Estimating Ideal Sleep Duration by Physical Fitness in South Korean Adults: A Correlational Epidemiological Study

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Abstract
This study aimed to verify the relationship between ideal sleep duration and physical fitness in South Korean adults and older adults. The secondary analysis data of 2,832 adults (19–64 years) and 629 older adults (65 years and above), obtained from the 2015 National Fitness Survey, were analyzed. Participants completed various physical fitness tests (grip strength, sit-ups, standing long jump, 50 m dash, sit-and-reach, and 20 m shuttle run in adults; grip strength, sit-up, sit-to-stand, sit-and-reach, back-scratch, one-leg standing test, and 6-minute walk in older adults) and were divided into four groups based on self-reported sleep duration. Group differences in physical fitness variables were analyzed with one-way analysis of variance, and Pearson’s correlation was used to verify the relationship between sleep duration and physical fitness; statistical significance was set at \( p < .05 \). In adult males, there was a positive correlation between explosive muscular strength (standing long jump) and sleep duration \( (p = .046) \), whereas in adult females, there was a negative correlation between cardiopulmonary endurance (20 m shuttle run) and sleep duration \( (p = .026) \). However, in older adults, there was no significant correlation between sleep duration and physical fitness \( (p > .05) \). Further, across the sample, there were no significant group differences in physical fitness variables. A positive correlation exists between sleep duration and muscular strength in adult males and a negative correlation between sleep duration and cardiopulmonary endurance in adult females. Designing sleep and exercise programs based on these results may improve physical fitness among adults and older adults. Future studies that include controlled variables that affect physical fitness and sleep patterns are warranted.

Keywords
adult, exercise, fitness, older adult, South Korean, sleep

Introduction
During sleep, the human organism physically restores itself, removing metabolic wastes that have built up during periods of activity (Parmeggiani & Velluti, 2005). Further, sleep facilitates the synthesis of molecules that help repair and protect the brain from harmful elements generated during waking (Siegel, 2005). Therefore, inadequate sleep causes many health problems. A previous study found that people who reported sleep durations of less than 5 hours were 1.5 times more likely to have metabolic syndrome than those with sleep durations greater than 5 hours (Iftikhar et al., 2015). Long periods of inadequate sleep increase the risk of metabolic disease and even death (Cappuccio et al., 2010).

In 2015, South Korea’s average sleep duration was the lowest among the 18 countries surveyed by the Organization for Economic Cooperation and Development (Jun, 2017). In general, there is a trend in South Korea of reducing sleep time to allow for incorporating various tasks into the day, which is detrimental to health and fitness. The number of South Korean adults with short sleep durations is increasing, and individuals with daily sleep durations of less than 6 hours are at a higher risk for metabolic syndrome than those with more than 6 hours (Kim, 2018; Park, 2016). Furthermore,
people with short sleep durations appear to exhibit higher chronic psychological stress (Glozier et al., 2010).

However, inadequate sleep is not the only problem; excessive sleep can also result in health problems. In a previous study, an increase in sleep duration of up to 9.9 hours was associated with a rise in testosterone; subsequently, testosterone levels decreased, resulting in an inverted U-shaped relationship (Auyeung et al., 2015). Similarly, decreased muscle power may mediate and/or confound the relationship between long sleep durations and adverse health outcomes in older adults (Chen et al., 2017).

The correlation between sleep and fitness level has been reported to differ by individual fitness variables. A study of 108 female older adults in South Korea found that the group that received over 8 hours of sleep displayed higher muscle strength, endurance, balance, walking ability, and cardiopulmonary endurance than the groups that received under 6 hours and 6 to 8 hours of sleep. However, flexibility was highest in the group that received 6 to 8 hours of sleep (Park, 2014). In contrast, in a study of 4,707 South Korean adults, sleep duration exceeding 7 hours was associated with a weaker grip (Jang et al., 2019).

As such, the results of studies on sleep time and fitness factors have been inconsistent. Further, there are few studies on the correlation between sleep duration and individual physical fitness variables in South Korea. Therefore, this study aimed to (1) analyze physical fitness in participants divided into groups based on sleep duration (≤4, 5–6, 7–8, and ≥9 hours) and (2) verify the correlation between sleep duration and physical fitness by sex in South Korean adults and older adults at a national level.

To this end, we proposed the following hypotheses:

\( \text{H}_1: \) Variation in sleep duration produces statistically significant differences in physical fitness among South Korean adults and older adults, including in muscular strength, muscular endurance, explosive muscular strength, speed, flexibility, and cardiopulmonary endurance.

\( \text{H}_2: \) Depending on sleep duration, there are statistically significant differences in physical fitness among South Korean adults and older adults, including in muscular strength, muscular endurance, explosive muscular strength, flexibility, balance, and cardiopulmonary endurance.

**Methods**

**Ethics Statement**

The National Fitness Survey was approved by the Korea Institute of Sport Science and Korea Ministry of Culture, Sports, and Tourism. The study was deemed to not require ethics approval as it is a secondary data analysis. The study was conducted in accordance with the principles outlined in the Declaration of Helsinki.

**Design**

This study employed a cross-sectional epidemiological design.

**Sample**

We obtained data from the National Fitness Survey 2015 conducted by the Korea Institute of Sport Science. The National Fitness Survey 2015 analyzed the data of 2,832 adults (age range 19–64 years) and 629 older adults (above 65 years). In the current study, we used data pertaining to height, weight, and body mass index. Identifying information, such as names, telephone numbers, home addresses, and social security numbers, was not collected. There were no specific inclusion criteria; however, we excluded from the analysis active-duty military and public-service personnel, full-time reserve service personnel, combat police (including auxiliary police), prison inmates with confirmed sentences, inmates in juvenile detention centers and treatment detention centers, prison guards, and the mentally and physically disabled. Figure 1 shows the selection of participants and data collection process for this study.

**Independent Variables**

Sleep duration was determined through self-report. Based on the responses to the question “How many hours a day do you sleep on an average?”, participants were categorized into four groups: ≤4, 5 to 6, 7 to 8, and ≥9 hours.

**Dependent Variables for Physical Fitness Examination**

In the National Fitness Survey 2015, the following dependent variables were used to determine physical fitness levels.

Muscular strength: To perform a grip strength test, participants were instructed to wrap the second knuckle of a finger around a Smedley-type dynamometer (Smedley YD-100; Yagami, Tokyo, Japan) and pull with full strength. The test was conducted with the dominant hand, and the result was recorded as a unit of 0.1 kg. The test was carried out twice, and the higher figure was recorded.

Muscular endurance: Adults were asked to perform sit-ups for 1 minute. Participants were instructed to lie on their backs on a mat, with a distance of 30 cm between their feet, knees bent at a right angle, and hands behind the head with fingers locked together. As an assistant pressed participants’ ankles against the floor with both hands, they raised their upper bodies until both elbows touched both knees and then returned to lying on their backs.

For older adults, muscular endurance was assessed with the sit-to-stand test. Participants were instructed to cross their arms on their chest, straighten their backs, and sit on a
The chair was fixed to the floor and participants’ feet remained in contact with the ground. When they were instructed to start, participants had to stand up completely, followed by completing a sitting motion. Each participant’s score consisted of the number of repetitions of this movement completed in 30 seconds.

Explosive muscular strength: The standing long-jump test was used to evaluate explosive muscular strength in adults. Participants were instructed to jump forward as far as possible; the distance from the starting line to the landing point of the nearest heel was measured. The test was carried out twice, and the higher figure was recorded.
Speed: A 50-m dash was used to evaluate adults’ speed. Participants were instructed to run the 50-m distance as quickly as possible. The time was measured to the nearest 0.1 second.

Flexibility: The sit-and-reach test was conducted among the adults and older adults. Participants were instructed to remove their shoes and sit with knees fully extended, ensuring that their feet completely touched the vertical plane of the measuring plate. Then, they were instructed to extend both hands along a measuring ruler and bend forward as far as possible. The test was carried out twice, and the better result was recorded to a resolution of 0.1 cm.

To evaluate older adults’ flexibility, we also used the back-scratch test. Participants were instructed to stand, with one elbow facing up, and stretch the fingers as far as possible toward the middle of the back. The palm of the other hand was on the back of the waist; the goal was to touch or overlap the middle fingers of both hands. Disregarding hand alignment we measured the distance between the two middle fingers. If the middle fingers did not touch, participants received a negative score equal to the separation distance. We assigned a score of 0 if the middle fingers touched, and if the middle fingers overlapped, the score was equal to the length of the overlap. The test was carried out twice, and the better result was recorded to 0.1 cm resolution.

Cardiopulmonary endurance: A 20-m shuttle run test was used to evaluate adults’ cardiopulmonary endurance. Participants were instructed to run through a defined 20-m section and arrive at the second marker before a beep sounded. At the beep, the participants reversed their direction to return to the initial marker. This continued until the participant was unable to reach the required marker before the subsequent beep. As the test progressed, the time between beeps became shorter. The number of round trips was recorded.

For older adults, a 6-minute walk test was performed. Older adults often have limitations in daily life due to a decrease in physical strength or walking ability. Therefore, this test is useful in evaluating not only overall endurance, which is important for long-distance walking and climbing stairs, but also the activity ability of older adults. In the test, participants were instructed to try walking as fast as possible for 6 minutes. Each participant’s total distance traveled was recorded.

Equilibrium: The one-leg standing with eyes open test was used to evaluate equilibrium in older adults. Participants were instructed to stand on one foot and lift both arms parallel to the ground, and we measured the duration for which the participant successfully remained in the posture. The test was carried out twice and the longer duration was recorded to a 0.1-second resolution.

Statistical Analysis

Continuous variables were expressed as mean and standard deviation and categorical variables as number (%). Body mass index was calculated by dividing weight (kg) by height (m²). One-way analysis of variance was performed to identify mean differences in physical fitness among the four sleep duration groups. We also conducted Pearson’s correlation analysis to compare sleep duration with physical fitness by sex among adults and older adults. All statistical analyses were conducted using SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA). The alpha level for all analyses was set at .05.

Results

The data of 2,832 adults (19–64 years) and 629 older adults (aged over 65) were analyzed. Tables 1 and 2 present the descriptive statistics for each physical fitness variable and the number (%) of participants in each sleep duration group. We found that 1.7% of the adults and 5.1% of older adults in the study had a sleep duration of ≤4 hours, 2.6% of adults and 1.9% of older adults slept ≥9 hours, and 51.1% of adults and 40.9% of older adults achieved the optimal sleep duration of 7 to 8 hours.

As depicted in Tables 3 and 4, there were no statistically significant differences in sleep duration between adults and older adults. Among males, there was a positive correlation between the result of the standing long jump test and sleep duration (p < .05; Table 5). Among females, there was a negative correlation between the result of the 20-m shuttle run and sleep duration (p < .05; Table 5). Among older adults, there was no statistically significant correlation between any of the fitness variables and sleep duration (Table 6).

Discussion

The aim of this study was to verify the relationship between sleep duration and physical fitness in South Korean adults and older adults. In adult males, sleep duration was positively correlated with explosive muscular strength (standing long jump). A previous study (Knowles et al., 2018) found that one-time sleep deprivation reduced the muscle strength exerted during strength training, and that continued sleep deprivation could reduce the force exerted at multiple joints in the human body. However, the results of this study suggest that sleep duration is significant with explosive muscular strength. Because explosive muscular strength is important for producing a high velocity when rapidly changing direction or accelerating in various sports (Newton & Kraemer, 1994), adequate sleep is beneficial for participation in sports activities that involve skills such as throwing a ball or jumping long distances. Furthermore, the results of the study indicate that the quickness resulting from adequate sleep could also help prevent accidents. In females, we observed a negative correlation between sleep duration and cardiopulmonary endurance (20 m shuttle run). As a corollary to the finding that short sleep duration increases the incidence of cardiovascular disease (Tobaldini et al., 2017), this study suggests
that excessive sleep can also decrease cardiorespiratory endurance in women. However, it is necessary to longitudinally study the cardiorespiratory endurance of women who sleep excessively and the possibility of cardiovascular disease. Generally, among adults, cardiopulmonary endurance increased from the group with ≤4 hours to the group with 5 to 6 hours of sleep but declined in participants with sleep durations of >7 hours. Among older adults, cardiopulmonary endurance (6-minute walk) increased from the group with a sleep duration of ≤4 hours to those with 5 to 6 hours, after which endurance decreased in the group with 7 to 8 hours of sleep, with no major subsequent changes. This result is similar to the finding of a previous study wherein long-duration sleep was associated with high lower-body endurance in older adults (Lee et al., 2020). However, further research is needed to determine whether long-duration sleep is appropriate for adults who engage in aerobic exercise like jogging or who perform jobs requiring cardiopulmonary endurance.

Muscular strength (grip strength) decreased with a sleep duration of more than 5 to 6 hours in adults, whereas strength increased with increase in sleep duration among older adults. According to previous studies, for both males

| Table 1. Characteristics of Adult Participants. |
|------------------------------------------------|
| Variables | Males (n = 1,683) | Females (n = 1,149) | p-Value |
| Age (years) | 38.17 ± 12.71 | 39.43 ± 13.10 | .010* |
| Height (cm) | 173.11 ± 6.11 | 160.03 ± 5.70 | <.001*** |
| Weight (kg) | 73.15 ± 9.71 | 56.99 ± 7.70 | <.001*** |
| Body mass index (kg/m²) | 24.39 ± 2.85 | 22.27 ± 2.95 | <.001*** |
| Grip strength (kg) | 42.75 ± 9.09 | 25.01 ± 5.98 | <.001*** |
| Sit-up (reps/60 seconds) | 34.75 ± 11.94 | 20.98 ± 12.37 | <.001*** |
| Standing long jump (cm) | 197.71 ± 31.59 | 139.83 ± 26.25 | <.001*** |
| 50m dash (seconds) | 8.89 ± 1.69 | 11.34 ± 2.00 | <.001*** |
| Sit-and-reach (cm) | 9.37 ± 8.42 | 14.70 ± 8.25 | <.001*** |
| 20m shuttle run (seconds) | 32.87 ± 17.15 | 18.14 ± 8.26 | <.001*** |

Sleep duration (hours)

| ≤4 | 31 (1.84) | 18 (1.57) |
| 5–6 | 771 (45.81) | 492 (42.82) |
| 7–8 | 843 (50.09) | 603 (52.48) |
| ≥9 | 38 (2.26) | 36 (3.13) |

Note. Values are expressed as mean ± standard deviation or n (%).
* p < .05, *** p < .001; tested by independent t-test.

| Table 2. Characteristics of Older Adult Participants. |
|------------------------------------------------|
| Variables | Males (n = 264) | Females (n = 365) | p-Value |
| Age (years) | 72.20 ± 5.24 | 73.60 ± 5.87 | <.001*** |
| Height (cm) | 165.79 ± 5.52 | 153.85 ± 5.49 | <.001*** |
| Weight (kg) | 66.38 ± 7.98 | 56.67 ± 7.20 | <.001*** |
| Body mass index (kg/m²) | 24.13 ± 2.43 | 23.94 ± 2.84 | <.001*** |
| Grip strength (kg) | 32.14 ± 7.69 | 20.48 ± 5.40 | <.001*** |
| Sit-up (reps/60 seconds) | 13.30 ± 9.98 | 5.32 ± 7.44 | <.001*** |
| Sit-to-stand (reps/30 seconds) | 19.31 ± 7.75 | 16.22 ± 6.42 | <.001*** |
| Sit-and-reach (cm) | 4.30 ± 9.01 | 10.61 ± 8.58 | <.001*** |
| Back-scratch (cm) | −9.51 ± 12.32 | −3.90 ± 10.13 | <.001*** |
| One-leg standing test with eyes open (sec) | 33.23 ± 35.19 | 22.35 ± 25.91 | <.001*** |
| 6-minute walk (m) | 553.50 ± 123.90 | 485.68 ± 135.59 | <.001*** |

Sleep duration (hours)

| ≤4 | 11 (4.17) | 21 (5.75) |
| 5–6 | 127 (48.11) | 196 (53.70) |
| 7–8 | 116 (43.94) | 141 (38.63) |
| ≥9 | 10 (3.79) | 7 (1.92) |

Note. Values are expressed as mean ± standard deviation or n (%).
**p < .001; tested by independent t-test.
and females, inappropriate sleep durations, whether too short or too long, predict weaker subsequent grip strength and a faster rate of decline in hand grip strength over time, according to an inverted U-shape relationship (Chen et al., 2017; Wang et al., 2018). Our study provided different results, and further investigations with additional variables are necessary. For adults and those engaged in occupations involving high-intensity physical activity, excessive sleep can have adverse effects. Furthermore, muscular strength, including grip strength, is associated with mortality (Gale et al., 2007). Therefore, in older adults, sufficient sleep can slow muscle strength reduction and thus help prevent falls and other injuries.

Muscular endurance (sit-up test) decreased in adults who slept more than 5 to 6 hours per night. In older adults, muscular endurance (sit-up, sit-to-stand) decreased in individuals with > 7 hours of sleep. Although the differences between groups by sleep duration were modest, endurance is required for numerous postural muscles, such as the vertebral erectus, abdominals, and gluteal muscles, especially for workers who spend long hours standing or being sedentary (Baldwin et al., 1994; Takala & Viikari-Juntura, 1991). Therefore, adequate sleep is essential for maintaining muscle endurance.

Speed (50-m dash) sharply decreased in adults from the group with ≤4 sleeping hours to the group with 5 to 6 sleeping hours; small increases were observed in the other groups. Although sprinters can modify their sleep duration in preparation for competitions, 4 hours of sleep is unhealthy: Sleep loss has been found to be detrimental to cognitive performance and mood stability, which could hinder the neurocognitive components of many sports. Although sleep is generally considered critical for human and athletic performance, the current scientific literature shows mixed results regarding objective performance decrements (Fullagar et al., 2015); thus, more studies are needed to determine the appropriate sleep duration to optimize speed.

Lower-body flexibility (sit-and-reach) increased from adults with sleep durations of ≤4 hours to those with 5 to 6 hours, remained constant from 5–6 hours to 7–8 hours, and then increased again from 7 to 8 hours. Based on this result in adults, short sleep duration could result in lower flexibility, which causes several musculoskeletal disorders like osteoarthritis and muscle soreness in everyday life (Messier et al., 1992; Williford et al., 1986). However, older adults’ lower-body flexibility (sit-and-reach) produced the opposite results to that of adults. Further, shoulder flexibility (back-scratch test) was greatest among those with sleep durations of 5 to 6 hours and ≥9 hours, followed by 7 to 8 hours and ≤4 hours. Although our results regarding adults are similar to those of a previous study, this was not the case with older adults. In previous work, those who performed well on the back-scratch and chair-sit-and-reach tests were more likely than average to sleep longer than 8 hours a day (Lee et al., 2020). As such, the relationship

### Table 3. Results of Physical Fitness Tests by Sleep Duration in Adults.

| Variables                        | ≤4 (n = 49) | 5–6 (n = 1,263) | 7–8 (n = 1,446) | ≥9 (n = 74) | Overall F | Overall p |
|----------------------------------|-------------|-----------------|-----------------|------------|-----------|-----------|
| Grip strength (kg)               | 35.9 ± 12.48| 35.95 ± 35.32   | 35.32 ± 11.62   | 33.07 ± 11.02 | 1.764     | .152      |
| Sit-up (reps/60 seconds)         | 28.65 ± 14.40| 29.36 ± 13.73   | 29.03 ± 13.82   | 28.84 ± 16.95 | 0.165     | .920      |
| Standing long jump (cm)          | 165.78 ± 46.09| 174.51 ± 40.97   | 174.55 ± 40.62   | 168.79 ± 44.64 | 1.178     | .317      |
| 50 m dash (seconds)              | 10.25 ± 2.05 | 9.86 ± 2.22     | 9.88 ± 2.17     | 9.99 ± 2.09  | 0.565     | .638      |
| Sit-and-reach (cm)               | 10.51 ± 9.16 | 11.49 ± 8.76     | 11.54 ± 8.70     | 12.77 ± 9.32  | 0.729     | .535      |
| 20 m shuttle run (seconds)       | 23.39 ± 11.53| 27.2 ± 16.06     | 26.79 ± 15.90    | 25.94 ± 17.80 | 1.053     | .368      |

Note. Values are expressed as mean ± standard deviation. Tested by one-way analysis of variance.

### Table 4. Results of Physical Fitness Tests by Sleep Duration in Older Adults.

| Variables                        | ≤4 (n = 32) | 5–6 (n = 323) | 7–8 (n = 257) | ≥9 (n = 17) | Overall F | Overall p |
|----------------------------------|-------------|--------------|--------------|------------|-----------|-----------|
| Grip strength (kg)               | 24.44 ± 7.00| 24.88 ± 8.57 | 25.84 ± 8.76 | 29.46 ± 10.34 | 2.000     | .113      |
| Sit-up (reps/60 seconds)         | 6.50 ± 7.67 | 8.76 ± 9.51  | 9.01 ± 9.63  | 5.82 ± 8.26  | 1.198     | .310      |
| Sit-to-stand (reps/30 seconds)   | 15.97 ± 8.29| 17.24 ± 7.19 | 18.23 ± 6.98 | 14.88 ± 6.21 | 2.285     | .078      |
| Sit-and-reach (cm)               | 9.86 ± 10.92| 7.97 ± 9.05  | 8.02 ± 9.30  | 3.25 ± 9.75  | 1.915     | .126      |
| Back-scratch (cm)                | -7.55 ± 10.94| -5.74 ± 11.26 | -6.76 ± 11.46| -5.89 ± 15.20 | 0.529     | .663      |
| One-leg standing test (seconds)  | 24.96 ± 32.35| 25.92 ± 28.80 | 28.79 ± 32.72 | 21.03 ± 28.12 | 0.688     | .559      |
| 6-minute walk (m)                | 480.56 ± 142.83| 519.94 ± 127.78 | 511.26 ± 143.20 | 510.88 ± 123.87 | 0.902     | .440      |

Note. Values are expressed as mean ± standard deviation. Tested by one-way analysis of variance.
between sleep time and flexibility needs to be studied in consideration of more diverse variables.

Finally, balance (one-leg standing with eyes open for older adults) increased from the group with \( \leq 4 \) sleeping hours to the group with 7 to 8 sleeping hours, after which it sharply decreased. For people over 60, the progression of functional degradation is accompanied by an imbalance in everyday activities, difficulties in independent ambulation, and an increased likelihood of falls (Hobeika, 1999). Therefore, we conclude that excessive sleep of more than 8 hours is detrimental to older adults’ sense of balance and increases their risk of falling. In summary, we identified a relationship between explosive muscular strength, cardiopulmonary endurance, and sleep duration. While the other fitness variables showed insignificant differences, in competitive sports and medical treatment, even minute variations are meaningful.

This study has some limitations. Owing to the use of cross-sectional data, it is difficult to establish causality in the relationship between sleep and each physical fitness variable. Further, sleep quality was not taken into consideration; the focus was only on sleep time. To determine the ideal sleep duration, qualitative aspects of sleep should be considered and daily sleep patterns should be closely analyzed. Future studies aiming to encourage ideal sleep habits should consider not only optimal sleep duration but also individuals’ sleep homeostasis characteristics (Kitamura et al., 2016). Moreover, follow-up studies should additionally consider demographic characteristics, including sleep quality and the subject’s occupation. Moreover, well-designed studies including controlled variables which affect physical fitness and sleep patterns are warranted in the future. However, as this study examined the relationship between various physical fitness variables and sleep duration in a large sample of adults recruited through a reliable institution, the results are likely representative of all adults in South Korea.

### Conclusion

Based on our results, we may conclude that longer sleep duration in adult males and females is associated with more explosive muscular strength and lower cardiopulmonary endurance, respectively. Thus, we conclude that to improve adults’ fitness, it is important to not only implement well-designed exercise programs but also encourage suitable sleep duration. In older adults, we found neither a significant correlation between sleep duration and fitness variables nor a significant difference in fitness variables between sleep duration groups. The sleep duration groups differed in terms of which exhibited the highest performance on each of the fitness variables; thus, an ideal sleep duration by physical fitness level is not supported by this study. Therefore, to establish more detailed causal relationships between sleep duration and fitness variables, further research that accounts for sleep quality and patterns is required.

### Table 5. Pearson’s Correlations Between Sleep Duration and Physical Fitness in Adults.

| Variables                     | Sleep duration in males (\( n = 1,683 \)) | Sleep duration in females (\( n = 1,149 \)) |
|-------------------------------|--------------------------------------------|---------------------------------------------|
| Grip strength (kg)            | \(-.033\)                                  | \(.027\)                                    |
| Sit-up (reps/60seconds)       | \(.039\)                                    | \(-.031\)                                  |
| Standing long jump (cm)       | \(.049\) \(*\)                             | \(.019\)                                    |
| 50 m dash (seconds)           | \(-.047\)                                  | \(.002\)                                    |
| Sit-and-reach (cm)            | \(.031\)                                    | \(-.031\)                                  |
| 20 m shuttle run (seconds)    | \(.041\)                                    | \(-.066\) \(*\)                            |

*\( p < .05 \); tested by Pearson’s correlation.

### Table 6. Pearson’s Correlations Between Sleep Duration and Physical Fitness in Older Adults.

| Variables                      | Sleep duration in males (\( n = 264 \)) | Sleep duration in females (\( n = 365 \)) |
|--------------------------------|------------------------------------------|---------------------------------------------|
| Grip strength (kg)             | \(.062\)                                  | \(.015\)                                    |
| Sit-up (reps/60seconds)        | \(-.001\)                                  | \(-.040\)                                  |
| Sit-to-stand (reps/30seconds)  | \(.046\) \(*\)                             | \(.023\)                                    |
| Sit-and-reach (cm)             | \(-.012\)                                  | \(-.043\) \(*\)                            |
| Back-scratch (cm)              | \(.052\)                                    | \(-.041\) \(*\)                            |
| One-leg standing test with eyes open (seconds) | \(.035\) \(*\)                              | \(-.006\)                                    |
| 6-minute walk (m)              | \(.013\) \(*\)                             | \(-.037\) \(*\)                            |

Note. Tested by Pearson’s correlation.
Declaration of Conflicting Interests
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