
30 35 rotating night shift data, severity of LBP, previous episode of LBP, sleep problem, kinesiophobia  
31  
32 36 (Tampa Scale for Kinesiophobia), depressive condition (K6), physical flexibility, and frequency  
33  
34 37 of lifting at work. A logistic regression model was used to evaluate the factors associated with  
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36 38 disabling LBP (LBP interfering with work) among nursing personnel.

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39 39 **Results:** Of all participants, 110 (15.3%) reported having disabling LBP. The multivariable  
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41 40 logistic regression analysis after adjustment for several confounding factors showed that  
42  
43 41 kinesiophobia (highest tertile, adjusted odds ratio [aOR]: 6.13, 95% confidence interval [CI]:  
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45 42 3.34-11.27), previous episode of LBP (aOR: 4.33, 95% CI: 1.50-12.41), and insomnia (aOR: 1.66,  
46  
47 43 95% CI: 1.05-2.62) were significantly associated with disabling LBP.

48  
49 44 **Conclusions:** The present study indicated that kinesiophobia, a previous episode of LBP, and  
50  
51 45 sleep problems were associated with disabling LBP among nursing personnel. In the future,  
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53 46 workplace interventions considering assessments of these factors may reduce the incidence of  
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55 47 disabling LBP in nursing staff, although further prospective studies are needed.  
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5     **48     Strengths and limitations of this study**  
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- 7     49     ➤     This study was designed to assess simultaneously the multidimensional aspects (individual,  
8             50             physical, psychological, and occupational) of disabling low back pain among nursing  
9             51             personnel in Japan.  
10     52     ➤     This paper provides results that will be useful in understanding the complexity of low back  
11             53             pain and developing appropriate strategies for reducing the incidence of occupational low  
12             54             back pain.  
13     55     ➤     The major limitations of this study are the participants at a single center and the cross-  
14             56             sectional design.
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## 57 INTRODUCTION

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

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

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

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

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5 83 incidence of occupational LBP. Therefore, we aimed to perform a multidimensional assessment,  
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7 84 including individual, physical, psychological, and occupational aspects, of disabling LBP among  
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9 85 nursing personnel at a tertiary hospital in Japan.  
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## 13 14 87 **METHODS**

### 15 16 88 **Study populations**

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18 89 This cross-sectional study was based on a survey conducted among nursing personnel at  
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20 90 Kameda Medical Center at Chiba Prefecture, Japan during February 2017. During this period, an  
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22 91 anonymous, self-administered questionnaire was distributed to 1,152 workers at the nursing  
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24 92 department in the center. After the workers answered the questionnaires, they put them in sealed  
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26 93 envelopes. Then, occupational health staff collected and sent the envelopes to the authors. Staff  
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28 94 other than the authors were not allowed to open the sealed envelopes. Written informed consent  
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30 95 was obtained from each participant. All procedures were approved by the Research Ethics  
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32 96 Committee of Kameda Medical Center (Approval No. 16-159) and carried out according to the  
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34 97 Declaration of Helsinki.  
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### 37 38 39 99 **Study measures**

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41 100 The following items were assessed using the self-administered questionnaire: age, sex, height,  
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43 101 weight, occupation type (registered nurse, assistant nurse, midwife, or nursing aid), rotating night  
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45 102 shift (frequency of shift work per month), severity of LBP, previous episode of LBP, sleep  
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47 103 problem, fear-avoidance (kinesiophobia), depressive condition, physical flexibility, and lifting at  
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49 104 work. Body mass index (BMI) was calculated as weight (kg) divided by the square of height (m).  
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51  
52 105 The severity of LBP, evaluated by respondents, was classified into four grades: grade 0 (no  
53  
54 106 LBP), grade 1 (LBP that did not interfere with work), grade 2 (LBP that interfered with work),  
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56 107 and grade 3 (LBP that interfered with work and required sick leave). These grades were  
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58 108 determined with reference to Von Korff's grading method.<sup>21</sup> The area of LBP (between the costal  
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5 109 margin and inferior gluteal folds) was indicated as a diagram in the questionnaire.<sup>22</sup> LBP was  
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7 110 defined as pain lasting for  $\geq 1$  day and experienced during the past one month, in accordance with  
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9 111 the standard definition of LBP proposed by Dionne et al.<sup>23</sup> LBP associated with menstrual periods,  
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11 112 pregnancy, or febrile illness was excluded. Individuals with disabling LBP were defined as those  
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13 113 who had LBP interfering with work, irrespective of sick leave because of LBP (grade 2 or 3).<sup>24</sup>  
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15 114 Past LBP history characteristics were evaluated in a question regarding the previous episode of  
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17 115 LBP.

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20 116 Sleep problems were assessed using questions about the sleep duration and sleep habits in the  
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22 117 previous month.<sup>25</sup> Disability of sleep duration was defined by durations  $< 6$  hours. Difficulty  
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24 118 initiating sleep was defined as taking more than 30 min to fall asleep. Difficulty maintaining sleep  
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26 119 and early morning awakening were defined by the occurrence of nocturnal awakenings or early  
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28 120 morning awakenings three times or more per week. The presence of insomnia was defined if the  
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30 121 participants reported at least one positive response to the three symptoms of sleep habits above.<sup>25</sup>

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33 122 To assess fear of movement/(re)injury, we used the short version of the Tampa Scale for  
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35 123 Kinesiophobia (TSK-11).<sup>26</sup> The TSK-11 consists of 11 items, each of which is scored on a 4-point  
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37 124 Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). The total scores range from  
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39 125 11 to 44, with higher scores indicating greater fear of movement/(re)injury. The Japanese version  
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41 126 of TSK-11 has been translated and validated by Matsudaira et al.<sup>27 28</sup> Participants' scores were  
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43 127 classified into tertiles according to their total scores.

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45 128 Depressive condition was evaluated by using the Kessler 6-item psychological distress scale  
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47 129 (K6).<sup>29</sup> The K6 consists of six items that assess how frequently respondents experienced  
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49 130 symptoms of psychological distress such as nervousness, negative affect, fatigue, and  
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51 131 worthlessness over the past 30 days. Each item was rated on a 5-point scale ranging from 0 (none  
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53 132 of the time) to 4 (all of the time), with the total score ranging from 0 to 24. The K6 has been  
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55 133 translated to a Japanese version, whose reliability and validity have been confirmed by Furukawa  
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57 134 et al.<sup>30</sup> Individuals with a K6 score of  $\geq 10$  were defined as having a depressive condition in



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5 135 accordance with a previous study.<sup>31</sup>

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7 136 Physical flexibility was assessed by using the modified finger-to-floor distance<sup>32</sup> which mainly  
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9 137 represents trunk flexibility. The grade of this item was rated on a 7-point scale: 1) fingertips  
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11 138 cannot reach across the knees; 2) fingertips can reach across the knees but wrists not; 3) wrists  
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13 139 can reach beyond the knees, but fingertips cannot reach the ankles; 4) fingertips can reach the  
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15 140 ankles; 5) fingertips can touch the floor; 6) all of the fingers can touch the floor; and 7) palms can  
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17 141 touch the floor. Flexibility was classified into two groups based on whether wrists could reach  
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19 142 beyond the knee, but fingertips could not reach the ankles.<sup>24</sup>

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22 143 Physical work demand was measured with a question exploring the frequency of lifting at work.  
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24 144 The frequency of lifting was divided into 0, 1-4, 5-9, 10 times per shift, and lifting  $\geq 5$  times per  
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26 145 shift was defined as frequent with reference to a previous study.<sup>16</sup>

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### 30 31 147 **Statistical analysis**

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33 148 Data were presented as median (25th, 75th percentile) for continuous variables or number (%)  
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35 149 for categorical variables. Characteristics of participants were compared using the chi-squared test  
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37 150 for categorical variables and Wilcoxon rank-sum test for continuous variables. To assess factors  
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39 151 associated with disabling LBP, a logistic regression model was used to estimate the odds ratio  
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41 152 (OR) and 95% confidence interval (CI) for disabling LBP. In the model, the following factors  
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43 153 were included for adjustment: sex, age, BMI, frequency of shift work, sleep duration, insomnia,  
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45 154 previous episode of LBP, TSK and K6 scores, flexibility, lifting at work. Multicollinearity was  
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47 155 not suspected as all variance inflation factors (VIFs) were  $< 2$ . A p-value less than 0.05 was  
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49 156 considered to be statistically significant (two-sided). All statistical analyses were performed using  
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51 157 JMP version 13.0 (SAS Institute Inc., Cary, NC, USA).

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## 55 56 159 **RESULTS**

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58 160 Of all workers at the nursing department in the center, 1075 respondents provided answers in  
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5 161 the questionnaires. Since the present study was focused on nursing personnel who provide direct  
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7 162 care in the center, 146 employees who were not related to direct nursing care (clerical work or  
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9 163 providing guidance to patients, etc.) were excluded. We further excluded 211 participants with  
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11 164 missing data for any variable. As a result, 718 nursing staff completed the questionnaire with no  
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14 165 missing data and were included in the analysis.

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16 166 The median age of participants in the present study was 31.0 years, and 79.7% of the  
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18 167 participants were women. Of the included participants, 15.3% were reported to have disabling  
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20 168 LBP. The characteristics of participants with or without disabling LBP are shown in Table 1. The  
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22 169 proportions of insomnia ( $p < 0.001$ ) and previous episode of LBP ( $p < 0.001$ ) among participants  
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24 170 with disabling LBP were higher relative to those observed in participants without disabling LBP.  
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26 171 The proportions of those who had high TSK ( $p < 0.001$ ) or K6 ( $p < 0.038$ ) scores were higher in  
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28 172 the disabling LBP group than in the no disabling LBP group. In contrast, the groups with and  
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30 173 without disabling LBP showed no significant differences for physical flexibility and the frequency  
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33 174 of lifting at work.

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35 175 We calculated the crude and adjusted ORs and their 95% CIs for disabling LBP (Table 2). The  
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37 176 non-adjusted analysis showed that insomnia, previous episode of LBP, and TSK and K6 scores  
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39 177 were significantly associated with disabling LBP. Multivariable analysis after adjusting for sex,  
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41 178 age, BMI, and all explanatory variables showed that insomnia (adjusted OR [aOR]: 1.66, 95%  
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43 179 CI: 1.05-2.62), a previous episode of LBP (aOR: 4.31, 95% CI: 1.50-12.41), and TSK score (aOR:  
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45 180 2.08, 95% CI: 1.11-3.89 in middle, aOR: 6.13, 95% CI: 3.34-11.27 in high) remained significantly  
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48 181 associated with disabling LBP.

Table 1. Characteristics of the study participants

	Disabling LBP	No disabling LBP	<i>p</i> -value
	(n = 110)	(n = 608)	
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 <sup>2</sup>	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 ( $\leq 17$ )	18 (16.4%)	252 (41.4%)	< 0.001
Middle (18-23)	32 (29.1%)	206 (33.9%)	
High ( $\geq 24$ )	60 (54.5%)	150 (24.7%)	
K6			
<10	78 (70.9%)	485 (79.8%)	0.038
$\geq 10$	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)	<i>p</i> -value	OR (95% CI)	<i>p</i> -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 ( $\leq 17$ )	1.00		1.00	
Middle (18-23)	2.17 (1.19-3.99)	0.012	2.08 (1.11-3.89)	0.022
High ( $\geq 24$ )	5.60 (3.19-9.84)	< 0.001	6.13 (3.34-11.27)	< 0.001
K6				
<10	1.00		1.00	
$\geq 10$	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.

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## 185 DISCUSSION

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

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5 189 kinesiophobia were independently associated with disabling LBP. To our knowledge, this is the  
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7 190 first study that identified a significant association of pain-related fear and insomnia with disabling  
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9 191 LBP among nursing personnel in Japan.

11 192 In this study, disabling LBP was set as the outcome of interest to identify risk factors for LBP  
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13 193 among nursing personnel. In occupational fields, absence from work (absenteeism) due to LBP is  
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15 194 often used as the outcome of disability. However, the number of individuals taking a sick leave  
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17 195 due to LBP is considerably small. A previous international epidemiological study showed that the  
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19 196 prevalence of absenteeism due to musculoskeletal disorders, mainly LBP, was much less common  
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21 197 in Japan relative to that in the UK.<sup>12</sup> Moreover, it has been suggested that the loss of work  
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23 198 performance due to LBP has a greater negative economic impact on individuals and workplaces  
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25 199 in terms of healthcare costs and work productivity than sick leaves due to LBP.<sup>33 34</sup> Therefore, it  
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27 200 may be appropriate to define disabling LBP as LBP interfering with work performance with or  
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29 201 without sick leave.

32 202 Our results showed that high TSK scores were significantly associated with disabling LBP  
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34 203 among nursing personnel after adjustment for various confounding factors (the OR [95% CI] of  
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36 204 the highest tertile of TSK: 6.13 [3.34-11.27]). This result was similar to those obtained in our  
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38 205 previous studies with white-collar workers<sup>31</sup> and workers at nursing care facilities,<sup>35</sup> which  
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40 206 implies that kinesiophobia is an important factor for LBP regardless of job type. Kinesiophobia,  
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42 207 an irrational and debilitating fear of movement/(re)injury, can cause a negative vicious cycle in  
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44 208 the fear-avoidance model.<sup>36</sup> Avoidance of behavior based on kinesiophobia can cause physical  
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46 209 inactivity, which has a negative impact on physical and psychological aspects and results in  
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48 210 persistence of LBP. Werti et al reported that fear-avoidance beliefs were an important prognostic  
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50 211 factor for LBP chronicity<sup>7</sup> and predicted poor treatment responses in subjects with LBP of less  
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52 212 than 6 months.<sup>37</sup> Moreover, a recent systematic review has indicated that a greater degree of  
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54 213 kinesiophobia at baseline predicted the progression of disability and the subsequent decline of  
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56 214 quality of life among subjects with chronic musculoskeletal pain.<sup>38</sup> Therefore, our results suggest

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5 215 that assessment of negative beliefs such as kinesiophobia may help prevent the chronicity of LBP  
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7 216 in the workplace.

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9 217 We found that the presence of a previous episode of LBP was a significant factor associated  
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11 218 with disabling LBP, which is consistent with our earlier study in Japan.<sup>24</sup> Previous systematic  
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13 219 reviews also showed that individuals with a history of LBP were at increased risk of future  
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15 220 episodes.<sup>9 39</sup> Indeed, LBP has been suggested to be liable to recurrence. The recurrence rate of  
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17 221 LBP within the first year after the episode has been reported to range from 24% to 50% or more.<sup>39</sup>  
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19 222 <sup>40</sup> This may be because individuals with LBP sometimes reduce their levels of physical activity,  
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21 223 which leads to physical deconditioning, including functional changes of the trunk. A recent study  
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23 224 indicated that trunk muscle mass was associated with LBP disability.<sup>41</sup> Additionally, our results  
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25 225 may indicate that individuals with LBP continue to have the risk factors responsible for the initial  
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27 226 occurrence of LBP. Thus, a previous episode of LBP may be an important predictor of future  
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29 227 episodes also among nursing personnel.

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32 228 In this study, sleep disturbance defined as insomnia was found to be an independent factor  
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34 229 relevant to disabling LBP among nursing personnel. Previous studies reported that more than 50%  
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36 230 of those who suffer from LBP have sleep problems.<sup>42 43</sup> Although the relationship between  
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38 231 disturbed sleep and pain has been considered to be bidirectional, recent studies have focused on  
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40 232 the influence of disturbed sleep on pain. Several prospective studies have indicated that sleep  
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42 233 problems were associated with a higher risk of chronic musculoskeletal pain onset including  
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44 234 LBP.<sup>10 44</sup> Our findings may be attributable to the decreased pain threshold consequent to sleep  
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46 235 disturbance, which has been indicated by experimental studies.<sup>45</sup> Although the mechanism  
47  
48 236 underlying the association between sleep disturbance and pain remains to be fully understood, the  
49  
50 237 mesolimbic dopamine system has been suggested to play a role via an overlapping  
51  
52 238 neurophysiological mechanism between sleep and pain;<sup>46</sup> however, because the potential  
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54 239 mechanisms involved in these interactions are beyond the scope of our study, further studies  
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56 240 including pathophysiological assessments are needed. Our results suggest that in the treatment of  
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5 241 individuals with disabling LBP, assessment and management of both sleep problems and LBP  
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7 242 may have more positive effects on recovery relative to those achieved by targeting sleep or LBP  
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9 243 independently.

11 244 The present study investigated the association of disabling LBP with multidimensional factors  
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13 245 among nursing personnel, including selective variables with reference to previous findings. These  
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15 246 factors were assessed using validated tools, which would reduce the risk of classification bias.  
16  
17 247 However, the study had some limitations. First, participants were recruited from a single hospital,  
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19 248 which might limit the generalizability of our results. Second, due to the cross-sectional design,  
20  
21 249 the causality of the associations cannot be determined. Finally, our results might be affected by  
22  
23 250 some potential confounding factors such as psychosocial work-related stress, other lifestyle habits,  
24  
25 251 or socioeconomic status that were not considered in our study.

28 252 In conclusion, the present findings obtained with a multivariable logistic regression analysis  
29  
30 253 showed that kinesiophobia, previous episodes of LBP, and insomnia were significantly associated  
31  
32 254 with disabling LBP among nursing personnel. In the future, workplace interventions considering  
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34 255 the assessment of these factors can help reduce the incidence of disabling LBP among nursing  
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36 256 staff, although further prospective studies are needed to elucidate a causal relationship.

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57 266 publish, or preparation of the manuscript.

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7 268 **Competing interests:**

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30 279 **Authors' contributions**

32 280 TY and KM contributed to the conceptualization of this study. TY and SI contributed to the data  
34 281 acquisition. TY and HO analyzed and interpreted the data. SM, AK, and KM contributed to the  
36 282 supervision of this study. TY drafted the manuscript. All authors have read and approved the final  
38 283 manuscript.

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41 284

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

	Item No	Recommendation	Page No
<b>Title and abstract</b>	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
<b>Introduction</b>			
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
<b>Methods</b>			
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
<b>Results</b>			
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
<b>Discussion</b>			
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
<b>Other information</b>			
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](http://www.strobe-statement.org).

# BMJ Open

## 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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Keywords:	low back pain, nurse, kinesiophobia, sleep

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1 **Title:**

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

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5 23 **ABSTRACT**  
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7 24 **Objectives:** Low back pain (LBP) is a common cause of disability among nursing personnel.

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9 25 Although many studies regarding the risk factors for LBP among nursing staff have focused on  
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11 26 the physical load at work, multidimensional assessments of risk factors are essential to identify  
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13 27 appropriate preventive strategies. We aimed to investigate the association of multidimensional  
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15 28 factors (individual, physical, psychological, and occupational) with disabling LBP among nursing  
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17 29 personnel in Japan.

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20 30 **Design:** Observational study with comparative cross-sectional design.

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22 31 **Setting:** Data was collected using the self-administered questionnaire at a tertiary medical center.

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24 32 **Participants:** After excluding participants with missing variables, 718 nursing personnel were  
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26 33 included in the analysis.

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28 34 **Outcome measures:** A self-administered questionnaire assessed individual characteristics,  
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30 35 rotating night shift data, severity of LBP, previous episode of LBP, sleep problem, kinesiophobia  
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32 36 (Tampa Scale for Kinesiophobia), depressive condition (K6), physical flexibility, and frequency  
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34 37 of lifting at work. A logistic regression model was used to evaluate the factors associated with  
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36 38 disabling LBP (LBP interfering with work) among nursing personnel.

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39 39 **Results:** Of all participants, 110 (15.3%) reported having disabling LBP. The multivariable  
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41 40 logistic regression analysis after adjustment for several confounding factors showed that  
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43 41 kinesiophobia (highest tertile, adjusted odds ratio [aOR]: 6.13, 95% confidence interval [CI]:  
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45 42 3.34-11.27), previous episode of LBP (aOR: 4.33, 95% CI: 1.50-12.41), and insomnia (aOR: 1.66,  
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47 43 95% CI: 1.05-2.62) were significantly associated with disabling LBP.

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49 44 **Conclusions:** The present study indicated that kinesiophobia, a previous episode of LBP, and  
50  
51 45 sleep problems were associated with disabling LBP among nursing personnel. In the future,  
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53 46 workplace interventions considering assessments of these factors may reduce the incidence of  
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55 47 disabling LBP in nursing staff, although further prospective studies are needed.

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49 **Strengths and limitations of this study**

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

## 61 INTRODUCTION

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

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

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

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

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5 87 incidence of occupational LBP. Therefore, we aimed to perform a multidimensional assessment,  
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7 88 including individual, physical, psychological, and occupational aspects, of disabling LBP among  
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9 89 nursing personnel at a tertiary hospital in Japan.  
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## 14 91 **METHODS**

### 16 92 **Study populations**

18 93 This comparative cross-sectional study was based on a survey conducted among nursing  
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20 94 personnel at Kameda Medical Center at Chiba Prefecture, Japan during February 2017. During  
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22 95 this period, an anonymous, self-administered questionnaire was distributed to 1,152 workers at  
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24 96 the nursing department in the center. After the workers answered the questionnaires, they put  
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26 97 them in sealed envelopes. Then, occupational health staff collected and sent the envelopes to the  
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28 98 authors. Staff other than the authors were not allowed to open the sealed envelopes. Written  
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30 99 informed consent was obtained from each participant. All procedures were approved by the  
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33 100 Research Ethics Committee of Kameda Medical Center (Approval No. 16-159) and carried out  
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35 101 according to the Declaration of Helsinki.  
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### 39 103 **Study measures**

41 104 The following items were assessed using the self-administered questionnaire: age, sex, height,  
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43 105 weight, occupation type (registered nurse, assistant nurse, midwife, or nursing aid), rotating night  
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45 106 shift (frequency of shift work per month), severity of LBP, previous episode of LBP, sleep  
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47 107 problem, fear-avoidance (kinesiophobia), depressive condition, physical flexibility, and lifting at  
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49 108 work. Body mass index (BMI) was calculated as weight (kg) divided by the square of height (m).

51 109 The severity of LBP, evaluated by respondents, was classified into four grades: grade 0 (no  
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53 110 LBP), grade 1 (LBP that did not interfere with work), grade 2 (LBP that interfered with work),  
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55 111 and grade 3 (LBP that interfered with work and required sick leave). These grades were  
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58 112 determined with reference to Von Korff's grading method.<sup>22</sup> The area of LBP (between the costal  
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5 113 margin and inferior gluteal folds) was indicated as a diagram in the questionnaire.<sup>23</sup> LBP was  
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7 114 defined as pain lasting for  $\geq 1$  day and experienced during the past one month, in accordance with  
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9 115 the standard definition of LBP proposed by Dionne et al.<sup>24</sup> LBP associated with menstrual periods,  
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11 116 pregnancy, or febrile illness was excluded. Individuals with disabling LBP were defined as those  
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13 117 who had LBP interfering with work, irrespective of sick leave because of LBP (grade 2 or 3).<sup>25</sup>  
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15 118 Past LBP history characteristics were evaluated in a question regarding the previous episode of  
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17 119 LBP.

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20 120 Sleep problems were assessed using questions about the sleep duration and sleep habits in the  
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22 121 previous month.<sup>26</sup> Disability of sleep duration was defined by durations  $< 6$  hours. Difficulty  
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24 122 initiating sleep was defined as taking more than 30 min to fall asleep. Difficulty maintaining sleep  
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26 123 and early morning awakening were defined by the occurrence of nocturnal awakenings or early  
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28 124 morning awakenings three times or more per week. The presence of insomnia was defined if the  
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30 125 participants reported at least one positive response to the three symptoms of sleep habits above.<sup>26</sup>

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33 126 To assess fear of movement/(re)injury, we used the short version of the Tampa Scale for  
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35 127 Kinesiophobia (TSK-11).<sup>27</sup> The TSK-11 consists of 11 items, each of which is scored on a 4-point  
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37 128 Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). The total scores range from  
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39 129 11 to 44, with higher scores indicating greater fear of movement/(re)injury. The Japanese version  
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41 130 of TSK-11 has been translated and validated by Matsudaira et al.<sup>28 29</sup> Participants' scores were  
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43 131 classified into tertiles according to their total scores.

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45 132 Depressive condition was evaluated by using the Kessler 6-item psychological distress scale  
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47 133 (K6).<sup>30</sup> The K6 consists of six items that assess how frequently respondents experienced  
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49 134 symptoms of psychological distress such as nervousness, negative affect, fatigue, and  
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51 135 worthlessness over the past 30 days. Each item was rated on a 5-point scale ranging from 0 (none  
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53 136 of the time) to 4 (all of the time), with the total score ranging from 0 to 24. The K6 has been  
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55 137 translated to a Japanese version, whose reliability and validity have been confirmed by Furukawa  
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57 138 et al.<sup>31</sup> Individuals with a K6 score of  $\geq 10$  were defined as having a depressive condition in

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5 139 accordance with a previous study.<sup>32</sup>

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7 140 Physical flexibility was assessed by using the modified finger-to-floor distance<sup>33</sup> which mainly  
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9 141 represents trunk flexibility. The grade of this item was rated on a 7-point scale: 1) fingertips  
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11 142 cannot reach across the knees; 2) fingertips can reach across the knees but wrists not; 3) wrists  
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13 143 can reach beyond the knees, but fingertips cannot reach the ankles; 4) fingertips can reach the  
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15 144 ankles; 5) fingertips can touch the floor; 6) all of the fingers can touch the floor; and 7) palms can  
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17 145 touch the floor. Flexibility was classified into two groups based on whether wrists could reach  
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19 146 beyond the knee, but fingertips could not reach the ankles.<sup>25</sup>

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22 147 Physical work demand was measured with a question exploring the frequency of lifting at work.  
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24 148 The frequency of lifting was divided into 0, 1-4, 5-9, 10 times per shift, and lifting  $\geq 5$  times per  
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26 149 shift was defined as frequent with reference to a previous study.<sup>16</sup>

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### 30 31 151 **Statistical analysis**

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33 152 We conducted a multivariable logistic regression analysis because our dependent variable  
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35 153 (disabling LBP) was dichotomous. One guideline has suggested that a sample size with at least  
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37 154 10 cases for each independent variable is required to estimate a discriminant function parameters  
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39 155 accurately in logistic regression analysis.<sup>34</sup> Therefore, based on this guideline and our 11 predictor  
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41 156 variables, we required 110 cases for our analysis. Moreover, considering the prevalence of  
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43 157 disabling LBP and missing data, we calculated 1,000 participants to ensure the accurate estimation  
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45 158 in the analysis.

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47 159 Data were presented as median (25th, 75th percentile) for continuous variables or number (%)  
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49 160 for categorical variables. Characteristics of participants were compared using the chi-squared test  
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51 161 for categorical variables and Wilcoxon rank-sum test for continuous variables. To assess factors  
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53 162 associated with disabling LBP, a logistic regression model was used to estimate the odds ratio  
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55 163 (OR) and 95% confidence interval (CI) for disabling LBP. In the model, the following factors  
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57 164 were included for adjustment: sex, age, BMI, frequency of shift work, sleep duration, insomnia,  
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5 165 previous episode of LBP, TSK and K6 scores, flexibility, lifting at work. Multicollinearity was  
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7 166 not suspected as all variance inflation factors (VIFs) were <2. A p-value less than 0.05 was  
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9 167 considered to be statistically significant (two-sided). All statistical analyses were performed using  
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11 168 JMP version 13.0 (SAS Institute Inc., Cary, NC, USA).  
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## 16 170 **Patient and public involvement**

17 171 Patients and the public were not involved in the design or planning of the study.  
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## 22 173 **RESULTS**

24 174 Of all workers at the nursing department in the center, 1075 respondents provided answers in  
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26 175 the questionnaires (response rate: 93.3%). Since the present study was focused on nursing  
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28 176 personnel who provide direct care in the center, 146 employees who were not related to direct  
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30 177 nursing care (clerical work or providing guidance to patients, etc.) were excluded. We further  
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32 178 excluded 211 participants with missing data for any variable. As a result, 718 nursing staff  
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34 179 completed the questionnaire with no missing data and were included in the analysis (completion  
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36 180 rate: 66.8%).  
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39 181 The median age of participants in the present study was 31.0 years, and 79.7% of the  
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41 182 participants were female. The distribution of LBP severity according to grade was as follows:  
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43 183 grade 0 (n = 233), grade 1 (n = 375), grade 2 (n = 104), and grade 3 (n = 6). Thus, 15.3% of the  
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45 184 included participants were reported to have disabling LBP. The characteristics of participants with  
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47 185 or without disabling LBP are shown in Table 1. The proportions of insomnia ( $p < 0.001$ ) and  
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49 186 previous episode of LBP ( $p < 0.001$ ) among participants with disabling LBP were higher relative  
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51 187 to those observed in participants without disabling LBP. The proportions of those who had high  
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53 188 TSK ( $p < 0.001$ ) or K6 ( $p < 0.038$ ) scores were higher in the disabling LBP group than in the no  
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55 189 disabling LBP group. In contrast, the groups with and without disabling LBP showed no  
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57 190 significant differences for physical flexibility and the frequency of lifting at work.  
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5 191 We calculated the crude and adjusted ORs and their 95% CIs for disabling LBP (Table 2). The  
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7 192 non-adjusted analysis showed that insomnia, previous episode of LBP, and TSK and K6 scores  
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9 193 were significantly associated with disabling LBP. Multivariable analysis after adjusting for sex,  
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11 194 age, BMI, and all explanatory variables showed that insomnia (adjusted OR [aOR]: 1.66, 95%  
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13 195 CI: 1.05-2.62), a previous episode of LBP (aOR: 4.31, 95% CI: 1.50-12.41), and TSK score (aOR:  
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15 196 2.08, 95% CI: 1.11-3.89 in middle, aOR: 6.13, 95% CI: 3.34-11.27 in high) remained significantly  
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17 197 associated with disabling LBP.  
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Table 1. Characteristics of the study participants

	Disabling LBP (n = 110)	No disabling LBP (n = 608)	<i>p</i> -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 <sup>2</sup>	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 ( $\leq 17$ )	18 (16.4%)	252 (41.4%)	< 0.001
Middle (18-23)	32 (29.1%)	206 (33.9%)	
High ( $\geq 24$ )	60 (54.5%)	150 (24.7%)	
K6			
<10	78 (70.9%)	485 (79.8%)	0.038
$\geq 10$	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)	<i>p</i> -value	OR (95% CI)	<i>p</i> -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 ( $\leq 17$ )	1.00		1.00	
Middle (18-23)	2.17 (1.19-3.99)	0.012	2.08 (1.11-3.89)	0.022
High ( $\geq 24$ )	5.60 (3.19-9.84)	< 0.001	6.13 (3.34-11.27)	< 0.001
K6				
<10	1.00		1.00	
$\geq 10$	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.

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## 200 DISCUSSION

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

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5 204 kinesiophobia were independently associated with disabling LBP. To our knowledge, this is the  
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7 205 first study that identified a significant association of pain-related fear and insomnia with disabling  
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9 206 LBP among nursing personnel in Japan.

11 207 In this study, disabling LBP was set as the outcome of interest to identify risk factors for LBP  
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13 208 among nursing personnel. In occupational fields, absence from work (absenteeism) due to LBP is  
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15 209 often used as the outcome of disability. However, the number of individuals taking a sick leave  
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17 210 due to LBP is considerably small. A previous international epidemiological study showed that the  
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19 211 prevalence of absenteeism due to musculoskeletal disorders, mainly LBP, was much less common  
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21 212 in Japan relative to that in the UK.<sup>11</sup> Moreover, it has been suggested that the loss of work  
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23 213 performance due to LBP has a greater negative economic impact on individuals and workplaces  
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25 214 in terms of healthcare costs and work productivity than sick leaves due to LBP.<sup>35 36</sup> Therefore, it  
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27 215 may be appropriate to define disabling LBP as LBP interfering with work performance with or  
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29 216 without sick leave.

32 217 Our results showed that high TSK scores were significantly associated with disabling LBP  
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34 218 among nursing personnel after adjustment for various confounding factors (the OR [95% CI] of  
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36 219 the highest tertile of TSK: 6.13 [3.34-11.27]). This result was similar to those obtained in our  
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38 220 previous studies with white-collar workers<sup>32</sup> and workers at nursing care facilities,<sup>37</sup> which  
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40 221 implies that kinesiophobia is an important factor for LBP regardless of job type. Kinesiophobia,  
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42 222 an irrational and debilitating fear of movement/(re)injury, can cause a negative vicious cycle in  
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44 223 the fear-avoidance model.<sup>38</sup> Avoidance of behavior based on kinesiophobia can cause physical  
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46 224 inactivity, which has a negative impact on physical and psychological aspects and results in  
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48 225 persistence of LBP. Werti et al reported that fear-avoidance beliefs were an important prognostic  
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50 226 factor for LBP chronicity<sup>7</sup> and predicted poor treatment responses in subjects with LBP of less  
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52 227 than 6 months.<sup>39</sup> Moreover, a recent systematic review has indicated that a greater degree of  
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54 228 kinesiophobia at baseline predicted the progression of disability and the subsequent decline of  
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56 229 quality of life among subjects with chronic musculoskeletal pain.<sup>40</sup> Therefore, our results suggest  
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5 230 that assessment of negative beliefs such as kinesiophobia may help prevent the chronicity of LBP  
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7 231 in the workplace.

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9 232 We found that the presence of a previous episode of LBP was a significant factor associated  
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11 233 with disabling LBP, which is consistent with our earlier study in Japan.<sup>25</sup> Previous systematic  
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13 234 reviews also showed that individuals with a history of LBP were at increased risk of future  
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15 235 episodes.<sup>9 41</sup> Indeed, LBP has been suggested to be liable to recurrence. The recurrence rate of  
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17 236 LBP within the first year after the episode has been reported to range from 24% to 50% or more.<sup>41</sup>  
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19 237 <sup>42</sup> This may be because individuals with LBP sometimes reduce their levels of physical activity,  
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21 238 which leads to physical deconditioning, including functional changes of the trunk. A recent study  
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23 239 indicated that trunk muscle mass was associated with LBP disability.<sup>43</sup> Additionally, our results  
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25 240 may indicate that individuals with LBP continue to have the risk factors responsible for the initial  
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27 241 occurrence of LBP. Thus, a previous episode of LBP may be an important predictor of future  
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29 242 episodes also among nursing personnel.

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32 243 In this study, sleep disturbance defined as insomnia was found to be an independent factor  
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34 244 relevant to disabling LBP among nursing personnel. Previous studies reported that more than 50%  
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36 245 of those who suffer from LBP have sleep problems.<sup>44 45</sup> Although the relationship between  
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38 246 disturbed sleep and pain has been considered to be bidirectional, recent studies have focused on  
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40 247 the influence of disturbed sleep on pain. Several prospective studies have indicated that sleep  
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42 248 problems were associated with a higher risk of chronic musculoskeletal pain onset including  
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44 249 LBP.<sup>10 46</sup> Our findings may be attributable to the decreased pain threshold consequent to sleep  
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46 250 disturbance, which has been indicated by experimental studies.<sup>47</sup> Although the mechanism  
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48 251 underlying the association between sleep disturbance and pain remains to be fully understood, the  
49  
50 252 mesolimbic dopamine system has been suggested to play a role via an overlapping  
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52 253 neurophysiological mechanism between sleep and pain;<sup>48</sup> however, because the potential  
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54 254 mechanisms involved in these interactions are beyond the scope of our study, further studies  
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56 255 including pathophysiological assessments are needed. Our results suggest that in the treatment of  
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5 256 individuals with disabling LBP, assessment and management of both sleep problems and LBP  
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7 257 may have more positive effects on recovery relative to those achieved by targeting sleep or LBP  
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9 258 independently.

11 259 The present study investigated the association of disabling LBP with multidimensional factors  
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13 260 among nursing personnel, including selective variables with reference to previous findings. These  
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15 261 factors were assessed using validated tools, which would reduce the risk of classification bias.  
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17 262 However, the study had some limitations. First, participants were recruited from a single hospital,  
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19 263 which might limit the generalizability of our results. Second, due to the cross-sectional design,  
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21 264 the causality of the associations cannot be determined. Finally, our results might be affected by  
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23 265 some potential confounding factors such as psychosocial work-related stress, other lifestyle habits,  
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25 266 or socioeconomic status that were not considered in our study.

28 267 In conclusion, the present findings obtained with a multivariable logistic regression analysis  
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30 268 showed that kinesiophobia, previous episodes of LBP, and insomnia were significantly associated  
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32 269 with disabling LBP among nursing personnel. In the future, workplace interventions considering  
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34 270 the assessment of these factors can help reduce the incidence of disabling LBP among nursing  
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36 271 staff, although further prospective studies are needed to elucidate a causal relationship.

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46  
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50 277

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57 281 publish, or preparation of the manuscript.

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7 283 **Competing interests:**

8  
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10  
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30 294 **Authors' contributions**

31  
32 295 TY and KM contributed to the conceptualization of this study. TY and SI contributed to the data  
33  
34 296 acquisition. TY and HO analyzed and interpreted the data. SM, AK, and KM contributed to the  
35  
36 297 supervision of this study. TY drafted the manuscript. All authors have read and approved the final  
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38 298 manuscript.  
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43 300 **Data availability statement**

44  
45 301 The data used in the current study are available on reasonable request and only after approval by  
46  
47 302 the Research Ethics Committee of Kameda Medical Center.  
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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page No
<b>Title and abstract</b>	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
<b>Introduction</b>			
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
<b>Methods</b>			
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
<b>Results</b>			
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
<b>Discussion</b>			
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
<b>Other information</b>			
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](http://www.strobe-statement.org).