Frailty is associated with poor sleep quality in the oldest old

Abstract

Background/aim: Sleep disorders and frailty increase with advancing age, along with physical disabilities, cognitive dysfunction, mood disorders, and social vulnerability. Thus, the study objective was to evaluate the relationship between frailty and sleep quality in the oldest old patients.

Materials and methods: One hundred patients aged ≥ 80 years were included and assessed using comprehensive geriatric assessment (CGA) including basic activities of daily living (ADL), instrumental ADL, handgrip strength, geriatric depression scale-15, mini-mental state examination, and mini-nutritional assessment–short form. The patients’ sleep quality and frailty status were evaluated using the Pittsburgh sleep quality index (PSQI) and Fried frailty index, respectively.

Results: The median age of the participants was 84 years (80–92); 55% of them were women, and 41% of them were frail. There was no statistically significant difference between frail and non-frail groups in terms of age, gender, and co-morbidities (p-value > 0.050). Frail patients scored poorly according to the CGA tests when compared to the non-frail ones (p-value < 0.050). The median score for the PSQI was significantly higher in the frail group 12 points (3–19) versus 6 points (1–19) in non-frail patients (p-value < 0.001). The PSQI score (odds ratio [OR] of 1.308, 95% confidence interval [CI]: 1.092–1.566, p-value = 0.004), female gender (OR of 5.489, 95% CI: 1.063–28.337; p-value = 0.042), and basic ADL score (OR of 0.383; 95% CI: 0.207–0.706; p-value = 0.002) were found to be independently associated with frailty using multivariate analysis.
**Conclusion:** Sleep quality was significantly decreased in the oldest old frail patients compared to non-frail ones, and poor sleep quality was independently associated with frailty. Evaluating the sleep patterns of the oldest old patients with CGA in daily geriatric practice might help to improve the quality of life of frail patients.

**Keywords:** Frailty, insomnia, oldest old, sleep disorders, sleep quality

1. **Introduction**

Epidemiological studies have shown that more than 50% of people aged ≥ 65 years have sleep disorders,[1–5] the incidence of which increases with advancing age [6–8]. Poor sleep quality and sleep disorders are associated with decreased cognitive function, escalated falling, worsening health status, and increased mortality [6]. More than half the participants in an epidemiological study on 9,000 people aged ≥ 65 years, carried out at three different centers, reported having chronic sleep-related problems (i.e., trouble falling asleep, wakening during the night, wakening too early, difficulties with initiating or maintaining sleep, and insomnia) [9,10].

Frailty is a geriatric syndrome, and frail older adults are at risk of increased physical and cognitive vulnerability, as well as mood and social vulnerability. Frailty contributes to disease prognosis and negatively impacts mortality and morbidity. Impaired responses and increased sensitivity to external stressors contribute to frailty. Frailty is characterized by negative changes in the physiological capacity of multiple organs [11]. A decrease in psychological and cognitive function negatively affects individuals socially. Various factors, including the environment, the frequency of daily communication with other people, and the ability to exercise and go out, significantly contribute to the health of older adults. If their needs are not meet, they can be at risk of
social vulnerability [12]. Makizako et al. defined social vulnerability as spending less
time with friends, a reduction in communications with others, and decreased self-
efficacy; in turn, social vulnerability leads to an increase in levels of addiction and
disabilities in older adults [13]. Frailty can result in an increase in the number of falls,
deterioration in general health status, and premature death in older adults, and it is
closely associated with impacted sleep parameters, such as deterioration in sleep
quality, difficulty falling asleep, and distortion in the sleep–wake cycle [6,14]. The
prevalence of frailty increases with advancing age, for example, a rate of 7% for those
aged 65–74 years, which increases to 40% in those aged ≥ 85 years [6,14]. Sleep
disturbances adversely affect the general health of older populations and increase in
frequency with advancing age [7,14]. Many studies have demonstrated that oldest old
individuals (aged ≥ 80 years) experience a greater number of physical, mental, and
social changes than their younger counterparts (those aged 60-79 years) [15,16].
The relationship between frailty and sleep quality has not been adequately studied
before, in particular with regard to oldest old patients. Thus, the study objective was to
determine the relationship between frailty and sleep quality in this oldest old patients.

2. Methods

2.1 Sample and study design

The current study was conducted between January 2019 and April 2019. One hundred
consecutively presenting oldest old patients aged ≥ 80 years admitted to the geriatric
outpatient clinic at Gazi University Hospital were included in the study. A number of
assessments were administered to the study participants during face-to-face interviews
with a geriatrician. Cognitive function was assessed through a medical examination and comprehensive geriatric assessment (CGA) during an outpatient clinic visit. Patients who met Petersen criteria for Mild Cognitive Impairment or Diagnostic and Statistical Manual of Mental Disorders 5, Fifth Edition (DSM-5) criteria for dementia were excluded. We excluded all patients with major depressive disorder and bipolar disorder according to DSM 5 criteria. In addition, patients with disabilities (amputations, stroke-induced sequela, aphasia, and hearing problems), decompensated heart failure, acute myocardial infarction, acute stroke, exacerbation of chronic obstructive pulmonary disease, acute illnesses (i.e., infections and unstable general conditions), and those admitted to hospital or the intensive care unit within the last three months were excluded. Written informed consent was obtained from the participants. The socio-demographic data of the patients, their educational status, and the presence of chronic co-morbidities and medications were recorded. CGA, sleep quality, and frailty evaluations were performed by same geriatrician. CGA, a multidisciplinary approach that determines the medical, psychosocial, and functional status of older adults, enables physicians to make diagnoses and develop treatment plans to minimize complications and side-effects. In the current study, basic activities of daily living (ADL), instrumental activities of daily living (IADL), nutrition, cognition, mood, co-morbidities, number of medications, urinary incontinence, number of falls within the last year, and fractures were included in the CGA [17]. The Pittsburgh Sleep Quality Index (PSQI) and Fried Frailty Index (FFI) were used to evaluate sleep quality and frailty, respectively. This study was performed in accordance with the Declaration of Helsinki and received the approval of the Gazi University Faculty of Medicine clinical research ethics committee (Reference number: 952).
2.2 Sleep parameters

A validated Turkish version of the PSQI, which comprises 24 questions, was used to assess the patients’ sleep quality [18,19]. Nineteen of the questions were answered by the patients, and the remaining five questions were answered by each patient’s partner (who slept in the same room). However, the answers given by the partners were not included in the scoring. Eight components were taken into consideration when evaluating the results: (1) global score, (2) subjective sleep quality, (3) sleep latency, (4) sleep duration, (5) habitual sleep efficiency, (6) sleep disturbances, (7) the use of sleep medication, and (8) daytime dysfunction. The total score was obtained from a summation of the scores from all components. The PSQI score ranged from 0–21 points, with high-end scores reflecting poor sleep quality [18,19]. A PSQI score of ≥ 5 indicated impaired sleep quality [19].

2.3 Frailty

Frailty is a geriatric syndrome, and its prevalence increases with advancing age [7]. The FFI, developed by Fried et al., [14] is one of the most frequently used frailty indexes in clinical practice; it comprises five parameters of weight loss, exhaustion, low physical activity, slowness, and weakness. These factors are assessed and scored, with a maximum possible score of 5. Scores of 0, 1–2, and ≥ 3 points indicate that a person is robust, pre-frail, and frail, respectively [14].

In the Fried criteria, weight loss criterion means 4.5 or more kg loss within the last year. Patients with a Center for Epidemiological Studies Depression Scale score (CES-D) of ≥ 2 are considered to have exhaustion. A point is also added for physical activity performed by a man who consumes less than 383 kcal/weekly and physical activity
carried out by a woman who consumes less than 270 kcal/weekly. The patient’s walking
time over a distance of 4.6 m, adjusted for gender and height, is then determined.
Finally, handgrip strength is assessed, and the results are interpreted based on the body
mass index [14].

2.4 Other parameters

The socio-demographic data of the patients were evaluated, and CGA was performed.
Basic ADL scores were evaluated within the scope of the CGA [20,21]. A validated
Turkish version of Basic ADL was used (scores of 0–6) [20,22]. IADL scale (scores of
0–8), was also applied [23]. A validated Turkish version of the Mini-Mental State
Examination was performed to evaluate cognitive function (scores of 0–30) [24,25].
The Mini Nutritional Assessment-Short-Form (MNA-SF) test was employed to assess
malnutrition risk (scores of 0–14) [26]. The MNA-SF is valid and reliable in Turkish
population [27]. The Geriatric Depression Scale-15 (GDS-15), developed by Yesavage,
was utilized to evaluate the patients’ depression status. A validated Turkish version of
the GDS-15 was also used [28]. Total test score can range from 0 to 15 points [28,29]
and the patients were assessed for urinary incontinence. The number of falls within the
last year, fractures, bedsores, co-morbidities, and number of medications used were also
recorded.

2.5 Statistical analysis

Statistical analysis was performed with SPSS® Statistics for Windows® 22.0. The
categorical parameters were expressed as number (n) and percentage (%). Whether the
numerical parameters had a normal distribution was determined using a histogram,
variation coefficients, and the Kolmogorov–Smirnov test. Normally distributed
numerical parameters were expressed as mean ± deviation, and non-normally
distributed numerical data were expressed as median (minimum–maximum). Student’s
\( t \)-test was utilized to compare the normally distributed numerical parameters between
two independent groups, and the Mann-Whitney U test was used to compare the non-
normally distributed parameters. The categorical variables were compared using the chi-
square or Fisher’s exact tests.

The patients were divided into two groups based on their frailty status (frail and non-
frail). First, we performed univariate analysis to detect related parameters with frailty.
The parameters that have a \( p \)-value of < 0.200 were included in the multivariate analysis
to identify factors that were independently associated with frailty. When considering
type one error as 0.05 and power as 0.80 to find out significant differences about poor
sleep quality between frail and non-frail oldest old patients, the minimum number of the
patients including in the study is calculated as 74 (37 frail, 37 not-frail groups). A \( p \)-
value of <0.05 was considered statistically significant.

3. Results

One hundred patients were included in this research. There were 41 frail and 59 non-
frail patients. Table 1 depicts the clinical characteristics of the participants. A
statistically significant difference was not demonstrated between the frail and non-frail
groups in terms of age, gender, and co-morbidities \( (p \)-value > 0.050). Age did not differ
between frail and non-frail groups [82 years (80-92) vs. 84 years (80-91), respectively,
\( p \)-value= 0.151]. The differences between the groups in terms of co-morbidities such as
diabetes, hypertension, smoking, chronic obstructive pulmonary disease, coronary
artery disease, malignancy, and depression were without statistical significance \( (p \)-value
Frail patients were more likely to have urinary incontinence than non-frail patients (74.3% vs. 35.2%, respectively) \((p\text{-value} < 0.001)\). The findings of the CGA parameters are detailed in Table 2. The basic ADL, MMSE, and MNA-SF test scores were significantly lower and the GDS scores were higher in the frail group compared to the non-frail group.

The distribution of total PSQI scores and sub-scores by groups is shown in Table 3. Total PSQI scores and sub-parameter scores (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, and daytime dysfunction) were found to be significantly lower in the non-frail group compared to the frail group \((p\text{-value} < 0.001)\). The difference between the groups in terms of the PSQI subscale which is use of sleep medications was not statistically significant. Additionally, only 17 patients out of 100 in our study stated that they used sleeping drugs in the last month, 11 of them stated that they used drugs three or more days a week. Only 6 of 11 patients were using medication regularly. Four of these patients were using trazodone 50mg daily and two of them were using Hydroxyzine hydrochloride 25mg each day. There was no statistically significant difference about use of sleeping drugs between frail and non-frail groups.

The PSQI, basic ADL, MMSE, MNA-SF, and GDS-15 scores, the number of co-morbidities, gender, age, hypertension, and osteoporosis were included in the binary logistic regression model. The results of the logistic regression analysis are summarized in Table 4.

4. Discussion
An independent relationship was demonstrated between frailty and sleep quality in the oldest old patients in the current study. In general, the prevalence of frailty and sleep problems is high in older adults, increasing with advancing age. Many systems are adversely affected by deterioration in sleep quality and frailty. It has been consistently reported in the large epidemiological studies that frailty increases with advancing age, with the highest prevalence being reported in individuals aged ≥ 80 years [6]. For this reason, older adults aged ≥ 80 were included in the current study. The quality of life of the patients is adversely and significantly affected by frailty. A limited number of studies in the literature have explored the correlation between sleep quality and frailty in the oldest old patients. The present study demonstrated that the frailer the patients were, the more their sleep quality was impacted. Our findings are supported by those of a cohort study conducted on older, rural Mexican adults in which sleep complaints were associated with frailty in older women [29,30].

Frailty is an important geriatric syndrome, and it adversely affects geriatric test results. It has been shown that it leads to increased dependence and falls in older individuals [10, 14]. Fried et al. also showed that cognitive scores were lower and depressive symptoms were higher in frail patients [14]. The findings in our study were similar to these studies. We established that frail patients were more likely to have urinary incontinence. Similarly, Berardelli et al. demonstrated a strong correlation between frailty and urinary incontinence, they also suggested that urinary incontinence is a key component of frailty [31].

When the relationship between frailty and sleep quality, and their respective sub-parameters were examined, a significant relationship was established in all instances, except the number of sleep medications. Participants in the frail group experienced
reduced subjective sleep quality, poorer sleep latency and duration, greater disturbances
in sleep habits, and increased daytime sleepiness. A significant relationship was
observed concerning the total PSQI score between subjective sleep quality, sleep
disturbances, and daytime dysfunction in the frail group (p-value <0.001). We found a
significant relationship between frailty and daytime sleepiness, decrease in sleep
duration as a previous study [10]. The use of sleep medication was the only sub-
parameter that did not have any relationship with frailty. Most of the patients in the
current study did not use sleep medication. This may be related to the fact that the
majority of the patients included in the study did not have the diagnosis of insomnia.
Therefore, the medications used in the treatment of insomnia were not different between
the study groups. On the other hand, one of the reasons why the study groups did not
have significantly different frequencies in terms of using sleep-related medications may
derpend on the fact that the number of the patients taken these sleep-related medications
was small.

The PSQI score, ADL score, and female gender were independently associated with
frailty using multivariate analysis. Multiple mechanisms are responsible for the
independent relationship between PSQI and frailty. Deterioration in sleep quality may
indicate a worsening in health status, increased depressive symptoms, and decreased
physical activity [2,3,10,28]. Besides, immunological mechanisms, such as an increase
in proinflammatory cytokines, deterioration in renal function, and an increase in chronic
inflammation markers, relate to frailty [28]. Therefore, there might be a bidirectional
relationship between frailty and sleep quality, resulting in a vicious cycle. The loss of
basic ADL renders the oldest old patients more vulnerable, more psychically dependent,
and at higher risk of poorer health than their (relatively) younger counterparts.[15]
Therefore, the loss of basic ADL negatively impacts the frailty status of the oldest old patients. Female gender was found to have an independent relationship with frailty in the current study. This finding was an expected outcome since it has been reported elsewhere that frailty is common in older women. In addition, the fact that women have the lower muscle strength and leaner muscle mass compared to men may be another reason for the higher rates of frailty in women [7].

The small sample size was a limitation of our study. However, the study had adequate statistical power in terms of the number of participants included. Our study's strength was that only the oldest old (≥ 80 years) were recruited. The subjective assessment of sleep quality using the PSQI was another weakness. Polysomnography could have been performed to evaluate sleep disturbances objectively. However, it is neither a widely used nor readily available test. Further studies that assess insomnia using polysomnography and further evaluations of this study population are warranted. When using the PSQI, an increase in sleep duration positively influences the score. It has been reported elsewhere that an increase in sleep duration is associated with frailty [6]. Therefore, further studies are required to determine the optimum sleep duration in older adults.

Our research's key strength was that it is the first study to have evaluated the association between frailty and sleep quality in the oldest old. The fact that the oldest old patients are frailer than older adults indicates that many challenges, such as sleep disorders, should be examined in more detail in this population. Deterioration in sleep quality is a significant problem as it affects multiple systems and is often overlooked by physicians.
The finding that sleep quality was associated with frailty in the current study suggests that it is important to evaluate sleep disorders while performing CGA, especially in the oldest old. Further studies are needed to elucidate whether sleep disturbances play a role in the development of frailty and whether treating them would lead to an improvement in frailty status.

Acknowledgments

None declared.

References


**Table 1:** General characteristics and co-morbidities of the patients according to frailty status

<table>
<thead>
<tr>
<th>Properties</th>
<th>Not frail (n = 59)</th>
<th>Frail (n = 41)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (female), n (%)</td>
<td>28 (47.5)</td>
<td>27 (65.9)</td>
<td>0.069</td>
</tr>
<tr>
<td>Age (years), median (minimum–maximum)</td>
<td>84 (80–91)</td>
<td>82 (80–92)</td>
<td>0.151</td>
</tr>
<tr>
<td>Smoking, n (%)</td>
<td>2 (3.6)</td>
<td>0 (0.0)</td>
<td>0.235</td>
</tr>
<tr>
<td>Diabetes mellitus, n (%)</td>
<td>17 (30.4)</td>
<td>13 (33.3)</td>
<td>0.759</td>
</tr>
<tr>
<td>Hypertension, n (%)</td>
<td>40 (72.7)</td>
<td>33 (86.8)</td>
<td>0.103</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease, n (%)</td>
<td>4 (7.3)</td>
<td>4 (10.8)</td>
<td>0.710</td>
</tr>
<tr>
<td>Osteoporosis, n (%)</td>
<td>6 (12.0)</td>
<td>10 (28.6)</td>
<td>0.054</td>
</tr>
<tr>
<td>Coronary artery disease, n (%)</td>
<td>15 (26.8)</td>
<td>13 (35.1)</td>
<td>0.390</td>
</tr>
<tr>
<td>Urinary incontinence, n (%)</td>
<td>19 (35.2)</td>
<td>26 (74.3)</td>
<td>&lt; 0.001*</td>
</tr>
</tbody>
</table>

*: statistically significant
Table 2: Comprehensive geriatric assessment tests’ results according to frailty status

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Not frail (n = 59)</th>
<th>Frail (n = 41)</th>
<th>(p)-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of drugs</td>
<td>5 (1–14)</td>
<td>5 (0–19)</td>
<td>0.331</td>
</tr>
<tr>
<td>Number of co-morbidities</td>
<td>3 (1–6)</td>
<td>3 (2–7)</td>
<td>0.028*</td>
</tr>
<tr>
<td>Basic ADL</td>
<td>6 (0–6)</td>
<td>4 (0–6)</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Instrumental ADL</td>
<td>7 (0–8)</td>
<td>4 (0–8)</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Mini-Mental State Examination</td>
<td>27 (0–30)</td>
<td>21 (7–30)</td>
<td>0.005*</td>
</tr>
<tr>
<td>Mini Nutritional Assessment</td>
<td>12 (3–14)</td>
<td>10.5 (4–14)</td>
<td>0.002*</td>
</tr>
<tr>
<td>Geriatric Depression Scale-15</td>
<td>2 (0–14)</td>
<td>6 (0–11)</td>
<td>0.001*</td>
</tr>
</tbody>
</table>

*: statistically significant

ADL: activities of daily living

The numerical parameters are presented as median (minimum–maximum)

Table 3: Pittsburg Sleep Quality Index total and subgroup scores according to frailty status

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Not frail (n = 59)</th>
<th>Frail (n = 41)</th>
<th>(p)-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSQI total score</td>
<td>6 (1–19)</td>
<td>12 (3–19)</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Subjective sleep quality</td>
<td>1 (0–3)</td>
<td>2 (0–3)</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Sleep latency</td>
<td>1 (0–3)</td>
<td>2 (0–3)</td>
<td>0.003*</td>
</tr>
<tr>
<td>Sleep duration</td>
<td>0 (0–3)</td>
<td>2 (0–3)</td>
<td>0.039*</td>
</tr>
<tr>
<td>Habitual sleep efficiency</td>
<td>1 (0–3)</td>
<td>3 (0–3)</td>
<td>0.004*</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------</td>
<td>---------</td>
<td>--------</td>
</tr>
<tr>
<td>Sleep disturbances</td>
<td>1 (0–3)</td>
<td>2 (1–3)</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>Use of sleep medication</td>
<td>0 (0–3)</td>
<td>0 (0–3)</td>
<td>0.306</td>
</tr>
<tr>
<td>Daytime dysfunction</td>
<td>0 (0–3)</td>
<td>2 (0–4)</td>
<td>&lt; 0.001*</td>
</tr>
</tbody>
</table>

*: statistically significant

PSQI: Pittsburg Sleep Quality Index

The numerical parameters are presented as median (minimum–maximum).

Table 4: Independently associated factors with frailty using multivariate analysis

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Odds ratio</th>
<th>95% confidence interval</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower limit</td>
<td>Upper limit</td>
</tr>
<tr>
<td>PSQI</td>
<td>1.308</td>
<td>1.092</td>
<td>1.566</td>
</tr>
<tr>
<td>Basic ADL</td>
<td>0.383</td>
<td>0.207</td>
<td>0.706</td>
</tr>
<tr>
<td>Gender (female)</td>
<td>5.489</td>
<td>1.063</td>
<td>28.337</td>
</tr>
</tbody>
</table>

*: statistically significant

ADL: activities of daily living, PSQI: Pittsburg Sleep Quality Index

The parameters who had p-value of <0.200 were included in the multivariate analysis to identify factors that were independently associated with frailty. These parameters were PSQI, numbers of co-morbidities, basic ADL, mini-mental state examination, mini-nutritional assessment, geriatric depression scale-15, gender, age, hypertension, and osteoporosis. Backward stepwise model was used and last model (step-8) was presented.
in this table. Omnibus test for this model had p-value <0.001. Hosmer and Lemeshow test had p-value >0.050. Nagelkerke R square was 0.772 for this model.