Association between Social Frailty and Sleep Quality among Community-dwelling Older Adults: A Cross-sectional Study

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ABSTRACT. Objective: We examined the association between social frailty and subjective sleep quality among community-dwelling adults. Methods: This cross-sectional study recruited Japanese adults over the age of 60 years from health check-ups held in a public townhall in a suburban area between 2018 and 2019. Social frailty was evaluated using five criteria (living alone, not visiting friends sometimes, going out less frequently than the last year, not feeling helpful to friends or family, and not talking to someone every day) and categorized into three groups: non-frailty, pre-frailty, and frailty. Sleep quality was assessed according to the Pittsburgh Sleep Quality Index (PSQI) by giving participants a self-reported questionnaire. We performed multivariable linear regression analysis, denoting social frailty as an independent variable, and the global PSQI score as a dependent variable. Results: Data from 300 older adults were analyzed, 51.0% of whom were female. The participants' mean age was 73.0 years (standard deviation = 5.8). Multivariable analysis revealed the notable association between social frailty and a high global PSQI score (compared with non-frailty, frailty: $\beta = 0.94$, 95% CI = 0.08 to 1.80, $p = 0.033$). Of the five determiners of social frailty, not talking with someone every day was especially associated with a high global PSQI score ($\beta = 1.57$, 95% CI = 0.49 to 2.66, $p = 0.005$). Conclusion: The present study suggests that social frailty is associated with poor sleep quality among community-dwelling older adults. Our findings indicate the importance of social frailty on sleep quality among older adults.

Key words: Older adults, Pittsburgh Sleep Quality Index, Sleep quality, Social frailty

Poor sleep quality is one of the most common health issues in older adults. Approximately 50% of people older than 55 years suffer from sleep problems more frequently and severely than younger people. Poor sleep quality among the older population is attributed to fatigue, reduction of quality of life, risk of cardiovascular disease, and mental health disorders. In particular, it also seems to be associated with geriatric syndromes, such as cognitive impairment and sarcopenia, which could be addressed by preventive physical therapy. Thus, sleep problems in adults have become a new area to explore through the lens of preventive physical therapy.

Sleep hygiene has been garnering attention as a non-pharmacological form of therapy to improve sleep quality. In Japan, a research team led by the Ministry of Health, Labour and Welfare published "Sleep Guidelines for Health Promotion 2014," which has been incorporated into sleep hygiene education across the country. The guidelines mainly accredit healthy sleep to lifestyle factors like daytime physical activities, eating habits, and regular life rhythms, and also highlight the negative effects of alcohol, smoking, and caffeine consumption. However, they do not elaborate upon the social factors impacting...
sleep quality.

Recently, some reports regarding older adults have indicated a connection between their social relationships and sleep quality. Rich social relationships improve mental health through stress-buffering, regularizing life rhythms, and promoting physical activities by meeting friends and going out, which in turn enhances sleep quality\(^{17}\). Several cross-sectional studies have shown that high social support is associated with good sleep quality\(^{17,18}\) while social isolation and loneliness hamper the quality of sleep\(^{17}\). Moreover, in a longitudinal study, social isolation predicted poor sleep quality\(^{20}\), suggesting the possibility that the quality of sleep among older adults is hindered by social vulnerability. On the other hand, another longitudinal study depicted no association between social participation and sleep quality\(^{21}\). Therefore, the results are inconsistent.

These previous studies have focused on the effects of only one or two aspects of social factors and may not capture the overall effects of social vulnerability. Consequently, Bunt et al. proposed social frailty as a multifaceted concept with respect to social vulnerability and the incorporation of social resources, social behaviors, and social activities\(^{22}\). Social frailty can provide a comprehensive view of older adults’ social conditions, as opposed to assessing social factors from a single aspect, such as social isolation or lack of social support. However, few studies have examined the impact of social frailty on sleep quality. One cross-sectional study examined the association between sleep conditions and social frailty in community-dwelling Japanese older adults\(^{23}\), but it only analyzed sleep duration and daytime wakefulness as sleep conditions; thus, it may not provide a holistic assessment of sleep quality.

Hence, the present study aimed to examine the association between social frailty and self-reported sleep quality among community-dwelling older adults. We hypothesized that social frailty was connected to poor sleep quality and assessed the importance of social frailty in addressing poor sleep quality among older adults.

**Methods**

**Study population**

The present cross-sectional study recruited Japanese older adults from the Togo town study carried out in cooperation with Nagoya University (Department of Integrated Health Sciences) and the Togo Town office. The community-based health check-up survey was conducted in the public town-hall of Togo town, a sub-urban area in Japan, in July and August of 2018 and 2019. Inclusion criteria required that the participants had lived in Togo Town, participated in the health check-up survey, and were independent in daily living. Exclusion criteria required that the participants under the age of 60 years and those who had dementia or depression disorder. Of the total 320 participants, we excluded people who lacked gender information (n = 1), were under 60 years of age (n = 13), and suffered from self-reported dementia (n = 3) or depression disorder (n = 3). Finally, we analyzed 300 older adults, all of whom provided written informed consent beforehand. The study protocol was approved by the ethics committee of Nagoya University (No. 18-502) and conducted according to the guidelines of the Declaration of Helsinki.

**Outcome measure: sleep quality**

Sleep quality was assessed using a self-administered questionnaire, the Pittsburgh Sleep Quality Index (PSQI)\(^{24,25}\), in tandem with a Japanese version\(^{26,27}\). The PSQI focuses on sleep quality during the previous month, and consists of seven subcomponents: subjective sleep quality, sleep latency (the time it takes to fall asleep), sleep duration, habitual sleep efficiency (the ratio of total sleep time to time in bed), sleep disturbances, the use of sleep-promoting medication (prescribed or over-the-counter), and daytime dysfunction. Each sub-component is scored from 0 to 3 points, with a total of 21 points (global PSQI score). Notably, higher scores indicate poorer sleep quality. A previous study has shown a global PSQI score cut-off (5.5 points) for reduced sleep quality\(^{20}\). However, because there were somewhat small numbers of eligible study participants (n = 57), the present study used the global PSQI score as a continuous variable. We also assessed the symptoms during sleep that could be associated with sleep disorders using the additional items of the PSQI questionnaire: loud snoring ("snoring loudly") and sleep apnea ("long pauses between breaths while asleep"), restless leg syndrome ("legs twitching or jerking while asleep"), and parasomnia ("episodes of disorientation or confusion during sleep"). We identified participants who depicted these symptoms objectively, while sleeping in the same bedroom as their roommates: loud snoring (n = 9), sleep apnea (n = 5), and restless leg syndrome (n = 5). None of them reported experiencing parasomnia.

**Exposure measure: social frailty**

Based on a previous study\(^{19}\), social frailty was assessed using five items on a self-reported questionnaire: living alone, not visiting their friends sometimes, going out less frequently than the last year, not feeling helpful to friends or family, and not talking to someone every day. Participants were allocated into three groups based on how many items applied to them: non-frailty (none), pre-frailty (one), and frailty (two or more).

**Covariates**

A self-reported questionnaire recorded sociodemographic characteristics: age, gender, body mass index (BMI), educational attainment, household equivalent income, working status, present illnesses, instrumental activities of
daily living (IADL), smoking, drinking, frequent urination, physical activity, and depressive symptoms. Age, BMI, household equivalent income, and physical activities were treated as continuous variables. BMI was calculated from height and weight measured using a multifrequency bioelectrical impedance analyzer (MC-780A, Tanita, Tokyo, Japan). Meanwhile, educational attainment was categorized as follows: <9, 10 to 12, and ≥13 years. Household equivalent income was evaluated by dividing the income of each household by the square root of the household size (number of family members). Working status was dichotomized as “not working” and “working.” Present illnesses were assessed using a question that asked respondents whether they had received a diagnosis of cancer, heart disease, stroke, respiratory disease, hypertension, dyslipidemia, or diabetes. Respondents indicated “yes” or “no” in response to each illness. IADL was measured using a five-item subscale of the Tokyo Metropolitan Institute of Gerontology Higher Competence Scale\(^9\). We categorized participants who had difficulty with at least one item as “with difficulty,” and others as “without difficulty.” Drinking and smoking were also dichotomized as “no” and “yes,” respectively. Frequent urination was assessed by the frequency of urination daytime (8 times or more/day) and nighttime (once or more/day), dichotomized as “no” (none) and “yes” (either daytime or nighttime). Physical activity was gauged using a simplified version of the International Physical Activity Questionnaire\(^{30}\). Depressive symptoms was assessed using the 15 items of the Depression Geriatrics Scale, and those who scored five or more were denoted as “with depressive symptoms.” Since physical activity and depressive symptoms were considered intermediate factors, they were not included in the main analytical model.

Statistical analysis

First, descriptive statistics were calculated to summarize the participants’ characteristics according to the social frailty category. Second, we calculated the descriptive statistics regarding the PSQI score for each of the five components of social frailty. Third, to examine the association between social frailty and sleep quality, we applied multivariable linear regression analysis and obtained unstandardized regression coefficients (βs) and 95% confidence intervals (CIs) on the global PSQI score. We used social frailty as an explanatory variable. For the main analytical model, we performed the analysis using a crude model and a multivariable-adjusted model with covariates of potential confounders (age, gender, education, income, employment status, present illness, IADL, BMI, drinking, smoking, and frequent urination). Next, we also made evaluations including physical activity and depression in the analytical model. In addition, we conducted an analysis using social frailty subcomponents as explanatory variables in the same statistical model; the five subcomponents were simultaneously introduced into the analytical model. For the sensitivity analysis, we excluded those who potentially showed objective symptoms related to sleep disorders (loud snoring, sleep apnea, and restless leg syndrome) and confirmed the results.

To mitigate any potential bias caused by missing information, we used the multiple imputation approach under the missing at random (MAR) assumption (i.e., the missing data mechanism depends only on the observed variables). We generated 20 imputed datasets by utilizing the Multiple Imputation by Chained Equations (MICE) procedure and pooled the results using the standard Rubin’s rule\(^{32}\).

We used R software (Version 3.6.3 for Windows) for all statistical analyses, setting the significance level at \(p < 0.05\). The multiple imputation approach used the MICE function (mice package).

Results

In total, we evaluated 300 participants, whose characteristics are shown in Table 1. The mean age of participants was 73.0 (standard deviation = 5.8) years, and 153 (51.0%) were women. Regarding social frailty, 152 (50.7%) participants displayed characteristics of non-frailty, 82 (27.3%) of pre-frailty, and 52 (17.3%) of frailty. Socially frail individuals were likely to be older, male, less educated, and have lower household equivalent income, with a diagnosis of diabetes, but not stroke or respiratory disease. They also showed signs of being prone to IADL difficulty. In addition, individuals with greater social frailty had a longer sleep duration and higher global PSQI score.

Table 2 shows the descriptive statistics for the PSQI scores for each of the five sub-items of social frailty. Sleep duration was reported to be longer for participants who recorded not visiting friends sometimes, or not feeling helpful toward friends or family. As for the global PSQI score, the scores were higher for individuals who did not feel helpful toward friends or family, or did not talk to someone every day.

Table 3 shows the findings for the association between social frailty and global PSQI score. Multivariable linear regression analysis revealed that social frailty was significantly associated with a higher PSQI score when compared with non-frailty - after adjustment for all covariates of potential confounders (pre-frailty: \(β = 0.02, 95% \text{ CI} = -0.69 \text{ to } 0.73, p = 0.958\); frailty: \(β = 0.93, 95% \text{ CI} = 0.08 \text{ to } 1.79, p = 0.033\)). In addition, the PSQI score was significantly higher as the number of social frailty items increased (\(p \text{ for trend} = 0.030\)). Table 4 shows the association between social frailty subcomponents and global PSQI score. Among the five items of social frailty, not talking to someone every day showed a notable association with regard to a higher PSQI score (\(β = 1.64, 95% \text{ CI} = 0.55 \text{ to } 2.72, p = 0.003\)). Even when the sensitivity analysis was performed, exclud-
Table 1. Participants’ characteristics

| Social frailty* | Non-frailty | Pre-frailty | Frailty | P-value† |
|----------------|-------------|-------------|---------|----------|
|                 | n = 152     | n = 82      | n = 52  |          |
| Age (years), mean (SD) | 72.2 (5.5)  | 73.0 (5.6)  | 75.1 (6.7) | 0.008    |
| Gender, n (%)     |             |             |         |          |
| Male             | 71 (46.7)   | 38 (46.3)   | 27 (51.9) | 0.783    |
| Female           | 81 (53.3)   | 44 (53.7)   | 25 (48.1) |          |
| BMI (kg/m²), mean (SD) * | 22.3 (2.7)  | 22.7 (2.9)  | 22.8 (3.6) |          |
| Educational attainment (years), n (%) | 17 (11.2)  | 16 (19.5)   | 10 (19.2) | 0.098    |
| Under 9          | 66 (43.4)   | 34 (41.5)   | 28 (53.8) |          |
| 10 to 12         | 69 (45.4)   | 31 (37.8)   | 14 (26.9) |          |
| 13 or more       | 0 (0.0)     | 1 (1.2)     | 0 (0.0)   |          |
| Household equivalent income (10,000 JPY), mean (SD) * | 293.3 (122.0) | 240.6 (130.5) | 213.3 (83.3) | < 0.001 |
| Working status, n (%) | 138 (90.8) | 72 (87.8)   | 49 (94.2) | 0.553    |
| Not working      | 14 (9.2)    | 9 (11.0)    | 2 (3.8)   |          |
| Working          | 0 (0.0)     | 1 (1.2)     | 1 (1.9)   |          |
| Present illness, n (%) |             |             |         |          |
| Cancer           | 142 (93.4)  | 75 (91.5)   | 49 (94.2) | 0.830    |
| No               | 5 (3.3)     | 4 (4.9)     | 2 (3.8)   |          |
| Yes              | 5 (3.3)     | 3 (3.7)     | 1 (1.9)   |          |
| Heart disease    | 137 (90.1)  | 75 (91.5)   | 47 (90.4) | 0.802    |
| No               | 10 (6.6)    | 4 (4.9)     | 4 (7.7)   |          |
| Yes              | 5 (3.3)     | 3 (3.7)     | 1 (1.9)   |          |
| Stroke           | 140 (92.1)  | 76 (92.7)   | 50 (96.2) | 0.674    |
| No               | 7 (4.6)     | 3 (3.7)     | 1 (1.9)   |          |
| Yes              | 5 (3.3)     | 3 (3.7)     | 1 (1.9)   |          |
| Respiratory disease | 137 (90.1) | 76 (92.7)   | 49 (94.2) | 0.555    |
| No               | 10 (6.6)    | 3 (3.7)     | 2 (3.8)   |          |
| Yes              | 5 (3.3)     | 3 (3.7)     | 1 (1.9)   |          |
| Hypertension     | 94 (61.8)   | 55 (67.1)   | 28 (53.8) | 0.263    |
| No               | 58 (38.2)   | 26 (31.7)   | 24 (46.2) |          |
| Yes              | 0 (0.0)     | 1 (1.2)     | 0 (0.0)   |          |
| Dyslipidemia     | 99 (65.1)   | 53 (64.6)   | 31 (59.6) | 0.746    |
| No               | 53 (34.9)   | 28 (34.1)   | 21 (40.4) |          |
| Yes              | 0 (0.0)     | 1 (1.2)     | 0 (0.0)   |          |
| Diabetes         | 141 (92.8)  | 69 (84.1)   | 43 (82.7) | 0.067    |
| No               | 11 (7.2)    | 12 (14.6)   | 9 (17.3)  |          |
| Yes              | 0 (0.0)     | 1 (1.2)     | 0 (0.0)   |          |
| IADL, n (%)      | 149 (98.0)  | 78 (95.1)   | 45 (86.5) | 0.004    |
| Without difficulty | 3 (2.0)   | 4 (4.9)     | 7 (13.5)  |          |
| Yes              | 88 (57.9)   | 46 (56.1)   | 34 (65.4) | 0.572    |
| Yes              | 64 (42.1)   | 35 (42.7)   | 18 (34.6) |          |
| Missing          | 0 (0.0)     | 1 (1.2)     | 0 (0.0)   |          |
| Physical activities (Mets hour/day), mean (SD) * | 5.4 (7.4)  | 5.7 (8.0)   | 4.3 (5.4) | 0.553    |

*Significant at p < 0.05.
ing those suspected of having sleep-related disorders (loud snoring, sleep apnea, or restless leg syndrome), the association between social frailty and PSQI score exemplified little variation (Supplementary Table 1 and 2). On the other hand, the significant connection between social frailty and sleep quality diminished upon introduction of the analytical model of depressive symptoms (Supplementary Table 3 and 4).

### Discussion

In the present cross-sectional study, we investigated the consequence of social frailty on sleep quality among older adults living in a community. Social frailty was associated with poor sleep quality; not talking with someone every day had a particularly strong effect. Our findings suggest that rich social relationships could be beneficial for older adults’ sleep quality.

Several previous studies have specified that flourishing social relationships through social support[17,18], and reduced social isolation[19,20], and loneliness[19] can improve sleep quality. Our results also corroborated this association in terms of social frailty, substantiating previous studies. According to Japan’s Sleep Guidelines for Health Promotion 2014[21], the positive outcomes of daily exercise habits[22], eating habits[23], and regular life rhythms[24], as well as the ramifications of alcohol[24], smoking[25], and caffeine[26] on sleep quality are considered as contributive lifestyle habits. Besides, our analyses prompt the notion of addressing social frailty to foster sleep hygiene in older adults.

Social frailty can find many pathways to potentially impair sleep quality, one of which may be through deteriorating mental health, stemming from insufficient social support, low physical activity, and irregular life rhythms due to a lack of daytime social activities. In our supplementary analysis, adding the intermediate variables to the analytical model showed that depressive symptoms could justify many of the associations between social frailty and poor sleep quality. Therefore, addressing social frailty might contribute to better sleep quality by improving mental health. However, the association between social vulnerability, such as social isolation and depressive symptoms, is known to be bidirectional[27]. Because the present study employed a cross-sectional design, it was difficult to separate confounding and mediating effects of depressive symptoms, so the results should be interpreted with caution. Therefore, further investigations using longitudinal panel data are necessary.

Of the sub-items, not talking with someone every day had a significant effect on poor sleep quality. Social relationships have two aspects: structural factors like social networks or participation in organizations - all of which are quantity-based - the quality-based functional elements, such as social support and social interactions[28]. Among social frailty subcomponents, living alone, frequency of going out, and visiting friends are categorized as structural aspects of social relationships, while talking with someone and holding perceptions of helping friends and family are cate-

### Table 1. Participants’ characteristics (continued)

| Social frailty* | Non-frailty | Pre-frailty | Frailty | P-value† |
|----------------|------------|------------|--------|---------|
|                | n = 152    | n = 82     | n = 52 |         |
| Depressive symptoms, n (%) | No          | 133 (87.5) | 62 (75.6) | 27 (51.9) | < 0.001 |
|                     | Yes         | 8 (5.3)    | 11 (13.4) | 19 (36.5) |
|                     | Missing     | 11 (7.2)   | 9 (11.0)  | 6 (11.5)  |
| Sleep duration (hours/day), mean (SD) * | 7.2 (1.0)  | 7.5 (1.3)  | 7.6 (1.4) | 0.016 |
| Global PSQI score, mean (SD) * | 4.0 (2.4)  | 3.9 (2.6)  | 4.8 (2.9) | 0.134 |
| PSQI subitem score, mean (SD) * |             |            |         |         |
| Subjective sleep quality | 1.2 (0.7)  | 1.2 (0.6)  | 1.3 (0.7) | 0.593 |
| Long sleep latency     | 0.8 (0.9)  | 0.8 (1.0)  | 1.2 (1.2) | 0.038 |
| Short sleep duration   | 0.4 (0.7)  | 0.3 (0.7)  | 0.3 (0.7) | 0.598 |
| Low habitual sleep efficiency | 0.03 (0.2) | 0.01 (0.11) | 0.1 (0.4) | 0.090 |
| Sleep disturbances     | 0.8 (0.5)  | 0.8 (0.6)  | 1.1 (0.6) | 0.004 |
| Use of sleep-promoting medication | 0.3 (0.8) | 0.3 (0.8)  | 0.4 (1.0) | 0.543 |
| Daytime dysfunction    | 0.4 (0.6)  | 0.6 (0.7)  | 0.5 (0.6) | 0.130 |

BMI: body mass index; IADL: instrumental activities of daily living; PSQI: Pittsburgh Sleep Quality Index; SD: standard deviation

*Missing data: social frailty, n = 14; BMI, n = 1; household equivalent income, n = 26; physical activities, n = 27; sleep duration, n = 6; global PSQI score, n = 57; subjective sleep quality, n = 7; long sleep latency, n = 22; short sleep duration, n = 6; low habitual sleep efficiency, n = 19; sleep disturbances, n = 21; use of sleep-promoting medication, n = 8; daytime dysfunction, n = 10

†Continuous variables were analyzed by analysis of variance, and categorical variables were analyzed by chi-square tests
Table 2. PSQI score for each component of social frailty

| Social frailty subcomponents* | Living alone | Sometimes visiting friends | Going out less frequently than the last year | Feeling helpful toward friends or family | Talking with someone every day |
|------------------------------|--------------|-----------------------------|---------------------------------------------|-----------------------------------------|--------------------------------|
|                              | No (n = 243) | Yes (n = 48)                | Yes (n = 225) No (n = 73)                   | Yes (n = 258) No (n = 40)               | Yes (n = 265) No (n = 31)       |
| Sleep duration (hours/day)   | 7.4 (1.1)    | 7.4 (1.6)                   | 7.2 (1.1) 7.7 (1.3)                         | 7.3 (1.2) 7.5 (1.3) 0.311             | 7.3 (1.2) 7.7 (1.4) 0.084       |
| Global PSQI score, mean (SD) | 4.0 (2.4)    | 4.7 (3.0)                   | 4.0 (2.6) 4.2 (2.4)                         | 4.1 (2.5) 3.8 (2.6) 0.602             | 3.9 (2.4) 4.9 (3.2) 0.085       |
| PSQI subitem score, mean (SD) | 0.900        | 0.147                       | 0.025                                       | 0.905                                   | 0.147                          |
| Subjective sleep quality     | 1.2 (0.7)    | 1.4 (0.7)                   | 1.2 (0.7) 1.2 (0.6)                         | 1.2 (0.7) 1.1 (0.6) 0.365             | 1.2 (0.7) 1.2 (0.7) 0.720       |
| Long sleep latency           | 0.8 (0.9)    | 1.2 (1.2)                   | 0.9 (1.0) 0.9 (1.0)                         | 0.9 (1.0) 0.8 (1.0) 0.469             | 0.9 (0.9) 1.1 (1.2) 0.127       |
| Short sleep duration         | 0.4 (0.7)    | 0.5 (0.9)                   | 0.4 (0.7) 0.3 (0.7)                         | 0.4 (0.7) 0.4 (0.7) 0.866             | 0.4 (0.7) 0.3 (0.7) 0.409       |
| Low habitual sleep efficiency| 0.03 (0.2)   | 0.1 (0.4)                   | 0.04 (0.2) 0.04 (0.2)                       | 0.04 (0.2) 0.1 (0.3) 0.746             | 0.04 (0.2) 0.03 (0.2) 0.878     |
| Sleep disturbances           | 0.8 (0.6)    | 1.0 (0.6)                   | 0.8 (0.6) 0.9 (0.6)                         | 0.8 (0.5) 1.0 (0.7) 0.028             | 0.8 (0.5) 1.0 (0.7) 0.055       |
| Use of sleep-promoting medic-| 0.3 (0.8)    | 0.3 (0.9)                   | 0.3 (0.8) 0.3 (0.8)                         | 0.3 (0.8) 0.2 (0.7) 0.491             | 0.3 (0.8) 0.5 (1.0) 0.269       |
| Daytime dysfunction          | 0.5 (0.7)    | 0.4 (0.5)                   | 0.4 (0.6) 0.6 (0.7)                         | 0.5 (0.7) 0.4 (0.5) 0.513             | 0.4 (0.6) 0.7 (0.8) 0.043       |

PSQI: Pittsburgh Sleep Quality Index; SD: standard deviation

*Missing data: living alone, n = 9; sometimes visiting friends, n = 2; going out less frequently compared with last year, n = 2; feeling helpful toward friends or family, n = 4; talking with someone every day, n = 6; global PSQI score, n = 57; average sleep duration, n = 6; subjective sleep quality, n = 7; long sleep latency, n = 22; short sleep duration, n = 6; low habitual sleep efficiency, n = 19; sleep disturbances, n = 21; use of sleep-promoting medication, n = 8; daytime dysfunction, n = 10

†Analyzed by Student’s t-test
Table 3. Association between social frailty and global PSQI score using multivariable linear regression analysis with multiple imputation approach (n = 300)

| Social frailty     | Crude model | Adjusted model* |
|--------------------|-------------|-----------------|
|                    | β (95% CI)  | P-value         | β (95% CI)  | P-value         |
| Non-frailty        | Reference   |                 | Reference   |                 |
| Pre-frailty        | 0.05 (-0.62, 0.72) | 0.890          | 0.02 (-0.69, 0.73) | 0.958          |
| Frailty            | 0.92 (0.14, 1.71) | 0.022          | 0.93 (0.08, 1.79) | 0.033          |

P for trend = 0.017*  P for trend = 0.030*

β: unstandardized regression coefficients; CI: confidence interval; PSQI: Pittsburgh Sleep Quality Index
*Adjusted model included all covariates in the analytical model: age, gender, education, income, employment status, present illness, instrumental activities of daily living, body mass index, drinking, smoking, and frequent urination

Table 4. Association between social frailty subcomponents and global PSQI score using multivariable linear regression analysis with multiple imputation approach (n = 300)

| Social frailty subcomponent | Crude model | Adjusted model* |
|-----------------------------|-------------|-----------------|
|                             | β (95% CI)  | P-value         | β (95% CI)  | P-value         |
| Living alone (ref: no)      | 0.02 (-0.83, 0.87) | 0.964          | -0.04 (-0.92, 0.84) | 0.934          |
| Sometimes visiting friends (ref: yes) | 0.04 (-0.63, 0.71) | 0.906          | 0.09 (-0.63, 0.80) | 0.814          |
| Going out less frequently compared with last year (ref: no) | -0.56 (-1.41, 0.28) | 0.191          | -0.53 (-1.41, 0.35) | 0.241          |
| Feeling helpful toward friends or family (ref: yes) | 0.29 (-0.68, 1.26) | 0.555          | 0.27 (-0.75, 1.29) | 0.605          |
| Talking with someone everyday (ref: yes) | 1.65 (0.61, 2.68) | 0.002          | 1.64 (0.55, 2.72) | 0.003          |

β: unstandardized regression coefficients; CI: confidence interval; PSQI: Pittsburgh Sleep Quality Index
*Adjusted model included all covariates in the analytical model: age, gender, education, income, employment status, present illness, instrumental activities of daily living, body mass index, drinking, smoking, and frequent urination

The key to addressing older adults’ sleep quality may lie in the functional aspects of social relationships rather than just the structural aspects. For instance, engaging in conversation as an exchange of social support may alleviate loneliness and offer a buffer from psychological stress. Sleep quality might be safeguarded particularly by receiving emotional support, such as asking others to listen to worries and complaints, rather than by providing social support, such as having a social role. Therefore, it might be important to develop relationships and communities that foster emotional support. However, since these are only speculations, further research is needed to identify the detailed mechanisms.

Our findings suggest the importance of social factors in older adults’ sleep hygiene, given the large proportion of this population suffering from sleep-related issues, and the correlation of poor sleep quality to geriatric syndromes such as cognitive impairment and sarcopenia. Since these geriatric syndromes are major targets of preventive physical therapy, therapists also need to consider the significance of older adults’ sleep quality. In addition to sleep hygiene approaches, such as improving daytime physical activity and regularizing life rhythms, improvement in social frailty through physical therapists’ efforts can contribute to boosting older adults’ sleep quality. For instance, therapists would be expected to help older adults build social relationships and promote the exchange of social support in community activities, such as “Kayoino-ba,” which is the population measure for long-term care prevention by Japanese central and local governments. We believe that contributions of therapists to community approaches to address social frailty could also be essential for older adults’ sleep hygiene.

Our study has several limitations that should be noted. First, the study’s cross-sectional nature means there was potential for reversal of causality, so further studies using longitudinal data are needed. Second, sleep quality was assessed using a self-administered questionnaire, creating the possibility of measurement errors. Thus, further investigations with objective measurements for sleep quality are needed.
needed, which can be done by utilizing devices such as actigraphs. Third, we did not have any information regarding the diagnosis of diseases related to sleep disorders. However, we did perform a sensitivity analysis, excluding participants portraying symptoms that alluded to sleep disorders, assessed from the additional PSQI items (loud snoring, sleep apnea, and restless leg syndrome); the results were almost the same. Therefore, we confirmed the robustness of our outcomes. Fourth, although adjusting the employment status based on the analytical model, we did not consider the participants’ work hours (i.e., shifts). This may have confounded our results. Fifth, we had no information about participants’ medication, so we could not consider it in the analysis. For instance, antidepressants and antianxiety medications can affect sleep quality. To address these issues, we excluded participants with self-reported depression disorder from the analysis. However, residual confounding is possible. Sixth, we used a social frailty index to examine the overall social vulnerability to sleep. However, there is still some disagreement over the definition of social frailty and the determination method. Although the definition of social frailty requires further debate, we were able to examine sleep from a multifaceted social perspective. Finally, participants in our study were recruited out of convenience, chosen from among individuals participating in health check-ups held in a suburban town-hall. These participants were healthier and younger than typical community-dwelling older people living in the town, which might reduce the generalizability of our results. In fact, only a few people had a higher PSQI score than the cut-off, and even those with social frailty had an average score below the cut-off point. Therefore, our results were applicable to healthy older adults whose sleep quality was not severely impaired, so it should be noted whether our results apply to the general population of older adults.

Conclusion

The present study supported the notion that social frailty was associated with poor sleep quality. Our results imply that promoting rich social relationships could be vital to improving sleep quality. Since sleep quality is associated with geriatric syndromes, which can be the target of preventive physical therapy, it would be essential to develop rich social relationships in order to address older adults’ sleep quality.

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Supplementary material (Appendix):
1. Supplementary Table 1. Association between social frailty and global PSQI score excluding participants with symptoms related to sleep disorders, multivariable regression analysis with multiple imputation
2. Supplementary Table 2. Association between social frailty subcomponents and global PSQI score excluding participants with symptoms related to sleep disorders, multivariable regression analysis with multiple imputation
3. Supplementary Table 3. Association between social frailty and global PSQI score, including intermediate variables, multivariable linear regression analysis with multiple imputation (n = 300)
4. Supplementary Table 4. Association between social frailty subcomponents and global PSQI score, including intermediate variables, multivariable linear regression analysis with multiple imputation (n = 300)