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## Clinical features of neck and shoulder pain (*Katakori*) in Japanese hospital workers

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### Abstract

**Background** : Non-specific pain or discomfort in the neck and shoulder girdle, called *katakori* in Japanese, is a common, chronic musculoskeletal condition worldwide. However, its various clinical features are incompletely characterized, even among medical professionals. We aimed to clarify factors affecting *katakori* and to investigate objectively the associated neck muscle stiffness and skeletal muscle volume.

**Methods** : All staff members at our private hospital were surveyed about their lifestyle, physical and mental status, and *katakori* symptoms, using a self-administered questionnaire. Multiple logistic regression analysis was used to explore possible *katakori* risk factors. On secondary assessment, ultrasound elastography of the trapezius muscle as well as limb/trunk muscle mass were compared between subjects with severe symptoms and subjects without *katakori*, using propensity score matching.

**Results** : Of 359 participants enrolled, nearly 75% had *katakori* to some degree. Spending time on a computer during work (adjusted odds ratio [aOR] : 1.82 for 3-6 hours, aOR : 2.48 for > 6 hours), being female (aOR : 3.75), and having unsatisfactory sleep (aOR : 2.92) were potential risk factors for *katakori*. Comparison of 13 matched pairs showed a significantly stiffer trapezius in subjects with severe *katakori* symptoms, but no apparent differences in limb/trunk muscle mass.

**Conclusions** : *Katakori* was particularly prevalent in our hospital staff. Possible risk factors for disabling *katakori* were doing long-term computer work, being female, and having unsatisfactory sleep. Symptoms seem to be associated with elevated neck muscle stiffness. These findings could guide working condition improvements to mitigate *katakori*.

**Key words** : *katakori*, neck/shoulder pain, neck muscle stiffness, musculoskeletal pain, occupational health

### Introduction

Chronic musculoskeletal disorders in the neck/shoulder region are common worldwide, particularly among middle-aged individuals. Of these, nonspecific chronic dull pain or discomfort of the neck and shoulder(s), called *katakori* in Japanese, had the sec-

ond highest prevalence among persons with any subjective symptoms in a comprehensive survey conducted in Japan in 2019<sup>1)</sup>. *Katakori* was the most frequent symptom (11.2%) in women and the second most frequent symptom (5.7%) in men, after low back pain, among overall complaints. However, specific clinical features of *katakori* are inadequately

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characterized, because medical clinic visits for this condition are infrequent and quantitative diagnostic tools for symptomatic patients are lacking.

Previous studies identified female sex<sup>2-7</sup>, low levels of worksite support<sup>2,3</sup>, psychological stress<sup>2,6</sup>, and sleep disturbance<sup>6,8</sup> as potential *katakori* risk factors. Moreover, neck/shoulder stiffness is associated with a reduction in health-related quality of life<sup>5,7</sup>. These analyses were mainly performed using data obtained from residents or workers in particular regions, in contrast to our investigation of all staff members at a hospital. Thus, the status of *katakori* in the context of a healthcare work environment can now be better understood, with the potential to improve interventions more broadly.

For non-invasive quantitative measurement of neck/shoulder muscle tension, some researchers have attempted to quantify muscle stiffness using various methods, including magnetic resonance elastography<sup>9,10</sup>, muscle hardness measurement<sup>11,12</sup>, and ultrasound elastography<sup>11,13-16</sup>. Ultrasound elastography may be the most feasible of these methods in medical practice. Increased stiffness of the upper trapezius, an area associated with *katakori*, was confirmed by elastography in young symptomatic patients when compared to healthy controls<sup>13,14,16</sup>. However, the groups' background characteristics were not well balanced, particularly considering that neck/shoulder complaints are more common among middle-aged workers. A study that minimizes confounding variables and includes middle-aged workers might provide a clearer understanding of *katakori*.

Additionally, bioelectrical impedance analysis, which allows body composition measurement, has recently been utilized in patients with not only sarcopenia but also chronic low back pain<sup>17</sup> and osteoporosis<sup>18,19</sup>. Increasing neck/shoulder pain severity, either alone or in conjunction with pain in other joints and in the lower back, has a substantial impact on physical function and well-being<sup>20</sup>. Considering the coexistence of pain at other body sites, there is a possibility of whole-body skeletal muscle mass reduction. However, to our knowledge, there have been no reports on the relationship between *katakori* and limb/trunk muscle volume.

This study aimed first to assess *katakori* status among all categories of hospital workers. Second, we objectively evaluated neck stiffness and limb/trunk muscle mass in propensity score-matched pairs with and without *katakori*.

## Subjects and methods

### Participants

In this cross-sectional, observational study, we approached all staff members ( $n = 470$ ) of our general hospital (198 beds) between May and July of 2020. Informed consent from all participants was documented in writing. A self-administered questionnaire about *katakori* and related daily life was concurrently distributed to all staff members and collected within 2 weeks for the primary survey. Staff included nurses, medical office workers, physiotherapists, nursing assistants, doctors, and others. Exclusion criteria included being on leave during the survey period. For a subset of paired subjects with severe *katakori* and without *katakori*, propensity score matching was used for a secondary survey within 2 months after the primary survey.

The study protocol was examined by and received approval (#20010801) from our hospital's ethics committee, which is guided by local policy, national law, the World Medical Association Declaration of Helsinki. This study was also registered in Japan's national clinical trial site (UMIN000040483).

### Assessment

The participants were initially asked to complete all questions specifically intended to assess individual characteristics (i.e., age, sex, body mass index [BMI], smoking habit, daily time using computers for work, daily time using mobile devices not work-related, physical and mental burdens in relation to work, regular exercise, and sleep satisfaction). BMI was calculated using self-reported weight and height. Smoking habit was dichotomized by the current status as *Yes* or *No*. Daily hours using occupational computers and non-occupational mobile devices were grouped into three categories (<3, 3-6, >6 hours). Levels of physical and mental burden could be *Mild*, *Moderate*, or *Severe* in response to the question, "How do you rate the physical and mental burden of your work?" Regular exercise habits were defined as continued exercise of at least 30 minutes/day on at least 2 days/week for at least a year, according to the Japanese Ministry of Health, Labour and Welfare. Sleep was assessed with the question, "How do you rate your sleep satisfaction?" Allowable answers were *Satisfied*, *Not Satisfied*, or *Neither*.

To assess *katakori*, the primary survey question solicited subjective assessment of bilateral or unilateral symptoms by frequency as *Constant*, *Oc-*

*casional*, or *None* during the past 3 months. Subjects with *katakori* symptoms used a numerical rating scale (NRS) to describe the worst symptoms they experienced during the past month. The 11-point scale ranged from 0 = no symptoms to 10 = worst imaginable symptoms. In the primary survey, factors related to the onset of *katakori* (*Constant* or *Occasional*) were investigated in comparison with a reference group without *katakori*.

As a secondary survey, propensity score-matched pairs were selected from a group with bilateral severe *katakori* (*Constant*; NRS  $\geq 8$ ) and a control group without symptoms, to adjust for individual characteristics. To evaluate the stiffness of the upper trapezius muscle directly, an ultrasonic diagnostic apparatus (HI VISION Avius®; Hitachi, Ltd., Tokyo, Japan), equipped for real-time tissue elastography with a linear array transducer, was used to measure muscle elasticity between 3:00 pm and 5:00 pm on a subject's work day. An acoustic coupler was connected to the transducer via a plastic attachment as a reference for strain in the control individuals. The transducer was placed on the superior trapezius, corresponding to the middle point of the spina scapulae in the sitting position. Strain was induced by repetitive light compression with the transducer. Bilateral muscle strain was measured by a physician, masked from participants' survey data, twice per side. The strain ratio (control reference/muscle) was automatically calculated and was used to compare muscle elasticity (the higher the strain ratio, the stiffer the muscle). The average of all obtained values for each subject was calculated. In our pilot study with 10 volunteers (5 with and 5 without *katakori*), the repeatability of ultrasonic measurements was determined by the intraclass correlation coefficient (ICC<sub>1,2</sub>). The ICC was 0.76 (95% confidence interval [CI]: 0.49–0.90), indicating good reliability of this method<sup>21</sup>.

Limb/trunk muscle volume was measured with a bioelectrical impedance analysis (BIA) device (InBody 770® body composition analyzer; InBody Co., Ltd., Seoul, Korea) in the standing position. Muscle mass was measured as tissue volume excluding fat and bone mass. Limb/trunk muscle masses were determined directly from lean mass values provided by the device. Limb/trunk muscle mass indices were acquired by dividing each muscle mass by body height squared (kg/m<sup>2</sup>) and were compared between the severe *katakori* and non-*katakori* groups.

### Statistical analysis

The primary analysis included all participants who responded to the questionnaire. Continuous variables, categorical variables, and ordered variables are presented as means  $\pm$  standard deviation, stand-alone numbers, and medians with interquartile range, respectively. Demographic data were assessed using the  $\chi^2$  test, unpaired *t*-test, and Mann-Whitney U test. Factors related to *katakori* were analyzed using single logistic regression. Results were initially reported as crude odds ratios (ORs) with 95% CIs. Furthermore, multiple logistic regression adjusted for the following independent variables: age, sex, BMI, smoking habit, computer use time, mobile device use time, physical burden, mental burden, regular exercise, and sleep.

In the secondary survey, we used 1:1 nearest-neighbor propensity score matching, based on the 10 aforementioned characterization variables, to create well-matched groups, inasmuch as the primary survey was an unmatched, case-control analysis of all participants. Differences in strain ratio and trunk muscle mass were compared between severe *katakori* and non-*katakori* groups using the non-paired *t*-test for data with a normal distribution and the Mann-Whitney U test for non-normally distributed data.

Statistical significance was set at  $P < 0.05$ . Data were analyzed using the freely available EZR (Easy R, ver. 1.40, Jichi Medical University, Kanda Yoshinobu).

## Results

Among 470 staff members, 101 declined participation and 10 did not complete the questionnaire, leaving 359 staff members (83 males and 276 females; mean age, 39.5 years; range 22–72 years) who were included in the analyses (Figure 1). These included 163 nurses (45.4%), 57 medical office workers (15.9%), 37 physiotherapists (10.3%), 26 nursing assistants (7.2%), 17 doctors (4.7%), and other staff members. The prevalence of self-reported *katakori* among nurses, medical office workers, physiotherapists, nursing assistants, and doctors was 80.4% (131 out of 163), 93.0% (53 out of 57), 51.4% (19 out of 37), 73.1% (19 out of 26), and 35.3% (6 out of 17), respectively.

Of the 359 participants, constant (134) or occasional (134) *katakori* was found in 268, a prevalence of 74.7% at the time of the primary survey. Of those, 243 (90.7%) had bilateral and 25 (9.3%) had unilateral symptoms. The characteristics according to subjective assessments are shown in Table

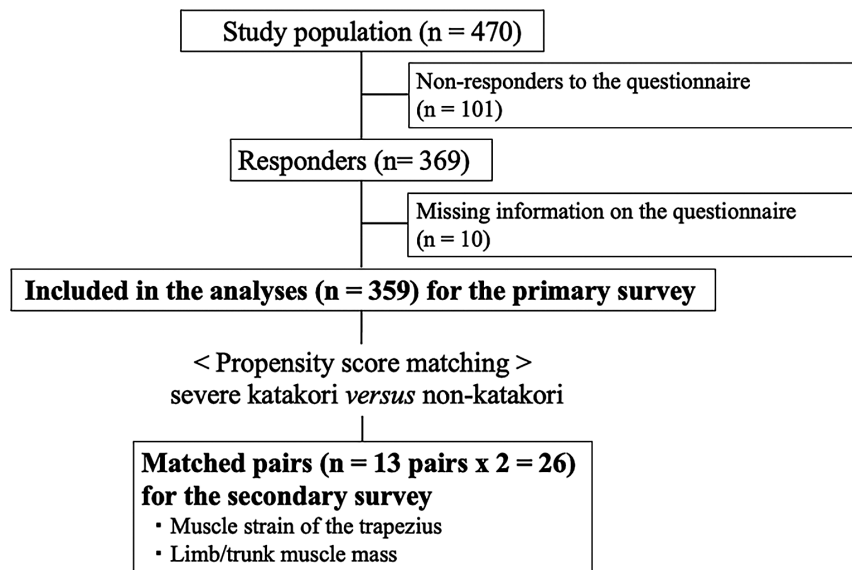


Fig. 1. Flowchart showing recruitment and inclusion of study participants of 470 eligible participants, 359 were included in analyses for the primary survey. After propensity score matching, 13 pairs were selected for the secondary survey.

Table 1. Characteristics of participants with and without *katakori*

	<i>Katakori</i>			<i>Katakori</i> <i>n</i> = 268	Non- <i>katakori</i> <i>n</i> = 91	<i>P</i> -value
	constant ( <i>n</i> = 134)	occasional ( <i>n</i> = 134)	<i>P</i> -value			
<b>Age</b>	41.3 ± 10.9	38.7 ± 11.7	0.06	40.0 ± 11.3	38.1 ± 14.2	0.19
<b>Sex</b>			0.10			<0.01
Male	17 (12.7%)	28 (20.9%)		45 (16.8%)	38 (41.8%)	
Female	117 (87.3%)	106 (79.1%)		223 (83.2%)	53 (58.2%)	
<b>BMI (kg/m<sup>2</sup>)</b>	21.8 ± 3.2	21.8 ± 3.4	0.95	21.8 ± 3.3	22.4 ± 3.4	0.17
<b>Smoking habit</b>			0.13			0.72
Yes	16 (11.9%)	8 (6.0%)		24 (9.0%)	10 (11.0%)	
No	118 (88.1%)	126 (94.0%)		244 (91.0%)	81 (89.0%)	
<b>Computer time at work</b>			<0.01			<0.01
< 3 (hours per day)	33 (24.6%)	51 (38.1%)		84 (31.3%)	45 (49.5%)	
3-6	63 (47.0%)	58 (43.3%)		121 (45.1%)	34 (37.4%)	
> 6	38 (28.4%)	25 (18.7%)		63 (23.5%)	12 (13.2%)	
<b>Mobile device time (non-work)</b>			0.25			0.92
< 3 (hours per day)	79 (59.0%)	87 (64.9%)		166 (61.9%)	58 (63.7%)	
3-6	48 (35.8%)	44 (32.8%)		92 (34.3%)	27 (29.7%)	
> 6	7 (5.2%)	3 (2.2%)		10 (3.7%)	6 (6.6%)	
<b>Physical burden at work</b>			0.65			0.99
Mild	36 (26.9%)	24 (17.9%)		60 (22.4%)	19 (20.9%)	
Moderate	78 (58.2%)	99 (73.9%)		177 (66.0%)	63 (69.2%)	
Severe	20 (14.9%)	11 (8.2%)		31 (11.6%)	9 (9.9%)	
<b>Mental burden at work</b>			0.052			0.27
Mild	9 (6.7%)	16 (11.9%)		25 (9.3%)	10 (11.0%)	
Moderate	80 (59.7%)	85 (63.4%)		165 (61.6%)	60 (65.9%)	
Severe	45 (33.6%)	33 (24.6%)		78 (29.1%)	21 (23.1%)	
<b>Regular exercise habit</b>			0.30			0.65
Yes	10 (7.5%)	15 (11.2%)		25 (9.3%)	10 (11.0%)	
No	124 (92.5%)	119 (88.8%)		243 (90.7%)	81 (89.0%)	
<b>Sleep satisfaction</b>			0.047			<0.01
Satisfied	31 (23.1%)	47 (35.1%)		78 (29.1%)	44 (48.4%)	
Neither (neutral)	30 (22.4%)	27 (20.1%)		57 (21.3%)	20 (22.0%)	
Dissatisfied	73 (54.5%)	60 (44.8%)		133 (49.6%)	27 (29.7%)	
<b>NRS</b>	6.8 ± 1.8	4.8 ± 2.0	<0.01	5.8 ± 2.2	N/A	N/A

Variable data : mean ± standard deviation ; categorical data : number of cases

BMI : body mass index ; NRS : numerical rating scale (0-10) ; N/A : not applicable

1. Comparing subgroups of *katakori*, NRS scores were significantly higher among those with constant *katakori* ( $6.8 \pm 1.8$ ) than those with occasional *katakori* ( $4.8 \pm 2.0$ ). A pronounced longer occupational computer-use time and lower sleep satisfaction were observed among those with constant rather than occasional *katakori*.

Compared to the non-*katakori* group, subjects with *katakori* were more commonly female and had longer occupational computer-use time and lower sleep satisfaction, by univariate analysis. Multivariate regression analysis revealed that being female (adjusted odds ratio [aOR]: 3.75, 95% CI: 2.04-6.87), computer-use time at work > 3 hours (aOR: 1.82, 95% CI: 1.01-3.28 for 3-6 hours; aOR: 2.48, 95% CI: 1.14-5.38 for > 6 hours), and dissatisfaction with sleep (aOR: 2.92, 95% CI: 1.60-5.32) were factors affecting *katakori* onset (Table 2). Other factors – age, BMI, smoking habit, non-work mobile device-use, physical burden, mental burden, and regular exercise – did not significantly affect outcomes.

As a secondary outcome, in the 13 matched pairs ( $n = 26$ ; mean age, 40.9 years), all subjects with *katakori* had bilateral symptoms in the area corresponding to the upper trapezius. There was a significant increase in the strain ratio of the trapezius in the severe *katakori* group compared to that in the non-*katakori* group (Table 3). There was no apparent difference in limb/trunk muscle mass between the two groups.

## Discussion

This study revealed that approximately 75% of hospital staff members overall complained of *katakori* to some degree. Multivariate analysis showed that being female, using a computer at work > 3 hours, and having unsatisfactory sleep were potential *katakori* risk factors. Furthermore, subjects with severe *katakori* had greater trapezius muscle stiffness than non-*katakori* subjects. *Katakori* was not associated with limb/trunk muscle mass.

Discomfort due to neck/shoulder pain or stiff-

Table 2. Factors related to the presence of *katakori*

	Crude odds ratio	95% CI	P-value	Adjusted odds ratio <sup>a</sup>	95% CI	P-value
<b>Age</b>	1.01	0.99-1.03	0.19	1.00	0.98-1.02	0.89
<b>Sex</b>						
Male	Reference			Reference		
Female	3.55	2.10-6.01	< 0.01	3.75	2.04-6.87	< 0.01
<b>BMI (kg/m<sup>2</sup>)</b>	0.95	0.89-1.02	0.17	0.97	0.89-1.05	0.40
<b>Smoking habit</b>						
Yes	Reference			Reference		
No	1.26	0.58-2.74	0.57	0.81	0.32-2.04	0.65
<b>Computer time at work</b>						
< 3 (hours per day)	Reference			Reference		
3-6	1.91	1.13-3.22	0.02	1.82	1.01-3.28	0.048
> 6	2.81	1.37-5.75	< 0.01	2.48	1.14-5.38	0.02
<b>Mobile device time (non-work)</b>						
< 3 (hours per day)	Reference			Reference		
3-6	1.19	0.71-2.01	0.51	1.18	0.64-2.17	0.59
> 6	0.58	0.20-1.67	0.32	0.54	0.16-1.78	0.31
<b>Physical burden at work</b>						
Mild	Reference			Reference		
Moderate	0.89	0.49-1.61	0.70	0.92	0.47-1.77	0.80
Severe	1.09	0.44-2.9	0.85	1.08	0.38-3.04	0.89
<b>Mental burden at work</b>						
Mild	Reference			Reference		
Moderate	1.10	0.50-2.43	0.81	0.81	0.34-1.97	0.65
Severe	1.49	0.62-3.57	0.38	1.10	0.40-2.99	0.87
<b>Regular exercise</b>						
Yes	Reference			Reference		
No	1.20	0.55-2.61	0.65	0.91	0.39-2.15	0.83
<b>Sleep satisfaction</b>						
Satisfied	Reference			Reference		
Neither (neutral)	1.61	0.86-3.02	0.14	1.63	0.83-3.20	0.16
Dissatisfied	2.78	1.60-4.84	< 0.01	2.92	1.60-5.32	< 0.01

CI : confidence interval

<sup>a</sup> Adjusted for all variables

Table 3. Matched-pair comparisons of individuals with severe *katakori* and without *katakori*

	Severe <i>katakori</i> (n = 13)	Non- <i>katakori</i> (n = 13)	P-value
<b>Strain ratio</b>	1.04 (0.76-1.45)	0.56 (0.46-0.67)	< 0.01
<b>Limb muscle mass (kg/m<sup>2</sup>)</b>	6.15 (5.70-7.29)	6.27 (5.96-8.16)	0.80
<b>Trunk muscle mass (kg/m<sup>2</sup>)</b>	6.93 ± 1.1	6.86 ± 0.75	0.84

Thirteen matched pairs were selected following propensity matching for age, sex, BMI, smoking habit, computer use time, mobile device use time, physical burden, mental burden, regular exercise, and sleep satisfaction.

Strain ratios and limb muscle mass indices are presented as medians with interquartile range.

Other variable data were presented as means ± standard deviation.

ness is not a life-threatening, serious musculoskeletal condition. However, it is common worldwide and is a major somatic complaint among Japanese. The peak age associated with this complaint is 50-54 years, with a 12.3% prevalence in a Japanese general population<sup>1</sup>. Previous reports showed that female sex<sup>2-7</sup>, sleep disturbance<sup>6,8</sup>, visual display terminal (VDT) use<sup>22,23</sup>, and impaired mental health<sup>2-6</sup> are possible risk factors for neck/shoulder pain. Our findings are substantially consistent with previously reports. The proportion of our hospital staff affected by *katakori*, 75%, far exceeded that of the general population. Approximately 80% of nurses and 93% of medical office workers presented with *katakori*. Furthermore, ongoing *katakori* in daily life was detected in 37.3% of all staff, with an average NRS score of 6.8. It is reported that the proportion of nursing staff with *katakori* at university hospitals was 68-71% overall<sup>4,12</sup>, and 20% for those with constant symptoms<sup>12</sup>. The even higher prevalence observed in this setting, versus a general population, may be due to the large proportion (77%) of female study participants and the occupational specialties targeted.

Females are thought to be more susceptible than males to neck/shoulder region discomfort. Indeed, *katakori* was found to be highly prevalent among females (aOR 3.75) as shown in Table 2. Biological evidence suggests that trapezius oxygen saturation is lower in females than in males<sup>24</sup>. Females also have lower pressure pain thresholds in the upper trapezius than males<sup>25</sup>. Other factors, including hormonal and psychosocial factors, might be involved in *katakori* pathogenesis. The VDT time during work where OR increased in response to duration was also a potential risk factor for *katakori*, at a threshold of 3 hours daily usage. It has been proposed elsewhere to reduce daily VDT time to less than 5 hours to protect users from adverse effects such as eyestrain and neck or upper extremity pain<sup>23</sup>. Along with the popularization of mobile devices, usage time is expected to increase. Inter-

estingly, time spent on non-work mobile devices was not associated with the onset of *katakori* in the current study. Mobile VDT use during non-work hours would more likely occur during relaxation and/or the usage time was relatively shorter than that of computer use at work, so the impact on *katakori* might be diluted. However, we did not collect adequate information about what the participants did on their mobile devices or what kinds of mobile devices (smartphone, tablet, and/or cell phone) were used. Therefore, the exact explanation is beyond the findings obtained in the current study. In any case, prolonged occupational VDT exposure should be avoided to prevent the development of neck/shoulder problems, along with paying attention to posture and frequency of breaks.

Sleep disturbance or day-time sleepiness is known to be a significant risk factor that causes musculoskeletal pain, and also impedes recovery<sup>8,26,27</sup>. One likely mechanism underlying the association of sleep disturbance and pain is increased production of inflammatory cytokines that trigger pain induction and maintenance<sup>28</sup>. Hence, intervention directed at the cause of sleep problems by a clinical psychologist might be a first step to ameliorate neck/shoulder pain, improve work-readiness and prevent major mental problems such as depression and anxiety. In terms of mental problems, we did not detect a relationship between *katakori* onset and occupational mental stress, contrary to previous reports<sup>2-6</sup>, though the occupational mental burden was modestly, but non-significantly, higher in those with constant *katakori* versus those with occasional *katakori* in subgroups. The difference between our and other reports might be partly due to different mental state assessments and/or a work environment with a lower occupational mental burden than that in other studies.

For objective *katakori* assessment, the stiffness of the upper trapezius muscle in individuals with severe *katakori* was compared to matched individuals without *katakori*. The upper part of the trapezius

is the most commonly affected anatomical region reported by patients<sup>4,29</sup>. Furthermore, attention has been focused on this muscle, which functions as the main shoulder stabilizer and is uniquely characterized by a lack of venous valves<sup>30</sup>, impaired microcirculation<sup>31</sup>, and a lower pain threshold than other neck/shoulder regions<sup>25</sup>. We found notable stiffness in subjects with severe *katakori*. Although increased stiffness in the upper trapezius and measurement reliability have been shown in symptomatic participants using ultrasound elastography, most previous study participants were in their twenties or thirties, not middle age, in which *katakori* is more prevalent<sup>13,14,16</sup>. Our findings, from a cohort including middle-aged workers, might be more representative of workers' neck/shoulder discomfort. The elevated stiffness in symptomatic subjects might suggest the validity of assessing *katakori*-induced stiffness among middle-aged adults. On the other hand, pain score and disability are reportedly not correlated with stiffness values<sup>11,15,16</sup>. Taş and colleagues point out a wide spectrum in stiffness values that inhibit establishing a correlation between those objective and subjective parameters in 35 symptomatic subjects<sup>16</sup>. Our data were limited to participants with severe symptoms and thereby could not establish a relationship between pain intensity and stiffness values. In a clinical situation, it consequently seems to indicate complementary utilization of elastographic quantification for observing an individual's progress. Further studies or methods with adequate sample size are warranted to standardize neck muscle stiffness based on individual values and to clarify a relationship between stiffness and pain/disability in a middle-aged population.

We also investigated the role of limb/trunk muscle mass relative to neck/shoulder pain. Even in participants with severe symptoms, no significant reduction in mass was detected. Neck/shoulder pain was found to be simultaneously associated with pain in other joints and poor functional capacity<sup>7,20</sup>. It is considered that multi-site musculoskeletal pain could gradually cause a decrease in muscle mass and whole-body strength. However, in this cross-sectional study of hospital workers, neck/shoulder pain did not affect limb or trunk muscle mass. It is plausible that muscle mass reduction may appear in subjects with chronic pain who are older and/or more disabled than those investigated in this study.

There were some limitations to our study. First, this survey was conducted at a general hospital in a provincial city, and thus was not representative of

the entire spectrum of Japanese hospital workers. Second, we did not find any difference in occupational mental burden between subjects with *katakori* and without *katakori*. Supplemental analysis between the constant *katakori* and non-*katakori* groups showed no difference in occupational mental burden (data not shown). However, the finding that sleep disturbance affected *katakori* might warrant follow-up observation to avoid the onset of mental disorders. Third, there is a possibility of residual confounding due to unmeasured factors and the imprecise assessments of physical and mental burden, regular exercise habits, and sleep satisfaction by questionnaire. Fourth, ultrasound strain elastography was performed by an examiner from whom *katakori* assessments were masked, but the examiner is one of the study coauthors who knew the protocol and was possibly aware of participants' *katakori* through prior contact. This bias may have led to overestimation or underestimation of the acquired data. Finally, we did not assess comorbid conditions such as a history of previous cervical/shoulder surgery or spinal alignments that in turn could be related to pain and stiffness around the head to back region.

Despite these limitations, the present study revealed the actual condition of work-related neck/shoulder pain that is a high frequency orthopedic disorder both subjectively and objectively. Our findings could be used to address working conditions or policies to avoid the development of neck/shoulder pain and discomfort in hospital workers.

Early intervention for sleep disturbance and shortening VDT time with care for repetitive movements and work posture might be effective in alleviating *katakori*, or at least preventing its aggravation. In the future, prospective intervention studies using quantifiable methods at the workplace may shed light on presenteeism related to this somatic disorder and further benefit workers' well-being.

### Conflict of interest

The authors declare no conflicts of interest associated with this manuscript.

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## References

1. Ministry of Health, Labour and Welfare. Japan : Comprehensive Survey of Living Conditions ; No. 14. Available from : <https://www.mhlw.go.jp/english/database/db-hss/cslc-Tables.html>. Accessed September, 2021.
2. Côté P, van der Velde G, Cassidy JD, *et al.* The burden and determinants of neck pain in workers : results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. *Spine*, **33**(4 Suppl) : S60-74, 2008.
3. Fujii T, Matsudaira K, Yoshimura N, Hirai M, Tanaka S. Associations between neck/shoulder discomfort (*Katakori*) and job demand, job control, and worksite support. *Mod Rheumatol*, **23** : 1198-1204, 2013.
4. Iizuka Y, Shinozaki T, Kobayashi T, *et al.* Characteristics of neck/shoulder pain (called *katakori* in Japanese) among members of the nursing staff. *J Orthop Sci*, **17** : 46-50, 2012.
5. Kimura T, Tsuda Y, Uchida S, Eboshida A. Association of perceived stress and stiff neck/shoulder with health status : multiple regression models by gender. *Hiroshima J Med Sci*, **55** : 101-107, 2006.
6. Sawada T, Matsudaira K, Muto Y, Koga T, Takahashi M. Potential risk factors for onset of severe neck/shoulder discomfort (*Katakori*) in urban Japanese workers. *Ind Health*, **54** : 230-236, 2016.
7. Takasawa E, Yamamoto A, Kobayashi T, *et al.* Characteristics of neck/shoulder pain in the Japanese general population. *J Orthop Sci*, **20** : 403-409, 2015.
8. Holm LW, Bohman T, Lekander M, Magnusson C, Skillgate E. Risk of transition from occasional neck/back pain to long-duration activity limiting neck/back pain : A cohort study on the influence of poor work ability and sleep disturbances in the working population in Stockholm County. *BMJ Open*, **10** : e033946, 2020.
9. Chen Q, Bensamoun S, Basford JR, Thompson JM, An KN. Identification and quantification of myofascial taut bands with magnetic resonance elastography. *Arch Phys Med Rehabil*, **88** : 1658-1661, 2007.
10. Chen Q, Wang HJ, Gay RE, *et al.* Quantification of myofascial taut bands. *Arch Phys Med Rehabil*, **97** : 67-73, 2016.
11. Akagi R, Kusama S. Comparison between neck/shoulder stiffness determined by shear wave ultrasound elastography and a muscle hardness meter. *Ultrasound Med Biol*, **41** : 2266-2271, 2015.
12. Yabuki S, Kikuchi S. Pathogenesis of the neck/shoulder stiffness. (in Japanese) *Rinsho Seikeigeka (Clinical Orthopaedic Surgery)*, **36** : 1241-1246, 2001.
13. Ishikawa H, Muraki T, Morise S, *et al.* Changes in stiffness of the dorsal scapular muscles before and after computer work : a comparison between individuals with and without neck/shoulder complaints. *Eur J Appl Physiol*, **117** : 179-187, 2017.
14. Kuo WH, Jian DW, Wang TG, Wang YC. Neck muscle stiffness quantified by sonoelastography is correlated with body mass index and chronic neck pain symptoms. *Ultrasound Med Biol*, **39** : 1356-1361, 2013.
15. Sawada T, Okawara H, Nakashima D, *et al.* Reliability of trapezius muscle hardness measurement : A comparison between portable muscle hardness meter and ultrasound strain elastography. *Sensors*, **20** : 7200, 2020.
16. Taş S, Korkusuz F, Erden Z. Neck muscle stiffness in participants with and without chronic neck pain : A shear-wave elastography study. *J Manipulative Physiol Ther*, **41** : 580-588, 2018.
17. Fujimoto K, Inage K, Eguchi Y, *et al.* Use of bioelectrical impedance analysis for the measurement of appendicular skeletal muscle mass/whole fat mass and its relevance in assessing osteoporosis among patients with low back pain : A comparative analysis using dual X-ray absorptiometry. *Asian Spine J*, **12** : 839-845, 2018.
18. Kawakubo A, Miyagi M, Fujimaki H, *et al.* Relationships between spinal alignment and muscle mass in osteoporosis patients over 75 years of age who were independent and maintained their activities of daily living. *Cureus*, **13** : e15130, 2021.
19. Tanaka S, Ando K, Kobayashi K, *et al.* A low phase angle measured with bioelectrical impedance analysis is associated with osteoporosis and is a risk factor for osteoporosis in community-dwelling people : the Yakumo study. *Arch Osteoporos*, **13** : 39, 2018.
20. Vogt MT, Simonsick EM, Harris TB, *et al.* Neck/shoulder pain in 70- to 79-year-old men and women : findings from the Health, Aging and Body Composition Study. *Spine J*, **3** : 435-441, 2003.
21. Koo TK, Li MY. A guideline of selecting and reporting intraclass correlation coefficients for reliability research. *J Chiropr Med*, **15** : 155-163, 2016.
22. Parihar JK, Jain VK, Chaturvedi P, Kaushik J, Jain G, Parihar AK. Computer and visual display terminals (VDT) vision syndrome (CVDTS). *Med J Armed Forces India*, **72** : 270-276, 2016.
23. Ye Z, Abe Y, Kusano Y, *et al.* The influence of visual display terminal use on the physical and mental conditions of administrative staff in Japan. *J Physiol Anthropol*, **26** (2) : 69-73, 2007.
24. Elcadi GH, Forsman M, Crenshaw AG. The relationship between oxygenation and myoelectric ac-

- tivity in the forearm and shoulder muscles of males and females. *Eur J Appl Physiol*, **111** : 647-658, 2011.
25. Binderup AT, Arendt-Nielsen L, Madeleine P. Pressure pain sensitivity maps of the neck-shoulder and the low back regions in men and women. *BMC Musculoskelet Disord*, **11** : 234, 2010.
  26. Generaal E, Vogelzangs N, Penninx BW, Dekker J. Insomnia, sleep duration, depressive symptoms, and the onset of chronic multisite musculoskeletal pain. *Sleep*, **40**, 2017.
  27. Gustafsson ML, Laaksonen C, Aromaa M, Löytyniemi E, Salanterä S. The prevalence of neck-shoulder pain, back pain and psychological symptoms in association with daytime sleepiness - a prospective follow-up study of school children aged 10 to 15. *Scand J Pain*, **18** : 389-397, 2018.
  28. Haack M, Sanchez E, Mullington JM. Elevated inflammatory markers in response to prolonged sleep restriction are associated with increased pain experience in healthy volunteers. *Sleep*, **30** : 1145-1152, 2007.
  29. Cerezo-Téllez E, Torres-Lacomba M, Mayoral-Del Moral O, Sánchez-Sánchez B, Dommerholt J, Gutiérrez-Ortega C. Prevalence of myofascial pain syndrome in chronic non-specific neck pain : A population-based cross-sectional descriptive study. *Pain Med*, **17** : 2369-2377, 2016.
  30. Nakamura T, Murakami G, Noriyasu S, Yoshio M, Sato I, Uchiyama E. Morphometrical study of arteries and veins in the human sheet-like muscles (pectoralis major, latissimus dorsi, gluteus maximus and trapezius) with special reference to a paradoxical venous merging pattern of the trapezius. *Ann Anat*, **188** : 243-253, 2006.
  31. Larsson R, Öberg ÅP, Larsson SE. Changes of trapezius muscle blood flow and electromyography in chronic neck pain due to trapezius myalgia. *Pain*, **79** : 45-50, 1999.