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Impact of quality and duration of sleep on sports performance in acrobatics and tumbling athletes

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Abstract: Sleep is a vital process for recovery and healing, especially in athletes. Therefore, sleep disturbances can have a negative impact on athletic performance. It was hypothesized that sleep quality and duration would be positively correlated with athletic performance in female collegiate acrobatics and tumbling athletes. 16 athletes volunteered (15 completed the study) to monitor their nightly sleep. Daily single-leg hop test battery (single hop, triple hop, and crossover; dominant and nondominant leg) results were analyzed for correlation with nightly sleep quality and duration. Despite prevalent sleep disturbance, neither sleep quality nor duration was significantly correlated with single-leg hop distance for any of the tests on either leg. These athletes may be insensitive to sleep disturbance, or anaerobic performance may be less affected by sleep quality and duration.

Keywords: sleep quality; sleep duration; athletic performance; acrobatics and tumbling; anaerobic power; balance

Introduction

Sleep is a vital process for recovery and healing, especially in athletes. Student-athletes often suffer from inadequate sleep due to poor sleeping habits (Lo et al., 2017). This can have a negative impact on athletic performance due to increased perception of effort and fatigue and reduced maximal exercise output (Cullen et al., 2020).

Acrobatics and tumbling (A&T) is an emerging female collegiate sport that entails the skill sets of athletes in gymnastics, cheerleading, trampoline, and acrobatics. As collegiate athletes, A&T athletes likely suffer from the deleterious effects of poor sleep observed in their peers in other sports. However, there has been limited research conducted on these athletes (Gómez-Landero et al., 2021), and there is a dearth of inquiry regarding the effects of sleep on their performance.

The purpose of this research is to assess the association of sleep duration and quality on performance in collegiate A&T athletes. It was hypothesized that there is (1) a positive correlation between nightly sleep duration and daily performance in a test of power and balance and (2) a positive correlation between weekly sleep quality and average performance in the same test.

Materials and Methods

Participants

Volunteer participants were recruited from the West Liberty University A&T team. In order to be eligible for the study, participants had to be at least 18 years old, female, and actively practicing during the data collection period, which was performed during the pre-season during a period of time in which athletes were lifting weights, practicing A&T, and attending collegiate classes but not competing. Of the 16 individuals that were recruited, 15 completed all data collection and testing. One dropped out due to a schedule conflict.

Design

Participation took place during the course of a week of pre-season conditioning training. During the first visit to the West Liberty Athletic Training room before practice on day one, participants received an oral explanation of the study, and written consent was obtained from each athlete. Demographic information including age, height, weight, A&T position, and dominant leg was collected. Participants were familiarized with the study and materials. The modified pre-Pittsburgh Sleep Quality Index (PSQI; Buysse et al, 1989) was given as a baseline. The PSQI was modified with permission to ask about the previous week as opposed to the previous month. No other modifications were made.

A sleep watch (Andor Technology Co., Hong Kong) and instructions to download a corresponding smartphone application associated with the watch were distributed to each participant. Individuals were instructed to wear the watch nightly from day one through day eight and to send a sleep summary to the researcher each morning. Summaries included sleep duration and a breakdown of individual sleep phases. Participants were also instructed to complete and send a sleep diary based on the standardized Consensus Sleep Diary 2011 (Carney et al., 2012) each morning.

Performance testing was conducted after A&T practice on days two through six. It was also noted if individuals lifted weights in the morning prior to practice and testing or if individuals lifted after the testing concluded.

The modified post-PSQI was distributed on day seven and collected on day eight.

All procedures were approved by the West Liberty University Institutional Review Board.

Performance Testing

To assess sports performance, each participant completed one single-leg hop test battery with each leg. The battery consisted of three tests. First was the single hop, in which the participant stood on one leg and jumped as far as they could, landing on the same leg. The second test was the triple hop, in which the participant stood on one leg and jumped forward three times on the same leg. The final test was the crossover test, in which the participant stood on one leg and jumped forward and laterally in a diagonal pattern landing on the same leg. Distances were recorded from the starting point to the furthest point reached for each test of the battery for a total of six jumps (three on the dominant leg and three on the nondominant leg) for each assessment.

Statistical Analysis

Linear regression analysis was performed to detect correlations between nightly sleep duration and single-leg hop distance on the following day. Multiple regression analysis was performed to detect correlations between modified post-PSQI scores and mean distance for each component of the single-leg hop battery across the week of testing. Separate analyses were performed for each type of jump (i.e., single, triple, and crossover on the dominant and nondominant leg). Age, height, weight, BMI, A&T position, and time of testing relative to weightlifting were included in multiple regression analyses as potential confounders in the sleep quality analyses. *Post hoc* covariate analysis was performed to analyze the components of the model for statistical significance. Data was analyzed using IBM SPSS v30 software with alpha level set at $p = 0.05$.

Results

Demographic information for the participants is displayed in Table 1.

Table 1: Participant demographics (N = 15). Data are mean ± SD.

Age (y)	19.82 ± 1.42
Body mass (kg)	72.30 ± 16.07
Height (cm)	164.06 ± 6.48
BMI (kg/m^2)	26.62 ± 5.94

On the pre-modified PSQI, 93% of participants scored > 5, indicating poor sleep, and the mean score was 7.93 ± 2.76 (Table 2). On the post-modified PSQI, 73% of participants scored > 5, and the mean score was 6.93 ± 3.65.

Table 2: Modified PSQI scores. Data are mean ± SD.

Modified PSQI	Score
Pre	7.93 ± 2.76
Post	6.93 ± 3.65

Linear regression analysis revealed no significant correlations between nightly sleep duration and distance the following day for any test of the single-leg hop test battery for either leg (Table 3).

Table 3: Linear regression analysis for sleep duration and single-leg hop distance.

Test	R^2	Slope	*p*
Single dominant	0.008	-1.02	0.217
Single nondominant	0.013	-1.28	0.164
Triple dominant	0.009	-3.35	0.201
Triple nondominant	0.013	-4.24	0.163
Crossover dominant	0.033	-5.73	0.057
Crossover nondominant	0.020	-4.7	0.103

Multiple regression analyses of each jump type revealed significant correlations between average jump distance and modified PSQI score for the single hop on both the dominant and nondominant legs (Table 4).

Table 4: Multiple regression analysis for sleep quality and mean single-leg hop distance over the week. Independent variables include modified post-PSQI score, age, BMI, A&T position, and weightlifting time. $p < 0.05$ is considered a significant correlation.

Test	R^2	Slope	*p*
Single dominant	0.021	-0.708	0.009
Single nondominant	0.001	-0.173	0.015
Triple dominant	0.131	4.94	0.118
Triple nondominant	0.088	-4.49	0.053
Crossover dominant	0.081	-3.02	0.222
Crossover nondominant	0.093	-3.82	0.11

Post hoc covariate analysis of the single hop on the dominant leg showed that the significant correlations with distance were with age and position (Table 5). There was no significant correlation between sleep quality and distance. Likewise, *post hoc* covariate analysis of the single hop on the nondominant leg showed no correlation between sleep quality and distance (Table 6). Only position significantly correlated with distance.

Table 5: *Post hoc* covariate analysis of model components for single dominant test distance. $p < 0.05$ is considered significant.

Model Component	*p*
Constant	<0.001
Modified PSQI	0.107
Age	0.012
BMI	0.195
Position	0.003
Lift Time	0.787

Table 6: *Post hoc* covariate analysis of model components for single nondominant test distance. $p < 0.05$ is considered significant.

Model Component	*p*
Constant	0.005
Modified PSQI	0.350
Age	0.077
BMI	0.283
Position	0.004
Lift Time	0.873

Discussion

The major finding here is that in a sample of A&T student-athletes displaying low sleep quality, there was no correlation between sleep duration, measured objectively, or quality, assessed subjectively, and sports performance. The only significant effects on performance were found within the single hops of the single-leg hop test battery, but the effects were not related to sleep quality. For the single hop on the dominant leg, there were significant correlations for the components of age and position to sleep quality. For the single hop on the nondominant leg, there was a significant correlation between sleep quality and position. Otherwise, there were no significant correlations between sleep quality or duration and performance on any test.

These findings were unexpected as the literature mostly supports that sleep impacts performance in athletes (Brauer et al., 2019). Perhaps A&T athletes

are less sensitive to variations in sleep quality and duration. The authors know of no previous study of sleep and performance in this population; however, Taheri & Arabameri (2012) found that anaerobic performance was not impacted by sleep deprivation in college students. The sport of A&T relies heavily on the anaerobic pathway for ATP synthesis.

There is the possibility that the single-leg hop test battery was not robust enough to detect differences in performance. This set of testing was selected as it requires both explosive (anaerobic) movement and balance, both of which are important to the performance of A&T athletes. Thus, if there is no effect of sleep quality or duration on anaerobic performance, then the results seen here would be expected. Other tests would be required to assess the impact of sleep quality and duration on other aspects of sports performance.

It is interesting that the single hops were the only tests in the battery in which significant associations with performance were measured. For both dominant and nondominant leg distance, there was a significant association with position. Specifically, the positions of top and tumbler were associated with greater distance than the position of base. The top and tumbler positions require greater dynamic and explosive movement than the base position, so this association may be explained by the different position requirements. It is interesting that no association was seen for the triple and crossover hops where the movements are more similar to those required by tops and especially tumblers compared to bases. The correlation between dominant leg single hop distance and age is not easily explained. There is a small range in ages as the participants were all college students, and there was no correlation seen on any other tests.

Another potential explanation for the findings is the timing of the study. All testing was performed over the course of a single week early in the A&T pre-season and in the athletes' academic year. Poor sleep may disrupt the athlete's ability to recover from training, resulting in an accumulation of fatigue over the course of the weeks and months of a season. Perhaps these athletes had not had enough time to accumulate fatigue that would result in a decrement in performance. Future research should focus on a longer period and various time points throughout a season as there are multiple sources of stress for student-athletes (e.g., training, competition, academics, and social factors) which could impact both sports performance and sleep hygiene.

The poor quality of sleep observed in this study (mean scores of 7.93 ± 2.76 and 6.93 ± 3.65 for pre and post modified PSQI, respectively) is similar to results from other studies of student-athletes (Mah et al., 2018; Leduc et al., 2019). This should rule out the possibility that there was no correlation between sleep quality and performance due to a lack of poor sleep quality.

The results of this study indicate that in a sample of college A&T athletes there is no correlation between sleep quality or duration and sport performance. It is possible that there is something unique about these athletes, perhaps linked to the anaerobic nature of their performance; therefore, further research should be conducted to better understand the links between sleep and performance in this population.

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