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Athlete's sleep: effects of partial deprivation on some physical qualities of INSEPS students

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Abstract :

Objective

To study among INSEPS students the effects of partial sleep deprivation on vertical jump, speed-coordination, endurance, heart rate, blood pressure and VO_2 max, occurring the day after a night of sleep deprivation.

Materials and methods

We recorded heart rate, blood pressure at rest and after the Cooper test, evaluated vertical jump, speed-coordination, maximum oxygen consumption (VO_2 max) of 15 INSEPS students, aged over 18 years and under 30 years, not suffering from any sleep disorder, and having given their consent, the day after a normal night sleep. A week later, the students underwent the same measurements, the same physical tests after a night of partial sleep deprivation of 4 hours.

Results

The average values of heart rate at rest (68.73 beat/min vs 69.3beat/min), at the end of the Cooper test (96 beat/min vs 102.5 beat/min), vertical jump (57.53 cm vs 58.47 cm), speed-coordination (16"56 vs 16"41) and maximum oxygen consumption (53.18 ml/kg/min vs 54.45ml/kg/min) recorded the day after a normal night sleep of 8 hours and the day after a night of partial sleep deprivation of 4 hours are not statistically different.

Conclusion

Partial sleep deprivation should not have negative consequences on heart rate, vertical jump, speed-coordination, maximum oxygen consumption. However, subjects have higher blood pressure after a night of partial sleep deprivation.

IndexTerms - **partial sleep deprivation, vertical jump, speed-coordination, VO_2 max, blood pressure.**

I. INTRODUCTION

Sleep allows us to recover our physical and intellectual capacities after the various activities we carry out during the day or night **[1].** It is an important part of our lives. During sleep, the body is at total rest, characterized by a number of physiological changes that can be observed: the electrical activity of the brain, heart and respiratory rythms, blood pressure, temperature, muscular activity, or eye movements.

Reason why its disruption leads to a significant reduction in the efficiency of our motor qualities, skill, endurance, speed and strength **[2]** .

The simultaneous recording of these modifications made it possible to characterize the two main types of sleep: “slow wave sleep” (SL) and “paradoxical” sleep (SP) **[3].**

A night of sleep has 3 to 5 cycles of 90 minutes on average and each cycle is divided into 5 stages **[4].** Stages 1 and 2, marked by a progressive falling asleep of the individual, are called “light or superficial sleep”. Then come stages 3 and 4 “deep slow-wave sleep” (SLP), constituting the physical recovery phase from the effort made during the day. In young athletes, the SLP represents 20% to 25% of sleep time. Finally, stage 5 or “paradoxical sleep” (SP), occupies 25% of the total sleep duration, marks the end of one cycle and the arrival of another. This stage is that of memorization and psychological maturation of tasks learned during the waking period, but also and above all that of dreams. Sleep duration is not the same for everyone. Each individual has their own sleep time, determined according to needs, the age of the person and the intensity of the activity practiced. Thus, research on sleep has made it possible to distinguish three categories of individuals: long sleepers with a sleep time of nine to ten hours (9 - 10), short sleepers of five to six hours (5 - 6), and in between the average sleepers who sleep seven to eight hours (7h – 8h) per night. Athletes undergoing intensive training are advised to sleep 8 to 9 hours per night **[5].**

Sports medicine provided information that allowed managers and athletes themselves to readjust their training and recovery programs. This is how coaches and sports staff began to carefully manage sleep on the eve of a competition [6]. Work has focused on the effects of total or partial sleep deprivation on physical qualities. But the majority of studies have focused on the consequences of long sleep deprivation on psychomotor performance.

Paradoxically, in Senegal, it turned out difficult to get people understand the role of sleep in recovery; an essential factor in achieving performance. This lack of information on the role of sleep in sports recovery is today a source of numerous conflicts between coaches and players in almost many sporting disciplines in Senegal. Often quoted as an example, the Senegalese "footballistic" world suffers enormously and continually from the ignorance of the repercussions of sleep on performance. from the old habits of the "nawetanes" players, who stay out late in the evening after training or before a match, to the national team where certain players go out late in the evening before an African or World Cup finals. This demonstrates, once again, the ignorance of this important factor (sleep) in top level sporting performance.

In addition, to our knowledge, to date, no study has been carried out in Senegal on the role of sleep in recovery, with a view to achieving better sporting performance. It is for all these reasons that we propose to study among INSEPS students, playing in the football team of said institute, the effects of partial sleep deprivation on certain physical qualities (vertical jump, speed -coordination, endurance) as well as on the cardiovascular (blood pressure) and respiratory (VO_2 max) responses occurring the day following the night of sleep deprivation.

MATERIALS AND METHODS

Fifteen (15) students from the National High Institute of Popular Education and Sports (INSEPS), aged over 18 and under 30, suffering from no illness or sleep disorders, working in the Institute's football team and having given their consent, participated in our study. The aim of this study is to highlight the influence of a night of partial sleep deprivation (4 hours) compared to a night of normal sleep (7 to 8 hours) on vertical jump, speed-coordination, endurance, maximum oxygen consumption, heart rate and blood pressure.

We first recorded heart rate and blood pressure at rest and immediately after the Cooper test, assessed vertical jump, speed-coordination, maximum oxygen consumption (VO_2 max) the day after a night normal sleep of 08 hours. A week later, the students underwent the same measurements and physical tests after a 4-hour night of partial sleep deprivation (from 10 p.m. to 2 a.m.).

1. Administration of one night of normal sleep and one night of partial sleep deprivation

1.1 Normal night's sleep

The 15 students playing in the INSEPS football team were gathered in the afternoon at 5 p.m. at the INSEPS residence hall where they carried out activities until 7 p.m., dinner time. After dinner, they continued their activities until 10 p.m., when bedtime was consensually planned. At 6 a.m., the scheduled wake-up time, all the students got up. At 7 a.m., they had breakfast. At 9 a.m., the students went to the Iba Mar stadium field where the experimenters were waiting for them to undergo measurements and physical tests.

1.2 Night with partial sleep deprivation

A week after having undergone the tests the day after a night of normal sleep, the students were brought together again in the same manner at residence hall until bedtime, this time scheduled for 2 a.m. At 6 a.m. all 15 students were woken up by the ringing of the large watch installed in the residence hall for this purpose. At 7 a.m., they had breakfast and at 9 a.m., they went to the stadium to undergo the same measurements and physical tests again.

2. Heart rate and blood pressure measurement

Heart rate and blood pressure at rest and immediately after the Cooper test were measured using wrist blood pressure monitors.

Resting heart rate and blood pressure were measured after 10 minutes of rest in a seated position on a chair, with the back firmly against the wall, the knees bent and the muscles of the lower limbs well relaxed. On the other hand, heart rate and post-exercise blood pressure were measured immediately at the end of the Cooper test by experimenters trained by the establishment's senior nurse.

3. Vertical jump test [7]

We use this test to assess subjects' vertical jump. Vertical jump indirectly assesses the power of the lower limbs and postural tone. The latter is one of the parts of the body that gains the most during sleep due to the lying position, subjects who are most often on their back. It also estimates the Maximum Anaerobic Power (MAP).

We ask the subject, already warmed up, to stand in profile 30cm from a wall on which we have drawn a vertical line graduated in centimeters from 2m. With heels glued to the ground, fingers wet with chalk, the subject raises his arm to maximum extension and makes a mark on the wall with the tip of his middle finger. This height which represents the standing height of the subject in addition to his raised arm is called mark (A). He then lowers his arms behind him, bending his knees in a semi-squatting position. He pauses for a moment in this position and then jumps as high as possible with his arm reaching forward and upward, touching the graduated line on the wall at the maximum height reached with his arm and fingers fully extended. The mark thus made is called mark (B).

The result of the vertical expansion corresponds to the difference (h) between the mark (B) and the mark (A). Each subject performs three trials separated by rest periods of 15 seconds. The best performance being retained as the final result.

Immediately after the 3rd test of the 15th subject, the whole group goes to the athletics track to undergo the speed-coordination test.

4. Speed-coordination test (10×5m)

The test takes place on the athletics track at the Iba Mar DIOP stadium. We define a corridor 5m long and 1m wide by placing 4 blocks at both ends of each line. The timekeeper positions himself on one of the two sides 10m from the edge of the racing area and the subjects pass one by one. The runner begins by getting into the starting position behind the line, placing one foot just behind it. The timer is started when the back foot leaves the ground. At the starting signal, the subject runs as quickly as possible to the other line, passes it or blocks one of his two feet on the line and returns as quickly as possible to the starting line. It performs 5 cycles or shuttles of 10m each; all making a total distance of 50m. At the end of the 5th cycle, the runner does not slow down when arriving at the terminal line, but continues to run. The evaluator stops the stopwatch and records the time taken by the subject to cover the distance. The test is performed only once.

5. COOPER test (12 mins)

The test is carried out on an athletics track marked with two blocks over 100 meters in a closed circuit; or 200 meters. Measurements are made using a tape measure.

The subjects, in groups of five, stand on the starting line delimited by a cone. A whistle marks the start of the race. At the same time, we start the stopwatch which we will limit to 12 minutes. The subjects run to the block opposite delimiting the running zone, go around it then begin the return to the starting point. Arriving at the latter, again, they go around and so on until the end of the test. At the end of 12 minutes, another whistle marks the end of the race and the subject must stop in place so that the performance can be measured. When the test stops, the experimenters, trained by the nurse, take measurements of the subjects' heart rate and blood pressure. Students helped us count the number of laps completed by each subject. If the runner completes a certain distance after having completed a lap, just before the final whistle, we use the tape measure to measure this distance from the last cone circled, and we add it to the number of laps completed.

VO2max is predicted by the distance traveled in 12 minutes using the equation below [8] :

$$VO_2max\ (ml/kg/min) = (0.001x\ \text{Distance traveled in meters}) + 21.90$$

6. Statistical processing

We compared the mean values of the group variables obtained after a night of normal sleep to those collected after a night of partial sleep deprivation of 4 hours, using a Student 's t test after checking the equality of the variances to refute or confirm the hypothesis that "there is a statistically significant difference between the mean values measured with or without sleep deprivation.

The probability of error is set at 5%, that is to say the error that we accept to make when making our decision.

If the error probability found is less than 5%, the hypothesis is confirmed. However, if it is greater than 5%, the hypothesis is invalidated.

RESULTS

TABLE 1 : Comparison of mean heart rate values at rest and post-exercise, the day after a normal night of sleep to that after a night with partial sleep deprivation.

VARIABLES	FC at rest (beats /min)		FC post -exercise (beats /min)	
AVERAGES	**SPS**	**APS**	**SPS**	**APS**
	68.73	69.3	96	102.5
P (Student)	0.85		0.06	
α	0.05		0.05	
Decision	DNSS		DNSS	

F.C : Heart rate (beat / min)

SPS: Without sleep deprivation

APS: With sleep deprivation

DNSS: Difference not statistically significant

TABLE 2 : Comparison of the mean values of systolic and diastolic blood pressure at rest, the day after a normal night of sleep to that after a night with partial sleep deprivation.

VARIABLES	SBP at rest (cmHg)		Resting DBP (cmHg)	
AVERAGES	**SPS**	**APS**	**SPS**	**APS**
	12	14	7	8
P (Student)	0.01		0.03	
α	0.05		0.05	
Decision	DSS		DSS	

cmHg : centimeter mercury

SBP: Systolic blood pressure

DBP: Diastolic blood pressure

SPS: Without sleep deprivation

APS: With sleep deprivation

TABLE 3 : Comparison of the mean values of post-exercise systolic and diastolic blood pressure, the day after a normal night of sleep to that after a night with partial sleep deprivation.

VARIABLES	SBP post -exercise (cmHg)		DBP post -exercise (cmHg)	
AVERAGES	**SPS**	**APS**	**SPS**	**APS**
	12	13	7	8
P (Student)	0.01		0.02	
α	0.05		0.05	
Decision	DSS		DSS	

cmHg : centimeter mercury

SBP: Systolic blood pressure

DBP: Diastolic blood pressure

SPS: Without sleep deprivation

APS: With sleep deprivation

TABLE 4 : Comparison of the average value of vertical relaxation the day after a night of normal sleep to that after a night with partial sleep deprivation.

VARIABLES	Vertical jump (cm)	
AVERAGES	**SPS**	**APS**
	57.53	58.47
P (Student)	0.72	
α	0.05	
Decision	DNSS	

Cm: centimeter

SPS: Without sleep deprivation

APS: With sleep deprivation

DNSS: Difference not statistically significant

TABLE 5: Comparison of the average value of speed-coordination, the day after a night of normal sleep to that after a night with partial sleep deprivation.

VARIABLES	Speed-coordination (s)	
AVERAGES	**SPS**	**APS**
	16"56	16"41
P (Student)	0.58	
α	0.05	
Decision	DNSS	

S: second

SPS: Without sleep deprivation

APS: With sleep deprivation

DNSS: Difference not statistically significant

TABLE 6 : Comparison of the average value of VO_2 max the day after a night of normal sleep to that of a night with partial sleep deprivation.

VARIABLES	VO_2 max (ml/kg/min)	
AVERAGES	**SPS**	**APS**
	53.18	54.45
P (Student)	0.13	
α	0.05	
Decision	DNSS	

VO_2 max: Maximum oxygen consumption (ml/kg/min)

SPS: Without sleep deprivation

APS: With sleep deprivation

DNSS: Difference not statistically significant

DISCUSSION

Our discussion focuses around heart rate, blood pressure, vertical jump, speed-coordination as well as maximum oxygen consumption (VO_2 max).

1. Heart rate

The average heart rate values at rest (68.73 beats/min vs. 69.3 beats/ min) and post-exercise (96 beats/min vs. 102.5 beats/min) of our subjects measured the day after a night without sleep deprivation did not significantly change the day after a night with partial sleep deprivation (Table 1).

Our results are in agreement with those of Azboy and Kaygisiz [9] who reported that lack of sleep has no significant effects on heart rate at rest and during exercise.

However, our results do not corroborate Mougin et al [10] who showed at the end of their study that lack of sleep causes an increase in heart rate during prolonged exercise. However, we note that the day after the night with partial sleep deprivation, the post-exercise heart rate increased in absolute value from 96 beats/min to 102 beats/min.

The non-statistically significant increase in heart rate (at rest or after exercise) could be explained by stress and the feeling of fatigue caused by lack of sleep **[11].**

2. Blood pressure

Unlike heart rate, resting blood pressures (12/7 vs. 14/8 cmHg) and post-exercise blood pressures (12/7 vs. 13/8 cmHg) measured the day after a night without sleep deprivation significantly increased the day after a night with partial sleep deprivation.

Our results are in line with those of Wolk [11] and Gangwisch [12] who reported that a lack of sleep can cause an increase in blood pressure. In addition, they showed that sleep deprivation of less than 5 hours can lead to the risk of high blood pressure and that each hour of less sleep increases the risk by 37%.

3. Vertical jump

The average vertical relaxation, an expression of the power of the lower limbs of our subjects, did not significantly vary the day after a night with partial sleep deprivation (57.53 cm vs 58.47 cm, table 4). This result could justify that of Mougin et al [10] who reported that lack of sleep would not be accompanied by an alteration of anaerobic qualities.

4. Speed-coordination

As a measuring factor for anaerobic physical qualities, the average speed-coordination of our subjects did not vary significantly following a night with partial sleep deprivation (16"56 cm vs 16"41 cm, table 5). The justifications provided for vertical jump are also valid to explain the non-significant variation in speed-coordination following partial sleep deprivation, because they are both anaerobic type tests.

Maximum oxygen consumption (VO2max)

The most objective criterion for evaluating a subject's endurance, the average maximum oxygen consumption recorded the day after a night without sleep deprivation (53.18 ml/kg/min) did not significantly vary, compared to one night with partial sleep deprivation (54.45ml/kg/min, table 6). Our results correspond to those of **Mougin et al [13]** , who found that the VO2 max of their subjects measured the day after a night without sleep deprivation was identical to that recorded the next day or two days after a night with deprivation. partial sleep. Thus, we would be tempted to argue that partial sleep deprivation would not have any effects on aerobic performance. However, Mougin et al (10) reported that sleep deprivation could impact the aerobic capacity of endurance athletes. This can be understood given that it is among the latter that we find the greatest need for sleep (more than 10 hours). We could therefore say that the degree of affect on sporting performance would depend on the duration of the deprivation, the type of work or effort to be carried out, but also and without a doubt the amount of sleep that each athlete needs.

CONCLUSION

Our objective was to study the effects of partial sleep deprivation on heart rate, blood pressure, vertical jump, speed-coordination and VO2 max of 15 students from INSEPS in Dakar.

The results of our study did not allow us to affirm the hypothesis according to which partial sleep deprivation would have negative consequences on the physical qualities above even if we note small variations in absolute value of vertical jump, speed-coordination, maximum Oxygen consumption. However, subjects appeared to have higher blood pressure after a night of partial sleep deprivation, compared to a night of normal sleep.

This shows that sleep is a factor in human performance in all his activities, especially for athletes who need to mobilize and maximize all the factors contributing to achieving better performance. The quality of sleep is one that athletes must strive to know and respect regularly for this purpose.

However, it is very difficult for some Senegalese athletes like competitive students to respect their sleep time because the accommodation conditions absolutely do not offer it. They share the university room with at least 3 other non-athletic students who are sources of nuisance preventing them from sleeping at the scheduled time to recover.

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