

# Association between upper extremity dysfunction and sleep disturbance in an elderly general population

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## Abstract

**Objective:** Several upper extremity disorders are associated with sleep disturbance in patient populations. This study evaluated the relation between self-assessment of upper extremity function and sleep disturbance in an elderly general population.

**Methods:** A total of 159 participants (56 men, 103 women, 38–88 years old, mean age of 66.4 years) completed a self-administered questionnaire including items for sex, weight, height, and dominant hand. Upper extremity dysfunction was investigated using Quick Disabilities of the Arm, Shoulder, and Hand of the Japanese Society for Surgery of the Hand. The sleep disturbance severity was evaluated using a Japanese version of the Athens Insomnia Scale. Quality of life was assessed using the EuroQol-5-dimension-3-level, Japanese version. We measured the bilateral hand grip as an indicator of hand muscle function. Statistical tests were applied to clarify the association between upper extremity dysfunction and screening results for sleep disturbance.

**Results:** Of 159 participants, 45 (28.3%) had sleep disturbance as assessed using Japanese version of the Athens Insomnia Scale (11 men and 34 women; mean age of 68.1 years). Japanese version of the Athens Insomnia Scale scores correlated with the EuroQol index; EuroQol visual analog scale; and Quick Disabilities of the Arm, Shoulder, and Hand scores. The Quick Disabilities of the Arm, Shoulder, and Hand score and dominant grip strength of the participants with sleep disturbance were significantly higher than those of the no sleep disturbance group. The EuroQol index score and visual analog scale of those reporting a sleep disturbance were significantly lower than those of the no sleep disturbance group.

**Conclusion:** Self-administered upper extremity health condition as assessed using Quick Disabilities of the Arm, Shoulder, and Hand correlated with sleep disturbance. Our results suggest a link between upper extremity conditions and sleep disturbance.

## Keywords

Orthopedics, rehabilitation, occupational therapy, epidemiology, public health, sleep disturbance, QuickDASH, quality of life

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## Introduction

Sleep disturbances such as difficulty falling asleep and difficulty staying asleep are increasingly common health problems among the general population.<sup>1</sup> The prevalence of insomnia is reportedly 4.7%–27%.<sup>2–4</sup> People with sleep disturbance have tended to have additional health problems such as obesity, hypertension, glucose intolerance, and cardiovascular disease.<sup>5–7</sup> Furthermore, sleep disturbance is known to be associated with multiple risk factors of increased

overall mortality, increased psychiatric morbidity, and decreased physical function and lower health-related quality

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of life (HRQoL).<sup>8,9</sup> Earlier studies demonstrated that a lower pain threshold is more closely associated with people with sleep disturbance than with people without sleep disturbance.<sup>10</sup> In addition, it has been documented that musculoskeletal pain is related with sleep disturbance.<sup>10,11</sup> Although sleep disturbance has been described for patients with musculoskeletal pain, quiet sleep can be hindered by clinical symptoms of numbness and tingling (even if not painful) that occur with entrapment neuropathies such as carpal tunnel syndrome (CTS) and cubital tunnel syndrome.<sup>12–14</sup> Reportedly, several severe upper extremity disorders are associated with sleep disturbance in patient populations.<sup>12–17</sup> Nevertheless, few reports of the relevant literature have described a relation between upper extremity dysfunction and sleep disturbance in an elderly general population. This study was therefore conducted to evaluate the association between upper extremity-specific health status and sleep disturbance among an elderly population. We hypothesized that the self-assessed upper extremity health status is associated significantly with sleep disturbance in the elderly population of a mountain village in Japan.

## Materials and methods

In 2018, 856 people (422 men, 434 women) underwent local medical examinations intended for the early detection of cancer and for prevention of lifestyle-related diseases. All were residents of a mountain village in Japan, where agroforestry and tourism are the main industries. From these 856 residents, 159 people (56 men, 103 women; 38–88 years of age, average 66.4 years) participated voluntarily in an orthopedic examination conducted for this study. They had been informed that their data would be published. They gave their consent to participate in this study, which was approved by the institutional review board. Each had completed a self-administered questionnaire with items related to gender and dominant hand.

### *Quick Disabilities of the Arm, Shoulder, and Hand assessment*

The Quick Disabilities of the Arm, Shoulder, and Hand of the Japanese Society for Surgery of the Hand (QuickDASH-JSSH) is an 11-item questionnaire that measures arm-specific disability.<sup>18</sup> The Japanese version of DASH (DASH-JSSH) was cross-culturally adapted and developed to produce QuickDASH-JSSH by extracting 11 items from the 30 items of DASH-JSSH related to disability and symptoms. Each item has five response choices, ranging from “no difficulty” or “no symptom” to “unable to perform activity” or “very severe symptom” and is scored on a 1–5 scale. The items ask about the severity of each pain symptom; activity related to pain, tingling, weakness, and stiffness (two items: numbers 9 and 10); the degree of difficulty in performing various physical

activities because of an arm, shoulder, or hand problem (six items: numbers 1–6); and the effect of the upper extremity problem on social activities, work, and sleep (three items: numbers 7, 8, and 11). After Imaeda et al.<sup>19</sup> evaluated the reliability, validity, and responsiveness of QuickDASH-JSSH, they reported that QuickDASH-JSSH has equivalent evaluation capacity to that of the original QuickDASH. Salaffi et al. evaluated the cut-off points of severity of functional disability of QuickDASH in the assessment of rheumatoid arthritis (RA) hand disability. They reported cut-off points for RA hand functional disability results: no impairment  $\leq 13$ ;  $13 < \text{low impairment} \leq 18.5$ ;  $18.5 < \text{moderate impairment} \leq 31.5$ ; and high impairment  $> 31.5$ .<sup>20</sup>

### *Athens Insomnia Scale (Japanese version) assessment*

The original version of Athens Insomnia Scale (AIS) is a self-administered eight-item questionnaire consisting of a two-factor structure (nocturnal sleep problem and daytime dysfunction).<sup>21</sup> The first five questionnaire items measure the difficulty of sleep initiation, awakening during night, early morning awakening, total sleep duration, and overall quality of sleep. The last three questionnaire items assess the daytime consequences of insomnia as difficulties with a sense of well-being, overall functioning, and sleepiness during the day. Each questionnaire of AIS is rated on a four-point scale Likert-type scale from no problem at all (0 points) to extremely problematic (3 points). The points are then summed to produce a total score (minimum 0, maximum 24). A higher total score is related with a worse sleep condition. Soldatos et al.<sup>22</sup> reported that a person with an AIS score of 4 or 5 points should be suspected of having pathological insomnia and that a person with a 6 point or higher score should be diagnosed as having pathological insomnia. Okajima et al.<sup>23</sup> validated the AIS-J and reported the estimated nocturnal sleep problem minimum cut-off value as four points.

### *HRQoL assessment*

We used the EuroQol-5-dimension-3-level (EQ-5D-3L) Japanese version, which is a non-disease-specific instrument developed by the EuroQol Group for evaluating HRQoL.<sup>24</sup> The EQ-5D-3L consists of five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each dimension of EQ-5D-3L is assigned a response of one of the three levels: no problem, some or moderate problem, or extreme problem. The EQ visual analog scale (VAS) was used to measure the self-related health status of the respondents to rate their overall health. The best health status represents a score of 100; the worst health status carries a score of 0. Tsuchiya et al.<sup>25</sup> validated EQ-5D-3L (Japanese version) as having evaluation capacity equivalent to the original version.

**Table 1.** Outcome variables of participants without and with sleep disturbance.

	Sleep disturbance (-) <i>n</i> = 114	Sleep disturbance (+) <i>n</i> = 45		<i>p</i> value
	No sleep disturbance AIS-J score 0–3	Suspected pathological insomnia AIS-J score 4 or 5	Pathological insomnia AIS-J score ≥6	
Gender				
Men	45	7	4	.09
Women	69	19	15	
Age	65.8 (13.6)	68.5 (13.0)	67.6 (8.7)	.47
BMI	22.6 (2.9)	23.3 (4.0)	22.7 (3.6)	.41
Dominant grip	27.7 (7.7)	24.8 (7.6)	24.9 (7.5)	.03
Nondominant grip	26.3 (8.2)	24.2 (7.5)	24.2 (7.8)	.13
QuickDASH	5.3 (7.5)	5.2 (5.4)	12.6 (14.3)	.014
EuroQol index score	0.89 (0.06)	0.85 (0.08)	0.83 (0.07)	<.001
EuroQol VAS	72.4 (19.0)	64.0 (16.5)	61.0 (14.6)	.002

AIS-J: Athens Insomnia Scale (Japanese version); BMI: body mass index; VAS: visual analog scale.

Values are means ± standard deviations.

Statistically significant:  $p < .05$ .

### Anthropometric and grip strength measurements

Height was measured using a digital height meter (A&D Co. Ltd., Tokyo, Japan). We measured weight using a multi-frequency segmental body composition analyzer (MC780U; Tanita Corp., Tokyo, Japan). A digital dynamometer (Takei Scientific Instruments Co. Ltd., Tokyo, Japan) was used to measure grip strength. We conducted grip testing using the standardized position recommended by the American Society of Hand Therapists. Participants were seated with the shoulder in adduction and neutral rotation, elbow flexed at 90°, forearm in a neutral position, and the wrist between 0° and 30° of extension and 0° and 15° of ulnar deviation.

### Statistical analysis

After data collection was completed, we stratified participants who scored ≥6 on the AIS-J questionnaire as the pathological insomnia group, participants who scored 4 or 5 on the AIS-J questionnaire as the suspected pathological insomnia group, and participants who scored <5 as having no sleep disturbance. Using an independent *t*-test or Mann-Whitney *U* test, we compared the age, body mass index (BMI), dominant and nondominant grip strength, the QuickDASH score, the EuroQol index score, and VAS between the participants without sleep disturbance and those who with sleep disturbance (suspected pathological insomnia group and pathological insomnia group). The gender differences of the two subject groups were compared using Fisher's exact test. The Spearman rank correlation coefficient was used to elucidate relations among age, anthropometric variables, dominant and nondominant grip strength, the AIS-J score, the QuickDASH score, the EuroQol index score, and VAS. One item of three symptomatic questionnaires in QuickDASH asks about the relation between sleep

disturbance and upper extremity pain: During the past week, how much difficulty have you had sleeping because of pain in your arm, shoulder, or hand? We assessed the correlation between the scale of this question and the AIS-J scores of all participants.

Correlation was characterized as low ( $r = .10-.29$ ), medium ( $r = .30-.49$ ), or high ( $r = .50-1.00$ ).<sup>26</sup> Data are presented as means and standard deviations (SDs). Results for which a *p* value of less than .05 were found were inferred as statistically significant. This study was approved by the regional ethics board.

### Results

Participant data are presented in Table 1. Of 159 participants, 45 (28.3%) had sleep disturbance as assessed using AIS-J (11 men and 34 women; mean age = 68.1 years).

Nineteen participants (12.0%) had pathological insomnia (AIS-J score ≥6). The QuickDASH scores of participants with sleep disturbance were significantly higher than those of participants without sleep disturbance. The EuroQol index score and VAS of participants with sleep disturbance were significantly lower than those of participants without sleep disturbance. Dominant grip strength of participants with sleep disturbance was significantly lower than that of participants without sleep disturbance (Table 1). The AIS-J score was found to have significant positive correlation with the QuickDASH score ( $r = .21$ ,  $p < .001$ ). Significant negative correlation was found with the AIS-J score and EuroQol index score ( $r = -.32$ ,  $p < .001$ ) and with EuroQol VAS ( $r = -.28$ ,  $p < .001$ ; Table 2). No significant correlation was found for any participants between the AIS-J score and the scale of the QuickDASH questionnaire responses related with upper extremity pain and sleep disturbance.

**Table 2.** Results of correlation between outcome variables for participants.

	Age	Height	Weight	BMI	Dominant grip	Nondominant grip	QuickDASH score	EuroQol index score	EuroQol VAS	AIS-J score
Age	1									
Height	-0.33**	1								
Weight	-0.23**	0.56**	1							
BMI	0.005	0.02	0.81**	1						
Dominant grip	-0.14	0.61**	0.50**	0.19*	1					
Nondominant grip	-0.16*	0.63**	0.51**	0.19*	0.89**	1				
QuickDASH	0.04	-0.17*	-0.09	0.003	-0.27**	-0.26**	1			
EuroQol index score	-0.14	0.20*	0.21*	0.13	0.19*	0.23**	-0.5**	1		
EuroQol VAS	-0.21**	0.16*	0.13	0.04	0.11	0.10	-0.30**	0.46**	1	
AIS-J score	0.09	-0.08	-0.08	-0.01	-0.12	-0.08	0.21**	-0.32**	-0.28*	1

AIS-J: Athens Insomnia Scale (Japanese version); BMI: body mass index; VAS: visual analog scale. Values are means (SD).

\*Statistically significant  $p < .05$ . \*\*Statistically significant  $p < .01$ .

**Table 3.** Univariate and multivariable linear regression analysis for predictors of Athens Insomnia Scale.

Independent variables	Athens Insomnia Scale					
	Univariate analysis			Multivariable linear regression		
	Standardized partial regression coefficient	Partial regression coefficient (95% CI)	<i>p</i> value	Standardized partial regression coefficient	Partial regression coefficient (95% CI)	<i>p</i> value
Age	0.11	-0.008 to 0.05	.16	0.01	-0.03 to 0.03	.91
Gender	0.14	-0.12 to 1.56	.10	0.08	-0.75 to 1.60	.47
BMI	0.005	0.13 to 0.14	.95	0.04	-0.09 to 0.16	.63
Dominant grip	-0.17	-0.11 to -0.006	.03	-0.04	-0.09 to 0.06	.73
QuickDASH score	0.34	0.06 to 0.16	<.001	0.24	0.02 to 0.11	.01
EuroQol index score	-0.33	-8.40 to 3.15	<.001	-0.13	-5.25 to 1.02	.18
EuroQol VAS	-0.28	-0.06 to -0.02	<.001	-0.17	-0.05 to 0.0008	.06

CI: confidence interval; BMI: body mass index; VAS: visual analog scale. Statistically significant  $p < .05$ .

## Discussion

The distinguishing characteristics of our study include the fact that the self-administered upper extremity health condition as assessed using QuickDASH is positively associated with total sleep quality based on AIS. In addition, participants with pathological insomnia as defined by the AIS score had significantly higher QuickDASH scores than participants without sleep disturbance (Table 3).

Earlier studies evaluated the association between the pathological condition of upper extremity disorder and the sleep quality.<sup>12-17</sup> Patel et al.<sup>12</sup> studied 66 patients with CTS and found positive correlation between CTS symptoms and functional severity and sleep disturbance. Westhovens et al.<sup>15</sup> demonstrated that disease activity of RA is correlated positively with worsening sleep symptoms. However, our study population was heterogeneous. We conducted this investigation of people who were not seeking care for upper extremity

symptoms, not of patients who sought medical treatment. We did not specify the reason for upper extremity symptoms or disability. Moreover, we were unable to give a definitive diagnosis or to investigate the objective pathophysiology. Our findings might indicate the potential effect of sleep disturbance with upper extremity dysfunction in the general public.

Earlier studies also examined the relations between sleep disturbance and phenomena such as musculoskeletal pain, disability, and depressive status.<sup>11,27</sup> Asih et al. assessed the relations between insomnia and each of pain intensity and depressive symptoms among people with disability reporting chronic muscle skeletal pain. Results for this population showed that clinical insomnia was independent of both pain intensity and depressive symptoms.<sup>11</sup> Parmalee et al. analyzed the relations among sleep, pain, functional disability, and depressive symptoms among 367 older adults with knee osteoarthritis in a cross-sectional and longitudinal study. The

results revealed the unique role of sleep problems as immediate drivers of pain and depression and as long-range influences on functional disability and depressed mood.<sup>27</sup> We investigated correlation between the scale of questions related with sleep disturbance and upper extremity pain in QuickDASH and AIS-J scores in all participants. We found no significant correlation between the sleep scale score of the QuickDASH question and AIS-J scores among any participants. The QuickDASH score, which we used, reflects comprehensive evaluation of disability and symptom of upper extremities.<sup>18</sup> QuickDASH mainly evaluates the musculoskeletal pain of upper extremities. QuickDASH might not pick up symptoms such as paresthesia, which is not painful, of entrapment neuropathy, which might influence the sleep condition. Our results indicate that functional disability of upper extremities might influence the sleep condition of people in our study population.

We evaluated the association between sleep disturbance and HRQoL. However, we did not assess sleep disturbance and psychological factors. In earlier studies, a multiple regression model revealed that sleep disturbance was associated with HRQoL in elderly people.<sup>28</sup> Cross-sectional models showed that upper extremity dysfunction was correlated with HRQoL in patient population.<sup>29,30</sup> Our findings demonstrated that HRQoL of participants with sleep disturbance were significantly lower than those of participants without sleep disturbance. Negative correlation was found between the HRQoL and AIS scores of all participants. Furthermore, HRQoL was negatively correlated with QuickDASH scores of all participants. These results suggest that the degree of sleep difficulty and upper extremity dysfunction is linked closely with HRQoL in elderly people.

Our findings showed that the dominant grip strength of participants with sleep disturbance was significantly lower than that of participants without sleep disturbance. Handgrip strength assessment has been used as a reliable index for whole-body muscle strength, but not for upper extremity muscle strength or function.<sup>31</sup> Earlier studies demonstrated that elderly individuals who report short sleep duration were less likely to meet physical activity guidelines advocated by the World Health Organization,<sup>32</sup> whereas those who report long sleep duration and good sleep quality are more likely to meet physical activity guidelines.<sup>33</sup> It is expected the low frequency of the use of hands and physical activity might influence the sleep condition of elderly people. However, hormonal changes are observed in persons with sleep disturbance. Insulin-like growth factors 1 and testosterone related to protein synthesis and to maintenance of muscle mass are down-regulated by sleep deficit.<sup>34</sup> Sleep disturbance might also affect the reduced muscle function. Sleep conditions and the decline of grip strength might be mutually interactive.

Earlier reports have described that improvement of pathophysiological conditions might contribute to improvement of sleep quality.<sup>17</sup> Tuipan et al. evaluated effects of various aspects of sleeping following carpal tunnel release (CTR) in 398 patients with CTS. They found that CTR surgery can quickly

(within 2 weeks) improve multiple aspects of sleep disturbance related with CTS in non-worker's compensation insurance cases.<sup>17</sup> This finding might indicate that insomnia before treatment intervention is reversible with appropriate treatment. A prospective longitudinal study should be used to investigate the relation with the change of upper extremity health status and sleep disturbance for homogeneous populations.<sup>13</sup>

This study and its results were burdened by several limitations. First, our sample size might limit the statistical power of our assessment of the relation between upper extremity disability and sleep disturbance. Second, our study was conducted with a cross-sectional design, which might not provide definitive information about cause-and-effect relations. Third, we collected data from residents of a mountain village in a rural area in Japan. Therefore, our findings might not be readily generalized. Additional study should be undertaken for participants in urban areas and rural areas to provide higher generalizability. Fourth, we did not assess other factors related to sleep disturbance such as psychological factors and other physical factors (trunk and lower extremity activity) and social factors and that might influence sleep quality.<sup>28,35</sup> Some studies have demonstrated that multiple factors causes sleep disturbance.<sup>36,37</sup> Additional studies investigating the respective relations between sleep quality and various psychological and social factors, as well as physical activity, might provide valuable results related with upper extremity health status and sleep disturbance. Fifth, we did not investigate a history of diagnosed upper extremity pathology or a history of upper extremity surgery in this study population. Additional information related with upper extremities might elucidate the association with the upper health condition and sleep disturbance more distinctively. Sixth, results related to upper extremity conditions might be influenced by selection bias. Study participants might have been more likely to be affected already by an upper extremity disability that caused distress.

In conclusion, results of the present study have demonstrated that the self-assessed health status of upper extremities is associated with pathological insomnia in this elderly population. We must recognize the contribution of upper extremity dysfunction to sleep disturbance for patients we encounter in clinical daily practice.

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### Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### Ethical approval

Ethical approval for this study was obtained from Gunma University Graduate School of Medicine of institutional review board (Approval Number/ID: 23-31).

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## Informed consent

Written informed consent was obtained from all subjects before the study.

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