Sleep characteristics of elite athletes: Comparison between subjective sleep questionnaire reports and objective measures using monitoring device

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Background

Sleep is a basic requirement of human health and known to be an important factor in the recovery process of athlete from training. A growing body of research have demonstrated the positive relationship between sleep and optimal performance. Recent studies demonstrated that athletes often have low sleep quality and quantity. Athletes' recovery predominantly occurs during Deep Sleep (DS) and Rapid Eyes Movement (REM) stages. Musculoskeletal recovery occurs mostly during DS, and learning skills/psychological recovery mostly during REM. The ability to objectively assess those sleep states and the Sleep Efficiency (SE) allows to adjust the training loads and to reduce the risk for overtraining.
The aims of the present investigation were: (1) to quantify and characterize sleep in elite athletes from various national teams in Israel, (2) to compare subjective/perceived sleep variables with their corresponding objective sleep metrics.

Method

1511 individual nights of sleep from a cohort of eleven elite athletes (7 females and 4 males mean age: 24.18±3.74, mean no. of nights of recordings per athlete = 137±63.8) were analyzed. The athletes were elite athletes from various sports: fencing (n=2), judo (n=6), windsurfing (n=1), track and field (n=1), and swimming (n=1).
The athletes monitored their sleep using a mobile app (SleepRate by Hypnocore LTD) and a contactless ballistic device placed under their mattress (EarlySense, Israel) and providing Heart Rate and movement data. Sleep evaluation was performed using a validated sleep analysis algorithm which is based on Heart Rate Variability (HRV) and a short digital subjective sleep questionnaire completed by all athlete every night and morning. The following questions were answered by each athlete upon wake up:
(1) How was your sleep?, (2) How long do you think it took you to fall asleep?, (3) If you woke up during the night, how long do you estimate you were awake for in total?
Comparison between subjective and matched objective variables was performed using non-parametric t-test-Wilcoxon matched-pairs signed rank test with statistical significance for P two-tailed $p<0.005$.

Results

Mean measured **Total Sleep Time (TST)** was 437.18±42.73 min, mean **Sleep Efficiency (SE)** was 86.32±2.74%, mean **Sleep Onset (SO)** was 31.27±6.43 min, mean percentage (%) **Deep Sleep (DS)** and % **REM** were 23.9% and 16.54% respectively. Individual data for 11 athletes is presented: Time in Bed (TIB) and TST (objective and subjective measures) are presented in **Figure 1**. Sleep stages duration are presented in **Figure 2** (WASO – wake after sleep onset, LS, DS and REM). **Figure 3** presents the individual differences between subjective reports of SE vs. the objective SE measure.
Note that in most athletes, significant differences were found between the subjective reports and the objective measures, and those differences are indicative of potential sleep issues in the elite athletes.

Table 1: Comparison between subjective and matched objective variables
Presents the results of the comparison between subjective and corresponding objective variables (SO, WASO, TST and SE).

Subject	N of nights	P value for SO (obj vs. sub)	P value for WASO (obj vs. sub)	P value for TST (obj vs. sub)	P value for SE (obj vs. sub)
A1	191	*	ns	ns	ns
A2	105	*	****	****	****
A3	154	*	****	****	****
A4	177	****	****	****	****
A5	257	****	****	****	****
A6	72	****	****	****	****
A7	109	ns	****	****	****
A8	149	****	****	****	****
A9	185	*	ns	*	*
A10	54	ns	****	****	****
A11	58	ns	****	****	****

* $p<0.005$, **** $p<0.0001$

Figure 1: Times in bed and total sleep times in 11 athletes (average/SD)

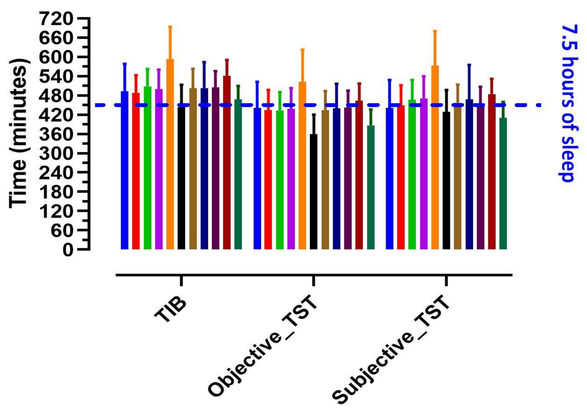


Figure 2: Sleep structure in 11 athletes (average/SD)

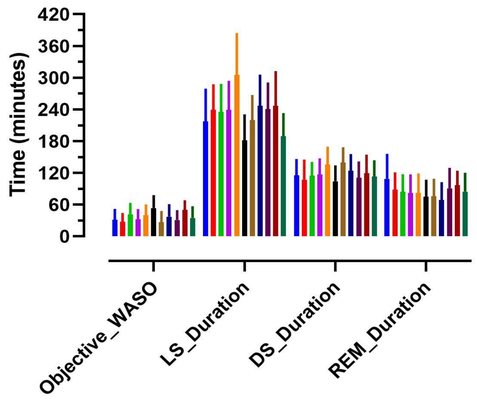
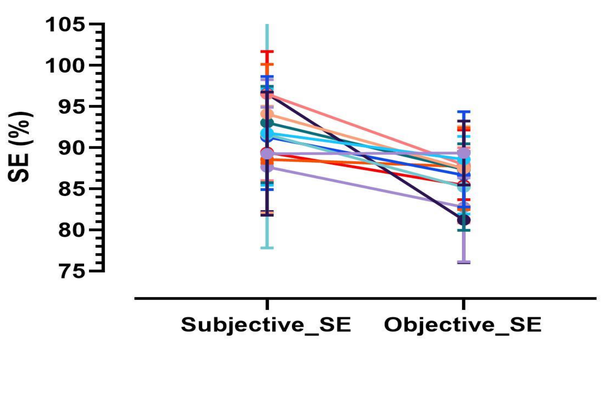


Figure 3: Sleep efficiency in 11 athletes (average/SD)



Discussion

- The results indicate that the athletes monitored had rather adequate TST compared to other reports on elite athletes in the literature, this might be due to greater awareness of the importance of sleep for recovery and its contribution to overall performance. However, the results indicate that on average most athletes sleep less than the recommended amount of hours per night (<8 hours a night) and should try to improve their TST and SE.
- Since, significant differences were found between the subjective sleep reporting and the objective measures, the use of questionnaires to monitor sleep duration and quality in elite athletes should be considered at times as an indicator of sleep issues. If sleep difficulties are ruled out, subjective sleep variables may be skipped.
- Nowadays, when mobile technology and wearable devices are available monitoring physiological parameters during the night in objective ways is within reach and should be considered for elite athletes.
- **Future directions** should focus whether the differences between the subjective and objective measures found in the current investigation have clinical implications, these differences might reflect sleeping disturbances that should be treated in order for the athletes to receive proper recovery and optimal performance.