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Original Article

# Association of Sleep Quality Status With Worsening Low Back or Knee Pain During The COVID-19 State of Emergency Among Old-Old Adults

Yuki Nakai, PhD, PT[#,*], Hyuma Makizako, PhD, PT[†], Daijo Shiratsuchi, BS, PT[‡,§], Yoshiaki Taniguchi, MS, PT[‡,‖], Shoma Akaida, BS, OT[†,‡], Mana Tateishi, BS[†,‡], Tomomi Akanuma, BS, RN[¶], Kaori Yokoyama, BS, RN[¶]

[#] *Department of Mechanical Systems Engineering, Faculty of Engineering, Daiichi Institute of Technology, Kagoshima, Japan. 1-10-2 Kokubuchuo, Kagoshima 890-4395, Japan*
[†] *Department of Physical Therapy, School of Health Sciences, Faculty of Medicine, Kagoshima University, Kagoshima, Japan. 8-35-1 Sakuragaoka, Kagoshima 890-8544, Japan*
[‡] *Graduate School of Health Sciences, Kagoshima University, Kagoshima, Japan. 8-35-1 Sakuragaoka, Kagoshima 890-8544, Japan*
[§] *Department of Rehabilitation, Japan Community Health Care Organization Kumamoto General Hospital, Kumamoto, Japan. 10-10 Toricho, Yatsushiro, Kumamoto 866-8660, Japan*
[‖] *Department of Physical Therapy, Kagoshima Medical Professional College, Kagoshima, Japan. 5417-1 Hirakawacho, Kagoshima 891-0133, Japan*
[¶] *Bibai City Department of Health and Welfare Aged Care Division, Bibai, Japan. 1-1-1 Nishi 3 Jo minami, Bibai, Hokkaido 072-8660, Japan*

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ABSTRACT

*Background:* Poor sleep quality has a negative effect on pain among older adults. During the coronavirus disease 2019 (COVID-19) state of emergency, lifestyle changes can cause psychologic stressors and lead to poor sleep quality.
*Aim:* This study examined whether sleep quality status was associated with low back or knee pain changes during the COVID-19 state of emergency among community-dwelling Japanese old-old adults.
*Design:* Cross-sectional investigation.
*Methods:* In July 2020, during the COVID-19 epidemic, we conducted a postal survey for old-old adults aged ≥77 years and collected data on 597 participants. For those who had low back or knee pain at the time of the survey (in July), characteristics such as low back pain, knee pain, changes in pain status, and sleep quality status during the COVID-19 state of emergency (in March) were assessed.
*Results:* Data from 597 participants showed the prevalence of low back pain (50.6%) and knee pain (40.7%) in July. Of those with low back or knee pain, 374 had pain changes during the state of emergency, with 12.3% worsening. Of these, 23.9% had poor sleep quality in March compared to non-change ($p = .008$). In a multivariate logistic regression model adjusted for potential confounders, poor sleep quality was significantly associated with pain worsening (odds ratio 2.80, 95% confidence interval 1.26-6.22).
*Conclusions:* During the COVID-19 state of emergency, poor sleep quality was associated with worsening low back or knee pain. This may indicate the need to pay attention to poor sleep quality to prevent the exacerbation of pain among old-old adults.
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The World Health Organization named the disease caused by the new coronavirus virus 2019 as “COVID-19” on February 11, 2020, and declared a pandemic in March of the same year (Timeline of WHO’s Response to COVID-19, n.d.). COVID-19 is a particular threat to older adults, with China and Italy reporting a higher case fatality rate in individuals >70 years of age (Onder et al., 2020). Lockdowns were implemented in many countries, and Japan’s “COVID-19 State of Emergency” in the first wave, which was not legally enforceable and required staying indoors, was implemented from April 7 to May 25, 2020 (Press Conference, n.d.). Lifestyle changes such as refraining from going out unnecessarily and reducing contact with people can cause physical, psychological, and social stress, such as that from long-term activity restrictions, fear of infectious diseases, uncertainty about the

* Address correspondence to: Yuki Nakai, Ph.D., P.T., Department of Mechanical Systems Engineering, Faculty of Engineering, Daiichi Institute of Technology, Kagoshima, Japan. 1-10-2 Kokubuchuo, Kagoshima 899-4395, Japan
*E-mail addresses:* y-nakai@daiichi-koudai.ac.jp (Y. Nakai), makizako@health.nop.kagoshima-u.ac.jp (H. Makizako), squall.lion8062@gmail.com (D. Shiratsuchi), p.taniguchi0601@gmail.com (Y. Taniguchi), t.akanuma@city.bibai.lg.jp (T. Akanuma).

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future, interpersonal relationships, and isolation (Casagrande et al., 2020). These harmful factors can exacerbate musculoskeletal pain in older adults (Marttinen et al., 2019).

Musculoskeletal pain in older adults may lead to increased depressive tendencies (Denkinger et al., 2014), increased risk of falls (Leveille et al., 2009), and deterioration of quality of life (Lacey et al., 2014). Low back and knee pains, which are common types of musculoskeletal pain, are risk factors that are frequently found to diminish quality of life (Kim et al., 2015). A previous study reported that low back or knee pain in community-dwelling older adults was associated with a risk of physical frailty (Nakai et al., 2019). Among middle-aged residents in the United Kingdom, those with chronic musculoskeletal pain during the COVID-19 lockdown perceived increases in their pain severity compared to the severity of pain before the lockdown (Fallon et al., 2020). Old-old adults are most susceptible to adverse health outcomes; however, no studies have examined changes in low back or knee pain and the factors influencing them among old-old adults during the COVID-19 state of emergency. Therefore, we felt it was important to investigate the prevalence of low back pain and knee pain during the COVID-19 epidemic and the circumstances of changes in the pain during the COVID-19 state of emergency among the old-old adults.

Sleep disorders can exacerbate the symptoms of pain (Finan et al., 2013; Lautenbacher, 2018). Previous studies have shown that poor sleep quality lowers pain thresholds, acts on the cerebral cortex, affects nociceptors, and raises subjective pain assessment (Roehrs et al., 2006; Simpson et al., 2018; Tiede et al., 2010). Deterioration of the intrinsic pain suppression system due to poor sleep decreases the pain threshold in healthy individuals and exacerbates pain symptoms in those with acute and chronic pain (Edwards et al., 2009; Julien et al., 2005). The COVID-19 pandemic has been reported to worsen sleep quality due to exposure to various physical, psychological, and social stressors (Mandelkorn et al., 2020). Thus, stress during the COVID-19 state of emergency may worsen sleep quality, which affects pain exacerbations.

The aim of this study was to clarify whether sleep quality status was associated with changes in low back or knee pain during the COVID-19 state of emergency. Knowing these associations will help in the proper quality of life management and nursing practice for older adults. In addition, it leads to early detection and early prevention of adverse outcomes in older adults. Identification of the association between sleep quality status and back and knee pains could be important to take measures against worsening pain when a state of emergency or lockdown is implemented again in the future, as COVID-19 shows no prospect of ending yet.

## Methods

### *Participants*

Between February 28 and March 19, 2020, the Governor of Hokkaido issued the notice of the "COVID-19 state of emergency" prior to the Japanese government's declaration of a state of emergency due to the early spread of COVID-19 infection in the region. Citizens were asked to refrain from going out. We conducted a postal survey of old-old adults aged ≥77 years who were living in Bibai, Hokkaido, Japan, all of whom had participated in the city's health checkup program in 2018. The questionnaire was mailed to 1,112 individuals on July 15, 2020, and returned by September 16, 2020. Bibai is a rural city with a population of 20,839 and an aging rate of 42.5%, as of 2020 (Bibai City Statistics Overview, n.d.). A total of 889 old-old adults responded to the survey. We excluded participants based on the following criteria: (1) a history of stroke, Parkinson's disease, rheumatoid disease, depression, or Alzheimer's disease, and (2) missing values in the answer sheets of the survey. Finally, the present cross-sectional study analyzed 597 old-old adults (mean age, 83.0 ± 4.3 years; female, 55.1%). Informed consent was obtained from all the participants prior to their inclusion in the study, and the Ethics Committee of the Faculty of Medicine, Kagoshima University approved the study protocol (No. 200065).

### *Low Back Pain and Knee Pain*

Prevalence of current low back pain was defined through the following questions: "Do you have low back pain at the present time?" (yes or no). Only if yes, the following question defined low back pain changes during the COVID-19 state of emergency: "Did your low back pain change during the COVID-19 state of emergency?" (1) the pain worsened; (2) the pain occurred; (3) the pain did not change; and (4) the pain improved. We dichotomized the answers into worsened/occurred (got worse) versus not changed/improved (nonchange). Knee pain was defined by similar questions. Participants with either low back or knee pain, and if either got worse during the COVID-19 state of emergency, formed the got worse group; and those with either low back or knee pain, but neither changed during the COVID-19 state of emergency, formed the nonchange group.

### *Sleep Quality Status During the COVID-19 State Of Emergency*

Sleep quality status was defined through a single question (Sampaio et al., 2014), "How was the average night sleep quality during the COVID-19 state of emergency compared to before the COVID-19 state of emergency?", and participants answered from the following three options: (1) slept well, (2) not changed, and (3) slept poorly. We combined the answer into well/not changed (nonchange) and divided them into nonchange versus poor.

### *Participant Characteristics*

Participant characteristics such as age in years, sex, polypharmacy (≥5), and filled 5-item version of the Geriatric Depression Scale (GDS-5) (Hoyl et al., 1999) at the time of the survey (in July) were collected. Data on physical exercise during the COVID-19 state of emergency (in March) was also collected. Physical exercise was defined by a single question, "What kind of exercise, including short-term exercise, were you doing during the COVID-19 state of emergency?" The physical exercise group was classified as those who exercised to some extent, and the non-exercise group were those who did nothing.

### *Statistical Analysis*

Continuous variables were summarized as mean ± standard deviation, and categorical variables were summarized as counts and percentages. The comparisons of characteristics among changes in pain were performed using Student's $t$ test for continuous data and Pearson's $\chi^2$ test for categorical data. Multivariate logistic regression analysis was performed to test the association between sleep quality status and pain changes during the COVID-19 state of emergency. The dependent variable was pain worsening, and the independent variable was poor sleep quality (crude model). In addition, it was adjusted for age, polypharmacy (≥5), GDS-5, and physical exercise during the COVID-19 state of emergency (adjusted model). Odds ratios (ORs), adjusted ORs, and 95% confidence intervals (CIs) were calculated. The data were analyzed using SPSS Statistics 25.0 (IBM Japan, Tokyo, Japan). The level of statistical significance was set at $p < .05$.

**Table 1**
Comparison of Characteristics of Participants With or Without Pain Worsening During the COVID-19 State of Emergency in March

| | | Pain Worsening | | |
|---|---|---|---|---|
| | Total (n = 374) | Yes (n = 46) | No (n = 328) | *p* |
| Age, y, mean ± SD | 83.1 ± 4.2 | 83.9 ± 3.9 | 83.0 ± 4.2 | .166 |
| Female, n (%) | 216 (57.8) | 27 (58.7) | 189 (57.6) | .890 |
| Polypharmacy (≥ 5), n (%) | 171 (45.7) | 25 (54.3) | 146 (44.5) | .210 |
| GDS-5, score, mean ± SD | 1.40 ± 1.24 | 1.61 ± 1.31 | 1.38 ± 1.23 | .230 |
| Physical exercise during the COVID-19 state of emergency, n (%) | 244 (65.2) | 33 (71.7) | 211 (64.3) | .323 |
| Poor sleep quality during the COVID-19 state of emergency, n (%) | 45 (12.0) | 11 (23.9) | 34 (10.4) | .008 |

All values are mean ± standard deviation or percentage. Continuous variables were analyzed by Student's *t* test, and categorical variables were analyzed by $\chi^2$ tests.
COVID-19 = coronavirus disease 2019; SD = standard deviation.

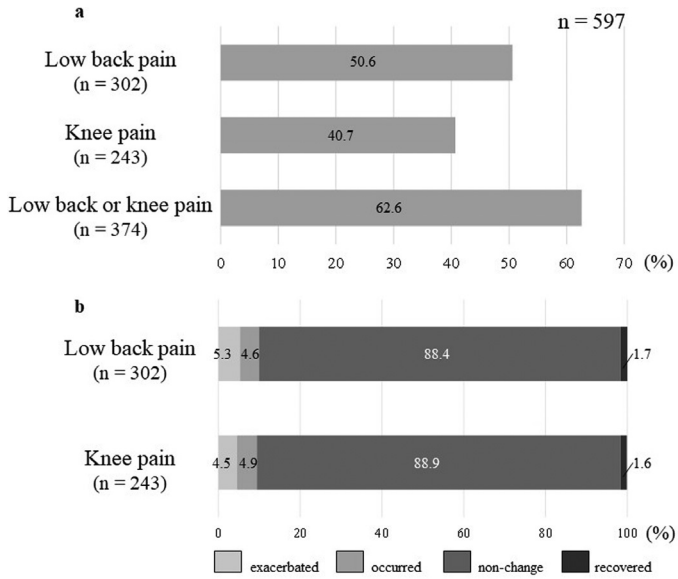


**Figure 1.** (a) The prevalence rates of low back pain, knee pain, and low back or knee pain at the time of the survey are shown (n = 597). (b) The percentages of pain changes during the coronavirus disease 2019 state of emergency (in March) among those who had low back pain (n = 302) and knee pain (n = 243) at the time of the survey (in July) are also shown.

## Results

Figure 1a shows the prevalence of low back and knee pain in the 597 participants at the time of the survey (in July). Of these respondents, 302 (50.6%) had low back pain, 243 (40.7%) had knee pain, and 374 (62.6%) had at least either low back pain or knee pain. Figure 1b shows the rate of changes in pain during the COVID-19 state of emergency for those who had low back pain and knee pain. The combined rate of pain exacerbation and pain occurred was 9.9% for low back pain and 9.4% for knee pain.

Table 1 shows a comparison of the characteristics of participants with and without pain worsening during the COVID-19 state of emergency in March 2020. Of the 374 respondents with or without changes in either low back or knee pain, 46 (12.3%) experienced worse pain during the COVID-19 state of emergency. There was no significant difference in age, sex, polypharmacy, GDS-5, or physical exercise during the COVID-19 state of emergency in the worsened group compared with the no-change group. The worsened group had a significantly higher rate of poor sleep quality during the COVID-19 state of emergency ($p = .008$).

Table 2 shows the results of the multivariate logistic regression analysis. Poor sleep quality during the COVID-19 state of emergency was associated with pain worsening during the COVID-19 state of emergency in the crude model (OR = 2.72; 95% CI = 1.27–5.84; $p = .01$). In a model adjusted for the potential confounders such as age, polypharmacy (≥5), GDS-5, physical exercise during the COVID-19 state of emergency, poor sleep quality was also significantly associated with pain worsening during the COVID-19 state of emergency model (OR = 2.80; 95% CI = 1.26–6.22; $p = .012$).

## Discussion

This study showed a high prevalence of low back pain and knee pain in about half of the community-dwelling Japanese old-old adults under the COVID-19 epidemic in July. Furthermore, during the COVID-19 state of emergency in March, despite the short duration of 3 weeks, the participants demonstrated a high rate (12.3%) of pain worsening. Poor sleep quality during the COVID-19 state of emergency had a greater odds ratio for pain worsening during the COVID-19 state of emergency, even in multivariate analysis after adjustment for age, polypharmacy, GDS-5, and physical exercise during the COVID-19 state of emergency. These results suggested that poor sleep quality among the old-old adults during the COVID-19 state of emergency may have affected the pain worsening during this time.

The prevalence of low back pain (50.6%) and knee pain (40.7%) were slightly higher in this study than in previous studies (Fujii & Matsudaira, 2013; Muraki et al., 2009). The prevalence of low back pain in Japanese adults, determined using a large-scale e-mail survey was demonstrated to be 35.7% (mean age, 47.7 years) (Fujii & Matsudaira, 2013). The prevalence of knee pain in older Japanese adults aged ≥60 years determined in a large-scale nationwide cohort study was 32.8% (mean age, 74.7 years) (Muraki et al., 2009). In general, the prevalence of low back and knee pain increases with advancing age (Takahashi et al., 2018). Participants in our study were old-old adults (mean age, 83 years), older than previous studies. This may have led to a higher prevalence.

During the COVID-19 state of emergency, 12.3% of the participants had worsening low back or knee pain. Referring to a previous study investigating the association between lifestyle changes and musculoskeletal pain changes in Japan after the 2011 Great East Japan Earthquake (Jinnouchi et al., 2020), it is seen that there was worsening of musculoskeletal pain in 5.9% of people between 75 and 89 years of age who were forced to change their lifestyle after the earthquake. The rate was about the same as in this study, considering that not only exacerbations but also onsets were combined, and the average age was higher in our study.

**Table 2**
Associations Of Sleep Quality Status and Changes in Pain During the COVID-19 State of Emergency in March

| | Changes in Pain During the COVID-19 State Of Emergency | | | |
|---|---|---|---|---|
| | Crude | | Adjusted | |
| Independent variables | OR (95% CI) | *p* | OR (95% CI) | *p* |
| Poor sleep quality during the COVID-19 state of emergency | 2.72 (1.27-5.84) | .010 | 2.81 (1.26-6.24) | .011 |
| Age | | | 1.06 (0.98-1.14) | .148 |
| Sex | | | 0.96 (0.50-1.83) | .896 |
| Polypharmacy (≥5) | | | 1.46 (0.77-2.77) | .247 |
| GDS-5 | | | 1.09 (0.84-1.42) | .503 |
| Physical exercise during the COVID-19 state of emergency | | | 0.61 (0.30-1.26) | .185 |

COVID-19 = coronavirus disease 2019; CI = confidence interval; GDS-5 = Geriatric Depression Scale 5; Adjusted for age = sex = polypharmacy (≥5) = GDS-5 = physical exercise during the COVID-19 state of emergency; OR = odds ratio.

In a previous study, sleep disorders due to lifestyle changes were positively associated with worsening of musculoskeletal pain (Jinnouchi et al., 2020). Various stresses caused by the circumstances surrounding the COVID-19 pandemic may have altered the neuroendocrine system and disrupted internal activities, including stress and immune responses (Lo Martire et al., 2020). Deterioration of sleep quality is associated with worsening intrinsic pain suppression and hypersensitivity to pain sensation mediated by serotonergic mechanisms (Karmann et al., 2014). Lifestyle changes also cause psychosocial changes, changing sleep and waking rhythms, and worsening the quality of sleep (Brooks et al., 2020). A study assessing the adverse effects of the COVID-19 lockdown on sleep quality and mental health in Italy reported that 55.3% of participants (range 18-82 years) had poor sleep quality; disrupted sleep patterns, severe stress, anxiety, and depression have been shown to be risk factor (Franceschini et al., 2020). In our study as well, during the COVID-19 state of emergency, outdoor physical activity and physical contact with others was curtailed, and along with lifestyle changes, and increased psychologic distress, habitual sleep patterns could have been disrupted. This resulted in poor sleep quality and may have been associated with the worsening of pain among old-old adults.

This study had some limitations. First, it was a cross-sectional study, and participants self-reported changes during the COVID-19 state of emergency by recall. This meant that although we could infer the adverse effects of poor sleep quality on low back or knee pain, we could not identify a causal relationship. Second, we could not measure worsening objectively by imaging diagnostics or intrinsic changes. Low back pain, knee pain, sleep quality status, and physical exercise was assessed using simple questionnaires by single items rather than a validated index. Although the validity of such surveys is not well established, face-to-face diagnosis during the COVID-19 pandemic is difficult and questionnaire surveys are used, due to their simplicity and easy classification (Shinohara et al., 2020). Third, the questionnaire was recall biased and the target area was localized, so care must be taken when generalizing the results. Fourth, we inferred that the increased pain and sleep interference was the result of anxiety from the COVID-19 state of emergency, but the anxiety itself was not measured. Fifth, we did not consider other factors related to sleep quality such as naps, awakenings, and falling asleep. The COVID-19 state of emergency changed normal routines and decreased social contacts. Participants would take more naps during the day, which may have affected their sleep quality (Salehinejad et al., 2021). Finally, low back pain and knee pain were not classified according to duration, severity, or pathological condition.

In nursing practice, interviews with patients are important. The nurse assesses the patient's situation and problems by asking questions and integrates both the nursing diagnosis and care processes (Kourkouta & Papathanasiou, 2014). Under various restrictions, such as during the COVID-19 state of emergency, patients experience stress such as anxiety, anger, and distrust. Nurses need to understand, accept and respond to these patient situations (Jason, 2000). However, in situations such as the COVID-19 pandemic where you must keep a distance, the interview time is limited. In this situation, a single item question may be useful in determining sleep quality to some extent. Simple questions seeking subjective answers may shorten the interview time, reduce the burden on the old-old adults, and be easier to ask by phone. This may help detect patients' sleep problems early and prevent worsening low back and knee pain after the COVID-19 pandemic.

## Conclusions

This study found that about half the community-dwelling Japanese old-old adults had low back and knee pains during the COVID-19 epidemic. During the COVID-19 state of emergency (around 3 weeks), 12.3% of those with low back pain or knee pain reported worsening of pain. We found a significant association between poor sleep quality and low back or knee pain worsening during the COVID-19 state of emergency among old-old adults. Interventions for psychosocial stress and associated sleep disorders caused by the COVID-19 state of emergency may be important in preventing exacerbation of pain.

## Declarations of Competing Interest

None.

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## References

Bibai City Statistics Overview. (n.d.). Retrieved from http://www.city.bibai.hokkaido.jp/. Accessed October 9, 2020.

Brooks, S. K., Webster, R. K., Smith, L. E., Woodland, L., Wessely, S., Greenberg, N., & Rubin, G. J. (2020). The psychological impact of quarantine and how to reduce it: Rapid review of the evidence. *The Lancet, 395*(10227), 912–920.

Casagrande, M., Favieri, F., Tambelli, R., & Forte, G. (2020). The enemy who sealed the world: Effects quarantine due to the COVID-19 on sleep quality, anxiety, and psychological distress in the Italian population. *Sleep Medicine, 75*(1), 12–20.

Denkinger, M. D., Lukas, A., Nikolaus, T., Peter, R., Franke, S., Geiger, H., & Rapp, K. (2014). Multisite pain, pain frequency and pain severity are associated with depression in older adults: Results from the ActiFE Ulm study. *Age and Ageing, 43*(4), 510–514.

Edwards, R. R., Grace, E., Peterson, S., Klick, B., Haythornthwaite, J. A., & Smith, M. T. (2009). Sleep continuity and architecture: Associations with pain-inhibitory processes in patients with temporomandibular joint disorder. *European Journal of Pain, 13*(10), 1043–1047.

Fallon, N., Brown, C., Twiddy, H., Brian, E., Frank, B., Nurmikko, T., & Stancak, A. (2020). Adverse effects of COVID-19-related lockdown on pain, physical activity and psychological well-being in people with chronic pain. *British Journal of Pain, 44*, Article 204946372097370.

Finan, P. H., Goodin, B. R., & Smith, M. T. (2013). The association of sleep and pain: An update and a path forward. *The Journal of Pain, 14*(12), 1539–1552.

Franceschini, C., Musetti, A., Zenesini, C., Palagini, L., Scarpelli, S., Quattropani, M. C., & Castelnuovo, G. (2020). Poor sleep quality and its consequences on mental health during the COVID-19 lockdown in Italy. *Frontiers in Psychology, 11*(11), 1–15.

Fujii, T., & Matsudaira, K. (2013). Prevalence of low back pain and factors associated with chronic disabling back pain in Japan. *European Spine Journal, 22*(2), 432–438.

Hoyl, M. T., Alessi, C. A., Harker, J. O., Josephson, K. R., Pietruszka, F. M., Koelfgen, M., & Rubenstein, L. Z. (1999). Development and testing of a five-item version of the geriatric depression scale. *Journal of the American Geriatrics Society, 47*(7), 873–878.

Jason, H. (2000). Communication skills are vital in all we do as educators and clinicians. *Education for Health (Abingdon, England), 13*(2), 157–160.

Jinnouchi, H., Ohira, T., Kakihana, H., Matsudaira, K., Maeda, M., Yabe, H., & Kamiya, K. (2020). In *Lifestyle factors associated with prevalent and exacerbated musculoskeletal pain after the Great East Japan Earthquake: A cross-sectional study from the Fukushima Health Management Survey: 20* (p. 677). BMC Public Health.

Julien, N., Goffaux, P., Arsenault, P., & Marchand, S. (2005). Widespread pain in fibromyalgia is related to a deficit of endogenous pain inhibition. *Pain, 114*(1), 295–302.

Karmann, A. J., Kundermann, B., & Lautenbacher, S. (2014). Schlafentzug und schmerz. *Der Schmerz, 28*(2), 141–146.

Kim, W., Jin, Y. S., Lee, C. S., Bin, S. il, Lee, S. Y., & Choi, K. H (2015). Influence of knee pain and low back pain on the quality of life in adults older than 50 years of age. *PM and R, 7*(9), 955–961.

Kourkouta, L., & Papathanasiou, I. V. (2014). In *Communication in nursing practice: 26* (pp. 65–67). Materia Socio-Medica.

Lacey, R. J., Belcher, J., Rathod, T., Wilkie, R., Thomas, E., & McBeth, J. (2014). Pain at multiple body sites and health-related quality of life in older adults: Results from the North Staffordshire Osteoarthritis Project. Rheumatology (Oxford, England),, *53*(11), 2071–2079.

Lautenbacher, S. (2018). Sleep and pain are definitely coupled—but how tight is this coupling? *Pain, 159*(1), 3–4.

Leveille, S. G., Jones, R. N., Kiely, D. K., Hausdorff, J. M., Shmerling, R. H., Guralnik, J. M., & Bean, J. F. (2009). Chronic musculoskeletal pain and the occurrence of falls in an older population. *JAMA, 302*(20), 2214–2221.

Mandelkorn, U., Genzer, S., Choshen-Hillel, S., Reiter, J., Meira e Cruz, M., Hochner, H., & Gileles-Hillel, A. (2020). Escalation of sleep disturbances amid the COVID-19 pandemic: A cross-sectional international study. *Journal of Clinical Sleep Medicine*, 1–6.

Marttinen, M. K., Kautiainen, H., Haanpää, M., Pohjankoski, H., Vuorimaa, H., Hintikka, J., & Kauppi, M. J. (2019). Pain-related factors in older adults. *Scandinavian Journal of Pain, 19*(4), 797–803.

Muraki, S., Oka, H., Akune, T., Mabuchi, A., En-yo, Y., Yoshida, M., & Yoshimura, N. (2009). Prevalence of radiographic knee osteoarthritis and its association with knee pain in the elderly of Japanese population-based cohorts: The ROAD study. *Osteoarthritis and Cartilage, 17*(9), 1137–1143.

Nakai, Y., Makizako, H., Kiyama, R., Tomioka, K., Taniguchi, Y., Kubozono, T., & Ohishi, M. (2019). Association between chronic pain and physical frailty in community-dwelling older adults. *International Journal of Environmental Research and Public Health, 16*(8), 1330.

Onder, G., Rezza, G., & Brusaferro, S. (2020). Case-fatality rate and characteristics of patients dying in relation to COVID-19 in Italy. *JAMA, 323*(18), 1775–1776.

Press Conference. (n.d.). Retrieved from https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/newpage_00032.html. Accessed March 12, 2021.

Roehrs, T., Hyde, M., Blaisdell, B., Greenwald, M., & Roth, T. (2006). Sleep loss and REM sleep loss are hyperalgesic. *Sleep, 29*(2), 145–151.

Salehinejad, M. A., Azarkolah, A., Ghanavati, E., & Nitsche, M. A. (2021). Circadian disturbances, sleep difficulties and the COVID-19 pandemic. *Sleep Medicine* Online ahead of print.

Sampaio, R. A. C., Sewo Sampaio, P. Y., Yamada, M., Tsuboyama, T., & Arai, H. (2014). Self-reported quality of sleep is associated with bodily pain, vitality and cognitive impairment in Japanese older adults. *Geriatrics & Gerontology International, 14*(3), 628–635.

Shinohara, T., Saida, K., Tanaka, S., & Murayama, A. (2020). Association between frailty and changes in lifestyle and physical or psychological conditions among older adults affected by the coronavirus disease 2019 countermeasures in Japan. *Geriatrics & Gerontology International, 21*(1), 39–42.

Simpson, N. S., Scott-Sutherland, J., Gautam, S., Sethna, N., & Haack, M. (2018). Chronic exposure to insufficient sleep alters processes of pain habituation and sensitization. *Pain, 159*(1), 33–40.

Takahashi, A., Kitamura, K., Watanabe, Y., Kobayashi, R., Saito, T., Takachi, R., & Nakamura, K. (2018). Epidemiological profiles of chronic low back and knee pain in middle-aged and elderly Japanese from the Murakami cohort. *Journal of Pain Research, 11*, 3161–3169.

Tiede, W., Magerl, W., Baumgärtner, U., Durrer, B., Ehlert, U., & Treede, R.-D. (2010). Sleep restriction attenuates amplitudes and attentional modulation of pain-related evoked potentials, but augments pain ratings in healthy volunteers. *Pain, 148*(1), 36–42.

Timeline of WHO's response to COVID-19. (n.d.). Retrieved from https://www.who.int/emergencies/diseases/novel-coronavirus-2019/interactive-timeline. Accessed March 12, 2021.