Subjective sleep quality and association with depression syndrome, chronic disease and health-related physical fitness in middle-aged and elderly

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Abstract

**Background**: Sleep quality as a complex phenomenon is difficult to define and measure objectively, multiple factors are related to sleep quality, such as age, lifestyle, physical activity, and physical fitness, are prominent in the older adult population. The aim of the present study was to evaluate subjective sleep quality using the Pittsburgh Sleep Quality Index (PSQI) and associate with the health-related physical fitness factors, depression symptom, and chronic disease numbers in middle-aged and elderly.

**Methods**: We enrolled a total of 283 participants with middle-aged and elderly from a rehabilitation clinic or health examination department. The PSQI was used to evaluate sleep quality. The health-related fitness assessment includes anthropometric and physical fitness. Depressive symptoms were measured by the Center for Epidemiologic Studies Depression Scale (CES-D) short form. Data were analyzed with SPSS 18.0, descriptive statistics and logistic regression analysis were performed for analysis.

**Results**: Overall, 27.9% of the participants in this study demonstrated poor sleep quality (PSQI score > 5), 10.2% of the study participants frequently used sleep medication to help them fall asleep, 6.0% reported having significant depressive symptoms (CES-D ≥ 10). The results have three major findings: (1) depression symptom, number of chronic disease, self-rate health and arthritis were significantly associated with poor sleep quality, (2) age was associated with sleep disturbance, (3) two-min step was associated with longer sleep latency. This results confirmed two-min step was associated with longer sleep latency among the health-related physical fitness items.

**Conclusion**: Our studies found that depressive syndromes, chronic disease numbers, poor self-rated health status and arthritis were the main risk factors that influenced subjective sleep quality.
Keywords: subjective sleep quality, Pittsburgh Sleep Quality Index, health-related physical fitness, depression symptoms, arthritis
Introduction

Sleep quality as a complex phenomenon is difficult to define and measure objectively(1), it is not directly associated with sleep quantity. Self-reported sleep does not correlate well with PSG defined sleep(2). Multiple factors are related to sleep quality in old age, lifestyle, physical activity, and physical fitness; moreover, alcohol drinking patterns (3), depression symptoms(4) and rheumatoid arthritis (5) may affect sleep quality.

Age-related sleep changes may lead to poor sleep quality in older adults with physical or psychiatric disorders (6). Insomnia is one of the most common examples of a poor sleep pattern. Reports indicate that 33% to 50% of the adult population have symptoms of insomnia (7). Other studies have revealed that 49% of community-dwelling older adults reported poor sleep quality (4) and 41.9% of adults ages 60 years or older suffer from sleep disturbance in Taiwan (8). Sleep disturbance is a common problem for older adults, and sleep complaints and sleep-related problems become more prevalent with age (9). Sleep disturbance was also associated with lower physical fitness levels, reduced health-related quality of life (10), nocturia, poor self-reported functional status, and mental status (8).

We defined poor quality of sleep in this study as a PSQI global score of more than five. One study reported that poor sleep patterns are related to poor physical and
mental health (11). Moreover, symptoms of depression have been identified as the factors most significantly associated with poor sleep quality among older adults (4, 8).

Studies have revealed the benefits of physical activity and regular exercise for improving sleep quality and reducing the occurrence of sleep disturbance (12-14) in middle-aged to elderly adults. Elderly women had better sleep quality if they were physically active rather than sedentary (15). Physical fitness and the ability to achieve certain performance standards for physical activity are also associated with sleep quality.

Health-related fitness is the ability to become and remain physically healthy. Health-related components of physical fitness include muscular strength, muscular endurance, cardiovascular endurance, joint flexibility, and body composition (American Alliance for Health, Physical Education, Recreation and Dance, 1980).

Few studies have examined the association between quality of sleep and physical fitness level. Therefore, the aim of the present study was to evaluate subjective sleep quality using the PSQI, depression, chronic disease and associate with the influence of health-related physical fitness factors in community-dwelling middle-aged and elderly.

Methods
**Design and Samples**

A cross-sectional survey was conducted in our study. We recruited older adults in northern Taiwan from August 2010 to July 2013. The inclusion criteria of the samples were as follows: (a) aged 40 years or older; (b) having no ambulatory problems or using any assistance for walking; and (c) able to communicate verbally. Those who had severe cardiovascular disease, neurological disease, or musculoskeletal impairment were excluded. In total, the sample size was 283 individuals. The study was approved by the Ethics Committee of the Far Eastern Memorial Hospital (No. 098101-3), and all subjects gave written informed consent before they participated in the study.

**Measures**

The evaluated characteristics of respondents included sex, age, marital status, education level, religious belief, number of current diseases (hypertension, heart disease, diabetes mellitus, pulmonary disease, peptic ulcer, liver disease, arthritis, osteoporosis, and cancer), smoking and alcohol drinking habits, tea or coffee consumption, regular exercise (more than 30 minutes at least three days per week). Self-ratings of health status, which reflected individuals’ personal perceptions of their overall health condition, were indicated on a 5-point Likert scale (scored 1 to 5, 1 = very poor and 5 = excellent).
The PSQI was used to evaluate sleep quality (1), and the Chinese version was applied in this study (16). Participants self-rated their sleep situations with respect to seven components: sleep duration, sleep disturbance, sleep latency, daytime dysfunction, sleep efficiency, subjective sleep quality, and use of sleep medication in the past one month. The origin score of each component ranged from 0 to 3, and the sum of these component scores, ranging from 0 to 21, was the total score serving as the measure of quality of sleep. A global score higher than five was defined as an indicator of poor sleep. In our study, we also used the original scores of the seven components and individually recoded them as dichotomous variables to examine the association of the correlates with these 7 components. The definition of poor sleep quality was as follows with respect to these 7 components: (1) short sleep duration less than six hours (score ≥ 2), (2) sleep disturbance score ≥ 2, (3) long sleep latency: more than 30 minutes required to fall asleep (score ≥ 2), (4) daytime dysfunction: daytime dysfunction score ≥ 2, (5) Poor sleep efficiency less than 80%, (6) subjective rating of sleep quality score ≥ 2, and (7) use of sleep medication.

The health-related fitness assessment includes the following anthropometric and physical fitness measurements: (1) Body weight and height were measured with a calibrated scale, and participants were asked to wear light clothes and no shoes. Body mass index was also calculated according to body weight (kg) divided by height (in...
(2) Mid-arm circumference, waist circumference, and buttock circumference were measured according to standard methods. (3) Body composition was assessed using bioelectrical impedance analysis (TANITA’s body composition analyzer, TBF 300, Tokyo, Japan) to derive the percentage of body fat, fat mass, and fat-free mass. (4) Physical activity was measured using the International Physical Activity Questionnaire (IPAQ) short version, which comprised four generic items. The questionnaire was developed in Geneva in 1998 and has undergone extensive reliability and validity testing across many countries and been translated into different languages. We adopted the Taiwanese version (17). Participants were asked to report their physical activity during the previous 7 days for estimation of the habitual level of physical activity. IPAQ was categorized as three levels of physical activity: low, moderate, and high.

Physical fitness assessment: We used a set of senior fitness test tools developed by Accuratus International Health Company in Taiwan. The test contained the following seven items. (1) sit-and-reach test: this test is common for measuring the flexibility of the lower back. The participants were asked to sit on the edge of a chair with one leg bent and the corresponding foot flat on the floor while the other leg is extended straight in front of the hip with the corresponding heel on floor and foot flexed at a 90 degree angle. The individual bends forward at the hip while sliding
hands down the extended led; this is performed twice, and the greater of the two 
distances is used. The score was negative if the reach distance was shorter than the 
distance to the toes and positive if it was beyond the toes. This test assessed the 
flexibility of the lower back. (2) One-leg stance test: this test was used to assess static 
balance. The participants were asked to initially stand still on both feet. Then they 
were requested to bend their left leg backwards. The time (in seconds) that they could 
remain standing on one leg with the other leg bent backwards without losing their 
balance was recorded. (3) 2-minute step test: this item assessed cardiovascular 
endurance. Steps were taken in which the participants’ knees were raised to a height 
halfway between the iliac crest and middle of the patella. The number of steps taken 
in 2 minutes was assessed. (4) Back muscle strength: the maximal isometric strength 
of the trunk muscles in a standing posture with 30-degree lumbar flexion using a back 
muscle strength meter was measured. (5) 30-second chair-stand test: this test was used 
to assess lower-body strength. The participants were asked to sit in the middle of the 
chair with their feet on the floor and arms crossed at the chest; they rose to a standing 
position and then sat back in the chair repeatedly. The number of times that 
participants could stand and sit in 30 seconds was assessed. (6) Grip strength: the 
muscle strength of the upper arms was measured. Participants were asked to stand up 
and grasp a grip strength measuring device (The Jamar® Plus+ Digital Hand
Dynamometer) (Sammons Preston, Rolyon, Bolingbrook, IL, USA). They performed this action 3 times, and the best score was recorded. (7) Up-and-go test: this test measured speed, agility, and balance while the body was moving. Participants were required to stand up from a chair, walk 2.5 meters to and around a cone, and return to the chair and sit down; the time required to complete this task was measured in seconds. All physical fitness measurements were performed by well-trained personnel, and the results were recorded by a computer.

Depressive symptoms were measured using the Center for Epidemiologic Studies Depression Scale (CES-D) short form (18). The Chinese version of 10 self-report items were used to measure the depressive symptoms that have frequently occurred in the previous one week. The score of each question ranged from 0 to 3; we considered depression to be a score greater than or equal to 10.

Statistical analysis

For the characteristics of subjects and health-related fitness variables, Descriptive statistics were recorded for each variable, with the quantitative data shown as mean and standard deviation. Different two group comparisons were analyzed with independent t-tests or chi-square tests. Pearson correlation was used for the PSQI and health-related fitness. Logistic regression analysis was performed to assess the characteristics and physical fitness that associated with the PQSI variables.
The level of significance was set as $\alpha = 0.05$. Data were analyzed with SPSS for windows version 19 software (IBM, SPSS Inc., Chicago, IL, USA).

**Results**

A total of 283 individuals completed the entire physical fitness evaluation, and the PSQI questionnaire. Table 1 lists the participants’ characteristics. The mean age was 59±7.3 years old, approximately third-fourths of the study population were female and had religious belief. Only 5.3% and 18% of participants had smoking history and at least once a week alcohol use, about 60% had tea and coffee at least once a week use, 49.5% of the participants had regular exercise and only 5.7% not arrived moderate-to-high level physical activity, 162(57.2%) subjects had chronic disease and 6% depression symptom. Older adults, less alcohol use and less depression symptom had significantly good sleep. Much more chronic disease especial heart disease and arthritis were associate with poor sleep quality.

Overall, table 2 shows the distribution of quality of sleep according to the PSQI questionnaire. Global scores indicated that 27.9% of the participants had poor sleep quality. The majority of participants (69.6%) reported that they had more than 7 hours of sleep at night, and most (86.9%) reported only a slight problem with sleep disturbances; 26.9% of participants reported needing more than 30 minutes to fall
asleep; the results of sleep efficiency revealed that three quarters of participants had sleep efficiency greater than 87.6%; however, approximately one third of participants self-rated their sleep quality as poor and most (83.7%) had not used sleep medication during the previous month.

The results of the distribution of health-related fitness between good and poor sleep quality is presented in Table 3. The poor quality of sleep participants reported significantly higher depression symptoms, chronic disease numbers and up and go times than good quality of sleep participants. In term of self-rate health, poor quality of sleep participants reported lower health condition. Other anthropometric index and physical fitness were no significantly different with good and poor quality of sleep.

Table 4 shows the results of Pearson correlation between PSQI and health-related fitness. In basic condition, depression symptom and chronic disease numbers were significantly positive correlation with PSQI (r=0.509, p=0.000; r=0.167, p=0.005), self-rate health was significantly negative correlation with PSQI (r=-0.388, p=0.000). In health-related fitness, two-min steps and chair stand in 30s were significantly negative correlation with PSQI (r=-0.150, p=0.009; r=-0.172, p=0.004), up-and-go significantly positive with PSQI (r=0.185, p=0.002). Other health-related fitness factors were no significantly correlation with PSQI (all p>0.05).

The results of the logistic regression analysis is presented in Table 5, with each
of the seven components of the PSQI and global score as dependent variables.

Covariates of age, sex, alcohol use, depression, number of chronic diseases, self-rated health, arthritis, and the four physical fitness items were used as independent variables. The results were as follows. Only depression was associated with short sleep duration (OR = 1.160, p < 0.05); age, depression and arthritis were associated with sleep disturbance (OR = 0.914, p < 0.05; OR = 1.208, p < 0.001; OR=5.572, p<0.05); Depression symptom, chronic disease numbers, self-rate health and two-min step were associated with longer sleep latency (OR =1.097, p < 0.05; OR=0.627, p<0.05; OR=0.883, p<0.01 and OR=0.982, p<0.05), and only depression was associated with daytime dysfunction (OR = 1.127, p < 0.05). No other physical fitness items were associated with poor sleep efficiency; depression, chronic disease numbers and self-rate health were associated with poor subjective sleep quality (OR =1.258, p < 0.001; OR=0.659, p<0.05; OR=0.855 and p<0.001); depression and self-rate health were associated with use of sleep medication (OR = 1.143, p < 0.01 and OR=0.862, p<0.01); Depression symptom, chronic disease numbers, self-rate health and arthritis were associated with poor sleeping quality (OR = 1.219, p < 0.001, OR=0.550, p<0.05, OR=0.860, p<0.001 and OR=4.369, p<0.01). Among the controlling variables, sex, alcohol use, heart disease, chair stand in 30 second, up-and-go and constant were not associated with any component of PQSI.
Discussion

Our study have three major foundling : (1) depression symptom, number of chronic disease, self-rate health and arthritis were significantly associated with poor sleep quality, (2) age was associated with sleep disturbance, (3) two-min step was associated with longer sleep latency.

This results confirmed the correlation with health-related physical fitness and sleep quality in middle-age and elderly, among the health-related physical fitness items measured only two-min step was associated with longer sleep latency. Our study revealed that 27.9% of participants demonstrated poor sleep quality. We discovered that 10.2% of the study participants frequently used sleep medication to help them fall asleep; 6.0% reported having significant depressive symptoms (CES-D ≥ 10). The components of sleep quality evaluated in this study were diverse, and two-min steps, chair stand in 30 seconds and up-and-go physical fitness items were significantly correlation with components of sleep quality, but only two-min step association with longer sleep latency after controlling for confounding factors. However, depressive symptoms, number of chronic disease, self-rated health status and arthritis were main risk factors influencing poor sleep quality among middle-age and elderly.

We found that depression symptom affected short sleep duration. Gerber et al.
(19) reported that low fitness levels and a perceived lack of physical activity was associated with longer sleep onset latency. We found not different that better two-minute step endurance was associated with lower risk of longer sleep latency. In our questionnaire, daytime function, including driving, eating meals, and engaging in social activity, required less the effects of depression. Lee and Lin (20) reported greater sit-and-reach distances in young women with favorable sleep quality, we found less depression symptom and chronic disease numbers, and better self-rate health with subjective good sleep quality. Furthermore, self-rated health status also had major influences on sleep latency, subjective sleep quality, and global sleep quality.

In this study, logistic regression analysis disclosed association of sleep disturbance and poor sleeping quality with arthritis. Patients with RA suffer from a variety of symptoms such as joint pain, fatigue, stiffness, sleep disturbance and functional disability (5). A high prevalence of abnormal sleep quality in both rheumatoid arthritis and osteoarthritis patient populations was observed. The most common abnormality was sleep fragmentation, with an increased sleep disturbance score. (21). Only 18.5% of RA patients had good sleeping quality, depression and risk of sleep apnea are independently associated with sleep impairment (22).

Older adults with long sleep duration had weaker hand grip strength, irrespective
of muscle mass (23). More muscle power corresponded to a lower probability of using sleep medication. Upper arm muscle strength was a factor related to sleep medication use. We found that sleep medication use was associated with self-rate health and depressive symptoms. Approximately 90% of patients with depression report poor sleep quality (24), for which depressive symptoms may have more influence than physical fitness.

This study has certain several limitations, including a small sample size, difference in the number of men and women recruited, sleep measurement was based on subjective descriptions and lack of control group. Furthermore, many factors, such as those pertaining to genetics and the environment, were not considered in our study and may be influential factors on sleep quality (25).

**Conclusion**

This study revealed that depressive symptoms, numbers of chronic disease, self-rated health status and arthritis were the main risk factors that influenced global sleep quality among the middle-aged and elderly who participated in this study.

**List of abbreviations**

PSQI= Pittsburgh Sleep Quality Index；CES-D= Center for Epidemiologic Studies Depression Scale；IPAQ= International Physical Activity Questionnaire；BMI=Body mass index；FFMI=Free Fat Mass Index
Declarations

All authors declare that they do not have any financial motivations or conflicts of interest in relation to the current manuscript.

Ethics approval and consent to participate

The study was approved by the Ethics Committee of the Far Eastern Memorial Hospital (No. 098101-3), and all patients gave written informed consent before they participated in the study.

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Authors' contributions

All authors were involved in the conception, design, data interpretation, manuscript preparation, and conduction of this study and have read and approved the final version of the manuscript.
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environmental influences on different components of the Pittsburgh Sleep Quality Index and their overlap. Sleep. 2010;33(5):659-68. Epub 2010/05/18.
Table 1. Characteristics of the subjects (N = 283)

| Variables                      | Quality of Sleep |
|-------------------------------|------------------|
|                               | N (%)            | good n(%) | poor n(%) | p    |
| **Age (yrs) (59±7.3)**        |                  |           |           |      |
| <65                           | 227 (80.2)       | 161(70.9) | 66(29.1)  | 0.024|
| 65-74                         | 45 (15.9)        | 38(54.4)  | 7(15.6)   |      |
| ≥75                           | 11 (3.9)         | 5(45.5)   | 6(54.5)   |      |
| **Gender**                    |                  |           |           | 0.317|
| Male                          | 60 (21.2)        | 47(78.3)  | 13(21.7)  |      |
| Female                        | 223 (78.8)       | 157(71.2) | 66(22.6)  |      |
| **Religious belief**          |                  |           |           | 0.513|
| No                            | 61 (21.6)        | 46(75.4)  | 15(24.6)  |      |
| Yes                           | 222 (78.4)       | 158(71.2) | 64(28.8)  |      |
| **Smoking history**           |                  |           |           | 0.284|
| No                            | 268(94.7)        | 195(72.8) | 73(27.2)  |      |
| Yes                           | 15 (5.3)         | 9(60.0)   | 6(40.0)   |      |
| **Alcohol use**               |                  |           |           | 0.048|
| No                            | 232 (82.0)       | 162(69.8) | 70(30.2)  |      |
| At least once a week          | 51 (18.0)        | 42(82.4)  | 9(17.6)   |      |
| **Tea use**                   |                  |           |           | 0.407|
| No                            | 116 (41.0)       | 85(73.3)  | 31(26.7)  |      |
| At least once a week          | 167 (59.0)       | 119(72.3) | 48(28.7)  |      |
| **Coffee use**                |                  |           |           | 0.521|
| No                            | 110 (38.9)       | 79(71.8)  | 31(28.2)  |      |
| At least once a week          | 173 (61.1)       | 125(72.3) | 48(27.7)  |      |
| **Regular exercise**          |                  |           |           | 0.526|
| No                            | 143 (50.5)       | 101(70.6) | 42(29.4)  |      |
| Yes                           | 140 (49.5)       | 103(73.6) | 37(26.4)  |      |
| **Chronic disease**           |                  |           |           | 0.025|
| No                            | 121 (42.8)       | 95(78.5)  | 26(21.5)  |      |
| Yes                           | 162 (57.2)       | 109(67.3) | 53(32.7)  |      |
| **Heart disease**             |                  |           |           | 0.017|
| No                            | 250 (88.3)       | 186(74.4) | 64(25.6)  |      |
| Yes                           | 33 (11.7)        | 18(54.5)  | 15(45.5)  |      |
| **Arthritis**                 |                  |           |           | 0.002|
| No                            | 258 (91.2)       | 193(74.8) | 65(25.2)  |      |
| Yes                           | 25 ( 8.8)        | 11(44.0)  | 14(56.0)  |      |
| **Physical activity**         |                  |           |           | 0.903|
| Low                           | 15 (5.7)         | 11(73.3)  | 4(26.7)   |      |
| Moderate                      | 135 (51.1)       | 95(70.4)  | 40(29.6)  |      |
| High                          | 114 (43.2)       | 83(72.8)  | 31(27.2)  |      |
| **Depression symptom**        |                  |           |           | 0.004|
| No                            | 264(94.0)        | 195(73.9) | 69(26.1)  |      |
| Yes                           | 17(6.0)          | 7(41.2)   | 10(58.8)  |      |

*a Chronic disease : Include heart disease and arthritis, hypertension, diabetes mellitus, lung disease, peptic ulcer, liver disease, osteoporosis, gout, cataract, except heart disease and arthritis have significantly, the others haven’t significantly. b mean±SD : 4129.72±4811.94; c CES-D score : 2.74±4.02
Table 2 Distribution of Quality of Sleep

| Variable items                        | n   | %   |
|---------------------------------------|-----|-----|
| Sleep duration (hours)                |     |     |
| 0:≥7                                  | 197 | 69.6|
| 1:6-6.9                               | 66  | 23.3|
| 2:5-5.9                               | 15  | 5.3 |
| 3:≤4.9                                | 5   | 1.8 |
| Sleep disturbance (scores)            |     |     |
| 0:0                                   | 19  | 6.7 |
| 1:1-9                                 | 246 | 86.9|
| 2:10-18                               | 17  | 6.0 |
| 3:19-27                               | 1   | 0.4 |
| Sleep latency (minutes)               |     |     |
| 0:≤15                                 | 142 | 50.2|
| 1:16-30                               | 65  | 23.0|
| 2:31-60                               | 46  | 16.3|
| 3:≥60                                 | 30  | 10.6|
| Daytime dysfunction                   |     |     |
| 0: Very good                          | 213 | 75.3|
| 1: Fairly good                        | 49  | 17.3|
| 2: Fairly bad                         | 19  | 6.7 |
| 3: Very bad                           | 2   | 0.7 |
| Sleep efficiency (%)                  |     |     |
| 0:≥85                                 | 248 | 87.6|
| 1:75-84                               | 23  | 8.1 |
| 2:65-74                               | 7   | 2.5 |
| 3:≤64                                 | 5   | 1.8 |
| Subjective sleep quality              |     |     |
| 0: Very good                          | 32  | 11.3|
| 1: Fairly good                        | 162 | 57.2|
| 2: Fairly bad                         | 63  | 22.3|
| 3: Very bad                           | 26  | 9.2 |
| Use of sleep medication               |     |     |
| 0: Not during past month              | 237 | 83.7|
| 1: Less than once a week              | 10  | 3.5 |
| 2: Once or twice a week               | 7   | 2.5 |
| 3: Three or more times a week         | 29  | 10.2|
| Global sleep quality                  |     |     |
| Good quality (≤5)                     | 204 | 72.1|
| Poor quality (>5)                     | 79  | 27.9|
Table 3 Distribution of health-related fitness between good and poor sleep quality (N=283)

| Variables                        | Mean (SD) | Quality of Sleep | t/p     |
|----------------------------------|-----------|------------------|---------|
|                                  |           | Good             | poor    |         |
| Basic condition                  |           |                  |         |
| Age                              | 58.94(7.61) | 58.99(7.53) | 58.82(7.86) | 0.161/0.872 |
| Depression                       | 2.71(3.96)  | 1.75(3.07)  | 5.16(4.86)   | -5.817/0.000 |
| Chronic disease numbers          | 0.88 (0.92)  | 0.81(0.91)  | 1.05(0.93)   | -1.994/0.047 |
| Self-rate health                 | 13.37 (3.98) | 14.18(3.66) | 11.26(3.92) | 5.849/0.000 |
| Anthropometric index             |           |                  |         |
| BMI (kg/m²)                      | 23.73 (3.36) | 23.88(3.37) | 23.35(3.30) | 1.170/0.243 |
| FFMI                             | 16.60(1.69)  | 16.63(1.74)  | 16.52(1.54) | 0.516/0.606 |
| Mid-arm circumference (cm)       | 29.02 (2.75)  | 29.13(2.77)  | 28.73(2.70) | 1.102/0.271 |
| Waist / hip ratio                | 0.85 (0.08)   | 0.85(0.08)   | 0.85(0.09)  | -0.129/0.898 |
| Physical Fitness                 |           |                  |         |
| Sit-and-reach (cm)               | 8.20 (10.57)  | 8.55(10.38)  | 7.30(11.06) | 0.886/0.376 |
| One leg stance (sec)             | 51.64 (16.34)  | 51.89(16.15) | 51.00(16.89) | 0.407/0.684 |
| Two-min step (times)             | 109.63 (22.10) | 110.89(22.84) | 106.36(19.79) | 1.542/0.124 |
| Chair stand in 30s (times)       | 16.37 (5.07)   | 16.62(4.98) | 15.73(5.28)  | 1.312/0.191 |
| Grip muscle strength (kg)        | 25.68 (8.97)   | 26.25(9.07) | 24.19(8.58)  | 1.724/0.086 |
| Up and go (sec)                  | **6.50 (1.44)**  | **6.39(1.44)** | **6.80(1.43)** | **-2.171/0.031** |
| Back muscle strength (kg)        | 49.94 (22.84)   | 51.15(23.13) | 46.84(21.93) | 1.414/0.158 |

BMI=Body mass index; FFMI=Free Fat Mass Index
Table 4 Pearson correlation between PSQI and health-related fitness

|                                |         |       |
|--------------------------------|---------|-------|
|                                | PSQI    |
|                                | $r$     | $p$   |
| Basic condition                |         |       |
| Age                            | .028    | 0.636 |
| **Depression**                 | **.509**| **0.000** |
| **Self-rate health**           | **-.388**| **0.000** |
| **Chronic disease (Numbers)**  | **0.167**| **0.005** |
| Anthropometric index           |         |       |
| BMI                            | -.043   | 0.476 |
| FFMI                           | .004    | 0.950 |
| Waist / hip ratio              | .023    | 0.694 |
| Physical Fitness               |         |       |
| Sit-and reach                  | -.091   | 0.126 |
| One-leg stand                  | -.109   | 0.068 |
| **Two-min steps**              | **-.156**| **0.009** |
| **Chair stand in 30s**         | **-.172**| **0.004** |
| Grip muscle strength           | -.100   | 0.094 |
| **Up-and-go**                  | **.185**| **0.002** |
| Back muscle strength           | -.092   | 0.125 |
Table 5. Logistic regression analysis of poor sleeping quality of the global score and in 7 components of PQSI (N=283)

| Variables               | Poor sleeping quality | Short sleep duration | Sleep disturbance | Longer sleep latency | Daytime dysfunction | Poor sleep efficiency | Poor subjective sleep quality | Use of sleep medication |
|-------------------------|-----------------------|----------------------|-------------------|----------------------|---------------------|-----------------------|-------------------------------|--------------------------|
| Age                     | 1.005                 | 1.003                | **0.914***        | 0.972                | 1.006               | 1.000                 | 0.989                         | 1.036                    |
| Sex                     | 1.705                 | 3.170                | 2.719             | 0.910                | 0.737               | 2.048                 | 1.352                         | 0.751                    |
| Alcohol use             | 0.571                 | 0.852                | 0.938             | 0.796                | 0.810               | 1.781                 | 0.648                         | 0.398                    |
| CES-D score             | **1.219***            | 1.160*               | **1.208***        | **1.097***           | **1.127***          | 1.000                 | 1.258***                      | 1.143**                  |
| Chronic disease numbers | **0.550***            | 0.426                | 0.911             | 0.627*               | 0.619               | 0.822                 | **0.659***                    | 0.970                    |
| Self-rate health        | **0.860***            | 0.945                | 0.964             | **0.883**            | 0.954               | 0.926                 | **0.855***                    | **0.862***               |
| Arthritis               | **4.369**             | 3.737                | **5.572***        | 1.940                | 2.232               | 2.740                 | 3.014                         | 1.663                    |
| Heart disease           | 2.125                 | 0.000                | 0.927             | 1.355                | 1.863               | 0.000                 | 1.003                         | 2.177                    |
| Two-min step            | 0.997                 | 0.984                | 0.983             | **0.982***           | 1.010               | 0.996                 | 0.993                         | 0.994                    |
| Chair stand in 30s      | 1.021                 | 0.993                | 0.978             | 1.028                | 0.907               | 1.027                 | 0.993                         | 0.972                    |
| Up-and-go               | 1.147                 | 1.210                | 1.423             | 1.087                | 1.033               | 1.124                 | 1.083                         | 0.969                    |
| Constant                | 0.360                 | 0.086                | 2.249             | 26.226               | 0.131               | 0.063                 | 5.119                         | 0.373                    |

Note: *p<0.05, **p<0.01, ***p<0.001