Comparison of Perceived and Objectively Measured Sleep Quality Among Elite Rowing Athletes

Sait AYAR*, Kursat KARACABEYb, Aykut AKSUc and Ahmet AYARD

a Republic of Turkey Ministry of National Education, Istanbul, Turkiye
bFaculty of Sports Science, Adnan Menderes University, Aydin, Turkiye
cIzmir Kavram Vocational School, Izmir, Turkiye
dKaradeniz University, Department of Physiology, Faculty of Medicine, Trabzon, Turkiye

ARTICLE INFORMATION
Original Research Paper
Doi: 10.26655/IJAEP.2019.9.12
Received August, 2019
Accepted September, 2019

Keywords:
Sleep, Sleep quality, Rowers, Sport.

ABSTRACT
There suggested to be a reciprocal relationship between sleep and exercise capacity, as physical activity is considered to be beneficial for improved sleep quality especially in those with sleep problems while adequate sleep increases exercise capacity and reduces risk of exercise-induced injuries. But the exact mechanism of this relationship and whether being engaged with every kind of sport branch is beneficial to sleep quality is not clear yet. Yet, the demands and expectations from modern people including elite athletes have placed increasing demands by cutting back on sleep despite scientific research is revealing that sufficient sleep is critical for safety, performance and productivity and the cost of insufficient sleep is well beyond than most people recognize. The aim of this study was to investigate profiles of sleep quality in rowing athletes. For this purpose, profiles of sleep quality, both objectively and subjectively assessed in 30 elite male rowing athletes (mean age 19.36±4.1 years) and age (22.20±2.5 years) and gender-matched non-athlete sedentary control individuals. Subjective sleep quality was evaluated using the the Pittsburgh Sleep Quality Index (PSQI); while a metabolic holter (SenseWear armband) was used for obtaining objective sleep quality related parameters. Independent t-test was used for comparing sleep quality between the group means. Statistical significance was set at p<0.05. In elite rower athletes, the means of sleep duration (according to metabolic holter: 442±56 min; according to PSQI: 449±37, p>0.05) and sleep efficiency [(in athletes 85.5±5.0%; in sedentary group 75.9±8.5 % (n=30)] (P<0.05) was better than sedentary individuals. The findings of the present study indicate that both objective and subjective sleep quality of elite rowers was significantly better than non-athlete sedentary controls.

1. Introduction
Sleep is a highly vital phase that comprises of approximately one third human life. Sleep has a critical importance with respect to lifelong physical and mental health. There is a multi-faceted relationship between sleep - specifically adequate and quality of sleep- and exercise.1,2,3

Compared to non-athletes; sleep is more critical for athletes in terms of individual benefits and necessity; in that sleep being one of the most important factors that create a difference from the point of “win” or “lose” by providing both mental and physical rest, recovery and renewal components for athletes1,4. Many athletes recognize the importance
of proper nutrition, hydration (fluid intake) and relaxation for optimum performance but the importance of sleep has not received deserved attention in this respect\textsuperscript{1,5}.

Sleep provides opportunity for the bodily structures that experience overstretch, fatigue or even injuries resulting from sports competitions or intensive training sessions, by increasing blood flow towards these structures accompanied by elimination of stress. Sleep not only has a critical importance for athlete’s performance from a recovery aspect -in terms of having a more fit body- but also for “muscle memory” aspects (learning of novel moves, activities, techniques and tactics through training and repetition). Therefore in order for attaining the maximum benefit from training sessions, for acquiring the presented novel techniques and tactics and efficiently realizing all of these, the highly contributory effect and even the need of sleep after these sessions was proven by scientific evidence even for elite athletes\textsuperscript{3,6}. This is because the information related to recently acquired motor skills and movements (e.g. a new move, tactic or technique related to sports) that are stored within hippocampal region of the brain is transmitted to the neocortex region during sleep, allowing such information to be recalled for extensive periods of times and even allowing them to be subconsciously realizable\textsuperscript{6}. It is a recognized fact that concepts exercised or learned during wakefulness is repetetively broadcasted during REM sleep charactered by rapid eye movements, as though by slow motion from a “videotape”. As a matter of fact, learning is more efficient during this stage, since there are no distracting factors. Hence, athletes should be experiencing both adequate and quality sleep that includes a sufficient REM phase, in order both for retaining all their physical, technical and tactical performances and improving all these. Brains of athletes that lack adequate levels of REM sleep is adversely affected such that they function abnormally. To clarify, hippocampal region of an individual that lacks adequate REM sleep functions less, whereas the regions containing amygdala function more. Since amygdala is related to anger and offensivenes, performance and success of athletes that suffer from sleep deprivation is adversely affected from their offensive and angry moods instead of having a positive mentality that is of vital importance regarding athletes. It is also known that sleep deprivation adversely affects reaction time, motivation and concentration of athletes. Considering all these facts, numerous prescribed drugs, medical tools and traditional methods exist for treatment of sleep disorders. However no reliable solution with an acceptable efficiency and reliability in terms of side effects is present. At this point, exercise emerges as a totally different option, being a convenient, safe, efficient and most important of all “medication free” approach\textsuperscript{7}. Still, despite the recognized fact that sleep and exercise reciprocally affect each other, the underlying mechanism has not been clearly and expressly identified. As soon as the intensity and duration of exercise that contributes to sleep quality most significantly would be identified; exercise could be “prescribed” to individuals suffering from sleep disorders, just like any other medication, plus within a personalized plan. On the other hand, though sleep is accepted to be an important concept regarding learning, growth, performance and sustaining a long & healthy life; sleep related concepts and issues for each sports branch were not identified in whole detail.

Rowing is a branch of sport that is performed by using almost all bodily muscles, mainly being the arms, legs, lumbar and abdominal muscles. Being a sports branch that requires balance, flexibility and coordination, rowing also calls for a high degree of concentration for attaining synchronization within the team. Being listed among Olimpic competitions, aerobic capacity required for rowing athletes is at the same level required for “cross-country skiing”. On the other hand, this branch of sports performed as a recreational activity by men and women of all ages, is recommended to injured individuals or individual that went through surgery for rehabilitation purposes. Identification of this sport’s effect on sleep is thus important both for better understanding the reflections of sleep on athletes’ competition performances and for providing possible scientific evidence for the recommendability of rowing to individuals suffering from sleep disorders as a recreational activity in case its enhancing effect on sleep quality would be established. It was thus aimed to investigate the sleep quality of individuals performing rowing, within the scope of this research.
2. Material and methods

2.1. Participants

**Study Group:** Study universe consisted of rowing athletes from Sakarya Youth Services, Provincial Directorate of Sports / Olympics Preparation Center of Turkey (TOHM), National Rowing Team Camps and national rowing athletes from Trabzon Karadeniz Technical University’s School of Medicine, and sedentary individuals. The sample group consisted of 30 national rowing athletes with a mean age of 19.36±4.1 and 30 sedentary individuals with a mean age of 22.20±2.5 that accepted filling in the PSQI survey and wearing the Metabolic Holter (SenseWear Armband) device for the determined period on a voluntary basis, and that signed the informed consent form after being informed on the research.

The Clinical Research Ethics Committee in Medical Faculty of Duzce University approved the study in accordance with the policy statement of the Turkey Ministry of Health.

3. Experimental procedure

3.1. Exercise intervention

**Measurement Tool:** Pittsburgh Sleep Quality Index is a self-reported scale that subjectively evaluates sleep quality and sleep disorders within a period of one month. PSQI was constructed by Daniel Buysse et al. from Pittsburgh School of Medicine in year 1989\(^8\). PSQI determines the sleep duration, delay of sleep, sleep latency, sleep efficiency, sleep disorders, utilization of sleep medication; along with severity and frequency of problems specific to sleep. By using PSQI that evaluates poor and fine sleep quality in a valid and standardized way, participants were asked to evaluate their sleep related issues corresponding to the previous month. PSQI is a convenient tool for evaluation of sleep quality that can be easily and rapidly utilized. With its provision of a standardized subjective assessment regarding sleep, PSQI makes a valid and reliable differentiation between fine and poor quality sleep\(^9\). 19 of the 24 questions of the scale were self-reported questions, whereas the remaining 5 were prepared to be responded by participant’s partner or room mate. These aforementioned five questions were only for the purpose of obtaining clinical information and were not included in the evaluation process. Last of the self-reported questions (Question no. 19) inquired the presence of a room mate and was not considered while determining the scale’s total elemental score. 18 questions of the scale that were being scored consisted of 7 factors, namely: Subjective sleep quality, sleep latency, sleep duration, habitualized sleep activities, sleep disorders, utilization of sleep medication, and daytime functioning disorders. Some of these factors were represented by a single question with regaring scoring of scale, whereas some others were represented by a group of several questions. Each of the factors were evaluated within the range of 0-3 points. Total points obtained from all 7 factors constituted total score of the scale and had a value within the range of 0-21. Higher scores indicated poor sleep quality. Having a total scale score less than 5 points indicated a good quality sleep, whereas a score higher than 5 indicated poor sleep quality. General Cronbach’s alpha coefficient of the scale was obtained to be 0.804; whereas Cronbach’s alpha coefficient for factors was found to be ranging between 0.35-0.92. Total score correlation coefficients of factors, on the other hand were found to be between 0.22-0.77. Test-retest reliability was found to be within the range of 0.93-0.98. Validity and reliability studies for adaptation to our country were conducted by Ağargün, Kara and Anlar\(^10\).

Metabolic Holter (SenseWear Armband) Device, Surveys, Polysomnography and Actigraphy can be utilized for measurement of sleep related concepts. Polysomnography is a time consuming and expensive invasive method that is utilized in specialized departments of hospitals. Actigraphy is a relatively cheaper, non-invasive method compared to Polysomnography that patients can use without disturbance to their daily lives. Actigraphy is offered in various forms such as the Actiwatch that is worn on the wrist, and Armband that is worn on upper part of the arm\(^11\).

SenseWear Armband is a metabolic, physical activity and lifestyle monitor that is globally used for clinical and research studies. SenseWear Armband is a multi sensor body monitor that can continuously collect lifestyle data up to...
two weeks. It calculates energy consumption, metabolic and physical activity within a free living environment, when worn on the triceps of the right arm\(^\text{12}\).

Operating on ultimately sensitive sensors that are also used for lie detectors, SWA detects even the smallest temperature change in the body and records the moment of activity. Thanks to its triaxial accelerometer, SenseWear Armband collects objective data on duration and intensity of physical activity, total energy consumption, duration and quality of sleep by measuring parameters such as the skin temperature, temperature change and galvanical skin reaction\(^\text{13}\).

With the help of embedded algorithms, SWA gathers information on commencement of sleep, depth of sleep and evaluation of sleep by sensing the changes in body temperature; and this information provides an opportunity with respect to clinical assessment. SWA allows for circadian rhythm monitoring in the long run.

In order for obtaining better data from the SWA utilized throughout the study, it was found better that the participants should wear the armbands for three consecutive days. National athletes and sedentary individuals to take part in the study were informed that they should wear the device on their right arms for the period defined, and that they should only take it off during daily bath for a period that does not exceed one hour. Data was collected by national rowing athletes and sedentary individuals wearing the SWA for three consecutive days. Collected data was then uploaded to computer environment and analyzed via Professional Software 7.0 program.

3.2. Statistical analysis

SPSS 24 and Windows 10.0 were used for evaluating collected data. Frequencies and percentage values were reported for statistical analyses of categorized data; whereas Mean ± SD and Min-Max values were reported for numeric data. T-test was used for intergroup comparisons of normally distributed data. Values with \(p<0.05\) value were considered to be statistically significant.

4. Results

Table 1. Demographical Characteristics of Participants

![Demographical Characteristics of Participants](image)

Demographical characteristics of sedentary individuals and rowing athletes were depicted as a scatterplot for each group in Table 1, where the mean age of athletes was found to be 19.36±4.1 (minimum 16, maximum 32) and mean age of sedentary individuals was found to be 22.20±2.5 (minimum 19, maximum 28) (n=30, for each group). Body mass index of athletes was found to be 22.8±1.5, whereas that of sedentary group was found to be 23.3±3.5.
Inspecting Table 2, it was observed that the sleep durations of sedentary individuals recorded by Metabolic holter were found to be 393.67±65 minutes (n=30), and 442±56 minutes (n=30) for athletes. It was determined that the sleep duration of athlete group was significantly longer than that of the sedentary group. Data was provided in the form of (±SE). P value indicates the results of the Student’s t test.

Table 2. Comparison of Daily Sleep Durations for Sedentary Individuals and Athletes

<table>
<thead>
<tr>
<th>Sleep duration (mins)</th>
<th>Sedentary (n=30)</th>
<th>Athlete (n=30)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>220-300</td>
<td>393.67±65</td>
<td>442±56</td>
<td>0.05</td>
</tr>
<tr>
<td>300-400</td>
<td>442±56</td>
<td>442±56</td>
<td>0.05</td>
</tr>
<tr>
<td>400-500</td>
<td>442±56</td>
<td>442±56</td>
<td>0.05</td>
</tr>
<tr>
<td>500-600</td>
<td>442±56</td>
<td>442±56</td>
<td>0.05</td>
</tr>
<tr>
<td>600-700</td>
<td>442±56</td>
<td>442±56</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Whereas a high consistency of data obtained by PSQI and metabolic holter data in terms of bedtimes, waking times and sleep durations was encountered by inspecting Table 3. Moreover, mean of “subjective sleep quality factor” for athlete group attained by PSQI was found to be 0.87±0.068 (n=30). High consistencies were observed between sleep quality values obtained by metabolic holter and subjective sleep quality values obtained by PSQI. Sleep quality value (Perceived sleep effectiveness) obtained through PSQI was found to be > 85.5±5.0 (n=30) for athletes.

Table 3. Relationship between data obtained by metabolic holter and PSQI with respect to sleep related parameters

<table>
<thead>
<tr>
<th></th>
<th>Metabolic Holter</th>
<th>PSQI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedtime (time/24 hours)</td>
<td>22.38±0.61</td>
<td>22.48±0.49</td>
<td>p&gt;0.05</td>
</tr>
<tr>
<td>Waking time (time/24 hours)</td>
<td>06.22±0.68</td>
<td>06.18±0.7</td>
<td>p&gt;0.05</td>
</tr>
<tr>
<td>Sleep duration (minutes)</td>
<td>442±56</td>
<td>449±37</td>
<td>p&gt;0.05</td>
</tr>
</tbody>
</table>

5. Discussion

Relationship between sports and sleep, specific to rowing athletes was investigated in this study. Sleep quality of individuals performing rowing was found to be significantly better than that of sedentary individuals of similar age. Despite the lack of a directly addressing protocol for the underlying mechanism, data obtained from this study was evaluated in the light of current data on rowing’s characteristics as a sports branch, and characteristics of selected rowing athletes.

Finding of higher sleep quality for rowing athletes compared to sedentary individuals, and positive effects of sleep quality on sleep quality was found to be similar to findings reported by studies present in literature. Metabolic holter data and total PSQI scores indicate that rowing athletes experience sleep of good quality. It was stated that a morning exercise for two weeks improved PSQI score significantly. It is here suggested that the difference between
sleep qualities of rowing athletes and sedentary group was significant, but restricted, since the current study included healthy individuals that did not have any specific sleep disorders as the control group. It was reported that regular physical exercise reduced symptoms of depression for adults that suffer from sleep disorders, and thus improved sleep quality\textsuperscript{16,17}. However, no findings related to depression were encountered for the current healthy control group (medical school students). For this reason, the lower value of difference between control group and athlete group, compared to similar research can be attributed to the control group of current study consisting wholly of healthy individuals. Athlete group whose data was collected during our study was a group that did not exercise at night or during late hours. Yet, exercise performed at night time or during late hours might have a risk of adversely affecting sleep quality. At this point it should be set forth that intensive physical activity is being performed in terms of football and basketball due to the financial pressures resulting from television broadcasting industry. Besides this fact, national teams that travel intercontinentally for competing at activities such as the World Cup face the requirement of performing at games that require significant alterations in their biological clocks; which in turn adversely affects both their sleep quality and their sportive performances. Moreover, pregame competition stress and intensive physical activity performed at late hours adversely affect sleep quality for game/competition day\textsuperscript{18}. Obligation of frequent travelling and training sessions adjusted according to the time of the game also cause development of serious sleep disorders in elite athletes\textsuperscript{19,20}. However, these sports and exercise related adverse effects do not result from the sports itself, but from the difficulties in biological clock adjustment due to the aforementioned economic pressure in such branches of sports\textsuperscript{21}. It was demonstrated that sleep helped gaining full power after an intensive training session, which was also coined as “You can gain the full power of the sleep-sweat”\textsuperscript{22}. Since research on sleep-exercise relationship is generally applied on small populations, power of current evidence with respect to the positive effect of exercise on sleep is being discussed and speculated on a certain extent. On the other hand, a very recent systematic review (a kind of analysis that supplies the most powerful evidence in terms of scientific research results) suggested that exercise significantly improved sleep quality and duration especially for groups with sleep disorders, regardless of disorder’s history and severity. This last analysis revealing that sleep and exercise reciprocally benefited from each other -as an evidence with utmost power- also highlighted that further research was needed in order for identifying the underlying mechanism for this interaction\textsuperscript{23}.

This mechanism was not investigated through current research either. However, there is evidence that exercise enhanced sleep quality through altering serotonin and melatonin levels. As a matter of fact, an indirect mediating effect on sleep regulation resulting from exercise by the release of melatonin is suspected\textsuperscript{24}. A study conducted with more than 2600 male and female participants within the age range of 18-65 determined that individuals exercising at least for 150 minutes during the course of a week experienced a significantly better quality sleep compared to individuals that do not exercise or compared to their non-exercising periods. Moreover, it was observed that this group was more careful and alert throughout daily activities and they experienced less cases of drowsiness\textsuperscript{25}.

Sleep quality both in this mentioned study and in our own study was measured with metabolic holter (accelerometer). Our findings were in line with this study in terms of having high quality of sleep for rowing athletes with respect to objective measurement data obtained from metabolic holter, and that no cases of daytime disfunction reported in PSQI. Better sleep quality is a gain that might remain with the participants representing the athlete group in current study, even if they might abandon sports in the future. This is because of the positive effects of regular exercise during their current periods of lives that might be ever-long lasting as was reported in literature\textsuperscript{26}. Moreover, a study conducted with 1361 participants, determined that males that undertook moderate to intensive exercises during their adolescence stage possessed better sleep quality accompanied by their being mentally and psychologically powerful\textsuperscript{27}. Data was recorded with reliability and validity proven PSQI for Turkey (in terms of Turkish culture), and with metabolic holter which is a convenient device for attaining objective data. An integrating approach for combining these two technical approaches for the athlete group, made this research powerful and authentic. To make this statement clear,
a high consistency was observed between metabolic holter values - that record data with respect to objective criteria but on a daily basis - such as daily sleep duration, bedtime, time of waking/rising and the PSQI values that record most of the same parameters reflecting a month’s average, based on self-reports. This consistency supported the fact that metabolic holter technique reliably reflected sleep quality and related parameters as was reported in literature.

There exists a close and reciprocal relationship between regular exercise and sleep; as exercise affects sleep quality and adequate and good quality sleep affects performance of the athlete. Sleep and exercise reciprocally affect each other through complex mechanisms that comprise of physiological and psychological components. On the other hand, sleeplessness or sleep deprivation adversely affect exercising capacity - including the athletes - and increases the risk of injury during prolonged of exercise or during performance of team sports. The fact that sleep is vital for recovery especially after intensive sports activities, and that exercising had positive effects on sleep is recognized. Despite the existence of a clear interaction between exercise and sleep quality, the underlying mechanism is not known.

Research findings demonstrate that elite athletes needed longer periods of sleep compared to normal individuals. According to a research conducted by Stanford’s Sleep Disorder Clinic and Research Laboratory, swimmers that slept for 10 hours a night for 7 straight weeks reached a peak in their performance and that they completed the 15 meter sprint 0.51 seconds faster, by reducing their reaction time. Moreover, another research investigating effects of extended sleep on sprint timing, success in three-point shots, reaction time and daytime drowsiness for college basketball players revealed that the extension of sleep duration resulted in a peak of players’ individual performances (9% increase in hits for 3-point shots). In addition to this fact, players reported that they felt both their mental and physical health was better during the training sessions and the game. A research conducted with tennis players of university teams determined an increase in service hits (from 35.7% to 41.8%; p<0.05) as a result of extended sleep duration. The finding of rowing athletes’ sleep duration being significantly longer compared to sedentaries’ sleep duration was thus consistent with literature. All these information suggests that there exists a symbiosis between sports and exercise - or sports activity - such that they reciprocally support each other. Despite the lack of data for directly comparing rowing athletes with; it was anticipated in some studies that did not investigate sleep profiles, that extending sleep duration would in turn enhance the team performance. It was reported that this would both mediate for competition performance and the recovery. Metabolic holter data obtained from 55 national rowing athletes that participated 2016 World Youth Championship demonstrated that an extension in sleeping duration positively affected both the performance and the recovery. Relationship between sleep quality and general parameters, and the -individual- sporting performances of rowing athletes was not considered in the current study. Yet, the athletes whose data was obtained were the young elite athletes.

6. Conclusion

As a result of this study, contribution was made to scientific evidence by demonstrating that sleep quality of rowing athletes were better than that of sedentary individuals of the same age. However; considering that this study would serve only as a case evaluation, further research is needed in terms of including a wider range of individuals that perform another sports/recreational activity in addition to the professional rowing athletes, and individuals of different ages suffering from serious sleep disorders. References


