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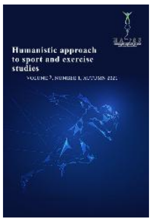

Original Article

The effect of insomnia caused by guarding duty on motor performance and salivary steroid concentration

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Abstract: This research investigated the effect of insomnia caused by military guarding on motor performance and salivary cortisol and testosterone concentration. Some 24 male active-duty soldiers were randomly selected and placed in two groups, insomnia, and control. Insomnia consisted of two hours of guarding with military equipment, two hours of on-call, and two hours of sleep, which started at 4:00 PM and lasted until 6:00 AM the next day. Agility, balance, and reaction time were measured as indicators of motor performance. Saliva samples were collected in the morning two days before, in the morning after applying insomnia, and after measuring motor performance. The results showed that agility performance in the insomnia group was weaker than in the control group. The balance performance of the insomnia group did not differ significantly from the control group. The reaction time in the experimental group was slower when compared to the control group. Although the reaction time was affected significantly, the findings of this research showed that salivary cortisol and testosterone concentration, as well as agility and balance, are not affected by this amount/type of sleep deprivation.

Keywords: insomnia, guarding, agility, balance, reaction time, saliva cortisol, testosterone;

1. Introduction

The effect of insomnia on human psychological and physiological effects has been the focus of many researchers. Sleep deprivation comes from long periods of work, shift work, and night work (Goh, Tong, Lim, and Low, 2001) and is common in some occupations, such as military service. Sleep deprivation may seriously compromise mental-motor and physical performance in some situations, such as military exercises and night work for doctors, nurses, and workers. Psychological disorders following insufficient sleep include increased sleepiness, decreased alertness, mood deterioration, and impaired concentration, all of which contribute to performance delays, increased errors, increased risk of accidents, and, ultimately, hesitancy in completing missions (Smith and Maben, 1993). The detrimental effects of sleep deprivation on performance are directly related to the amount of sleep reduction, so the longer the sleep deprivation, the more pronounced the disorder (Goh, Tong, Lim, and Low, 2001).

Studies conducted in this area have shown that up to 60 hours of sleeplessness does not affect people's performance in short-term exercises (Chen, 1991; Hill, Borden, Darnaby, and Hendricks, 1994; Mougin, Bourdin, Simon, Didier, Toubin, and Kantelip, 1996; Myles, 1985; Naitoh, and Townsend, 1970; Plyley and Shephard, 1987; Shephard, 1984; Souissi, Sesboue, Gauthier, Larue, and Davenne, 2003). Subjects who were deprived of sleep could still perform short-term intellectual tasks, but they faced problems in tasks that required long-term accuracy and concentration (Boonstra, Daffertshofer, and Beekp, 2005). After a few days of sleep deprivation, people who are deprived of sleep show the phenomenon of returning, and if they are given a chance to sleep usually, they spend more time in sleep. This return indicates that humans need a certain amount of sleep and individual differences are effective in this amount (Meny, Waterhouse, Atkinson, Reilly, and Davenne, 1998). Therefore, sleeping seems necessary to maintain the optimal conditions of the body and maintain its normal function and is somewhat affected by physiological needs (Droditch, and Swenson, 1992).

Since the desire to sleep is one of the necessary motivations of life, sleep deprivation can be a promising way to study its effects on the body. However, contrary to researchers' expectations, the studies related to sleep deprivation were not very revealing and mainly indicated that this deprivation did not affect physical performance but had a severe effect on brain function so that sleep loss (up to 65 hours) causes disorders. It creates a person's mood and causes the person's cognitive performance to decrease (Horn, 1978).

Cortisol is one of the most sensitive hormones to sleep, and insomnia disrupts the secretion of this hormone (Lac, 2003). Cortisol secretion is low at the end of the night, and this decrease continues in the first hours after sleep. During the third and fourth hours after sleep, its secretion increases, but the highest cortisol secretion begins in the sixth to eighth hours. About half of the total output of cortisol is secreted during this period. Cortisol secretion then gradually decreases during the day. Sleep patterns change this secretion, exposure to light and darkness, eating time, etc. (William, 1994). Weitzman and colleagues (1983), Mills (1985), and Lac and Chamoux (2003) have reported an increase in salivary cortisol after sleep deprivation (4, 10, 16). However, Goh and colleagues (2001) showed that one night of sleeplessness does not produce a significant difference in salivary cortisol concentration (Goh, Tong, Lim, and Low, 2001). Therefore, it seems that we should write a paragraph about testosterone as we did about cortisol.

In general, insomnia is substantial stress that causes many changes in physiological systems (Lac and Chamoux, 2003). For example, in military barracks, soldiers alternately guard the places and facilities against night to morning. Doing this task will probably cause their consciousness to deteriorate and their motor performance to weaken. On the other hand, the effect of sleep deprivation, as applied in military environments, on motor functions and physiological variables is not yet known.

Insomnias studied in previous studies differed in duration and frequency (Smith and Maben, 1993; Slade, 1989; and Shephard, 1984), and their results do not answer the present research question. Therefore, this research was designed with the aim of identifying the effect of insomnia caused by military guarding duty, in the form of two-hour shifts, during twenty-four hours, on motor function variables and salivary cortisol and testosterone concentrations.

2. Methods

2-1. Subjects

Twenty-four male duty soldiers were randomly selected as research subjects, whose job was to guard administrative parts, military facilities, ammunition storage, and the entire barracks area. All subjects had physical and mental health cortex, had no history of hormonal and behavioral disorders, and were not under medical treatment at the time of data collection. After selecting the subjects, they were given the necessary information about the stages of the research, and a written consent letter was obtained from them to participate in the study. The demographic information of the subjects is presented in Table 1.

Table 1. Demographic characteristics of the subjects; mean and SD are reported.

Insomnia Group			Control Group		
Weight (kg)	Height (cm)	Age (year)	Weight (kg)	Height (cm)	Age (year)
69.59±12.17	170.18±6.41	20±.45	67.79±8.83	173.96±4.16	20.75±1.29

All the subjects slept from 10:00 pm, the silent hour in military barracks until 5:30 am the night before insomnia. They woke up at 5:30 am the next day and did their administrative duties, including service, office, and procurement duties, until 2:00 pm and were free to have lunch until 4:00 pm. Subjects of the insomnia group stood guarding for two hours with military equipment from 4:00 pm and slept for two hours. This process continued until 6 am the next day. In the whole insomnia group, out of 14 hours, they were on guarding or ready for 10 hours and slept for 4 hours.

The subjects of the control group were at their disposal from 16:00 and slept at 22:00. The control group slept from 2:00 pm to 7:30 am and read newspapers, watched TV or talked to their friends at 6:30 am. Saliva collection.

2-2. Hormonal assay

Saliva samples were collected from both groups between 8:30 am, and 9:00 am two days before (to determine baseline levels) and the morning of the test day.

On the test day, after measuring agility, balance, and reaction time, both groups' saliva sampling was done again. In this way, first, each of the subjects drank about two hundred milliliters of water to prevent dehydration; after a few minutes, they washed their mouths and poured 4 milliliters of their saliva unstimulated into the tubes for collecting samples. Then, all the samples were frozen at -20 degrees Celsius to be tested at the right time. In order to prevent unwanted effects, all the sampling stages were carried out at the same time for both groups.

Salivary cortisol and testosterone concentrations were determined in duplicate using the ELISA method. Salivary cortisol concentration was determined by a commercial ELISA kit made by Human, Germany, with a sensitivity of 1.1-1.5 ng/ml. Salivary testosterone concentration was also determined by a commercial ELISA kit manufactured by ANC Diagnostics Biochem with a sensitivity of 0.022 ng/ml.

2-3. Performance measurement

The agility of the subjects was measured using an 8-directional electronic device manufactured by Satrap Metal Company in Iran, with an accuracy of 0.001 seconds. The subject stood in the middle of the electronic screen, and as soon as the numerical light stimuli went on, he quickly jumped to the corresponding side of the illuminated number. The numbering method was designed from simple to complex, and the device showed the movement and reaction time for each direction and overall agility.

The balance was also measured using a digital balance measuring device manufactured by Satrap Metal Company in Iran, based on the maximum speed of oscillations with a centimeter/second scale. In order to measure this capability, the subject stood in the middle of the electronic screen, and the device measured and analyzed the body fluctuations indirectly based on the reaction of the support surface to the forces caused by the person's center of gravity to measure the stability of the body position. In addition, information from body movement was used in real-time and visualization to calculate different parameters in two dimensions while standing with eyes open and closed.

The reaction time was measured using a digital reaction time measurement device manufactured by Satrap Metal Company in Iran, with an accuracy of 0.001 seconds. In order to measure this ability, selective reaction time, response time, and subject's movement time in response to light stimuli were used. Selective reaction time was the time interval between the receipt of possible stimuli and the start of the response; The movement time was from the start to the end, and the response time included the sum of the reaction and the movement time. The subject stood on the zero point of the sensitive screen, and after turning on the numerical light stimuli, he quickly jumped towards the illuminated number with a pair of feet.

The device recorded the time from the signal until the subject's legs left the surface. This was the selective reaction time. The movement time was from when the legs left the surface until landing on the specified surface. The sum of the two activities was named as the response time.

2-4. Analysis

All information is reported based on mean and standard deviation. First, the normality of data distribution was tested using the Kolmogorov-Smirnov test. Then, the data obtained from hormonal measurements were analyzed using the statistical model of one-way analysis of variance with repeated measurements and performance indicators with the Student t-test method for independent groups. A significant level was considered for all calculations ($p<0.05$).

3. Results

Salivary cortisol concentration of the insomnia group increased by 13.64% in the post-test phase compared to the previous 48 hours and by 8.08% between the beginning of the test and the post-test phase. Salivary testosterone concentration of the experimental group was 19.9% higher than the control group in the post-test phase.

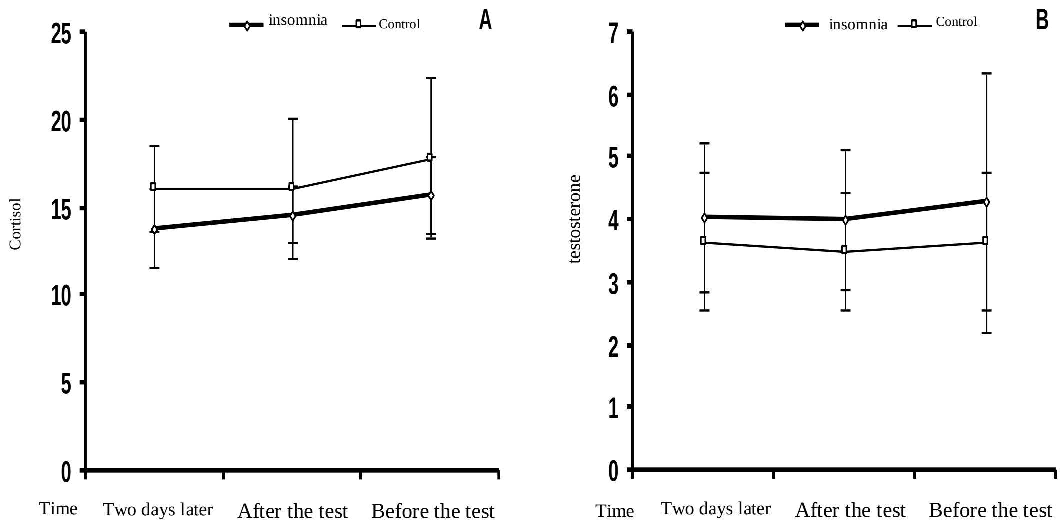

Figure 1. Mean and SD for saliva cortisol concentration (A) and Testosterone (B) collected in three stages in control and insomnia groups

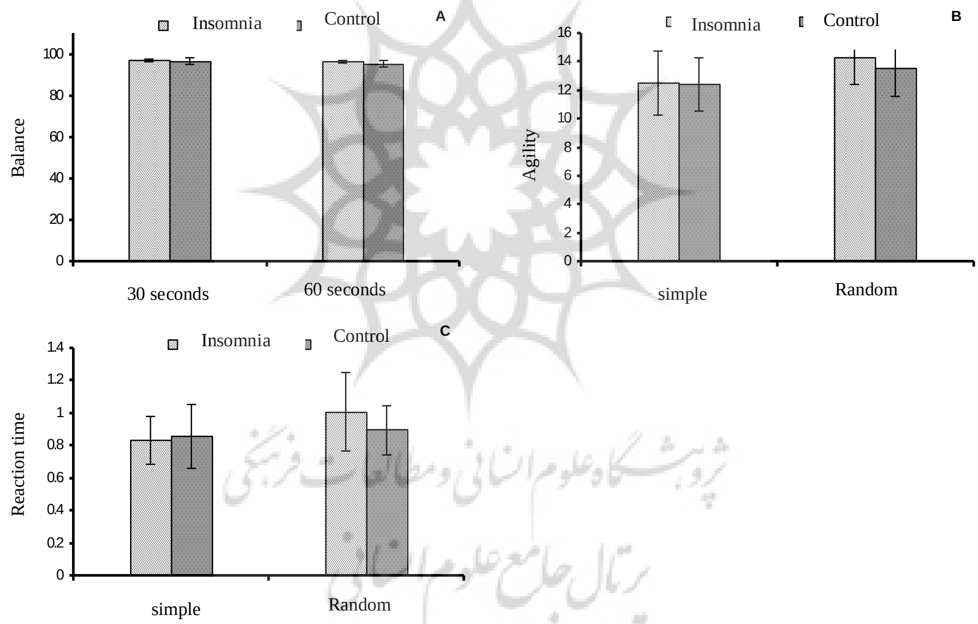

Figure 2. The mean percentage of balance in the control group and insomnia in two stages of 30 and 60 seconds (section A); agility with two random and simple models (section B); and reaction time with two random and simple models (Section (C) are shown.

Agility performance in the insomnia group was 5.6% weaker than in the control group. The balance performance of the insomnia group was 1.1% weaker in the 60-second test and 05% weaker in the 30-second test. The reaction time in the experimental group was 13.47% slower in the random model test and 2.75% slower in the simple model test compared to the control group.

4. Discussion

The first finding of this study showed that sleep deprivation caused by military guarding has no significant effect on salivary cortisol concentration. Salivary cortisol concentration of the insomnia group increased by 13.64% in the post-test phase compared to 48 hours before the test, and an 8.08% increase was observed between the beginning of the test and the post-test phase, which was not significant in both conditions.

In general, insomnia is stress that affects the body and causes many changes in physiological systems.

Significantly insomnia disrupts the biological rhythm in a person. In order to compromise by staying awake despite the increase in sleepiness, mental stress is created. Since cortisol is one of the most important stress hormones, its increase can be expected after insomnia. However, the reason that cortisol concentration did not increase in the present study is probably that sleep deprivation, as used in this study, did not cause stress and fatigue to the subjects. In explaining the findings of this research, it can be added that the current research subjects, who had spent an average of one year of their service period, have probably adapted to this type of insomnia. It is possible that the one-year experience of insomnia caused by military guarding prevented the significant manifestation of the consequences of the cortisol hormone in this research. Another reason is that most of the studies conducted in this regard were completely sleepless nights or between 24 and 36 hours; Even insomnia used in Simons' study was 60 hours (Symons, VanHelder, and Myles, 1988). While insomnia used in this study was first of all 14 hours, and it was also with the model of military guarding that the subjects could sleep for two hours after two hours of guarding and two hours of standby. Because the stages of sleep, including REM sleep and non-REM sleep, are organized in a 90-minute cycle (Shapiro, 1982 and Slade, 1989). It is possible that the research subjects were able to complete their sleep cycle in each period. The non-significance of the effect of insomnia on physiological variables is probably related to the completion of this cycle.

The second finding of this study showed that a period of insomnia caused by military guarding has no significant effect on salivary testosterone concentration. Salivary testosterone concentration in the post-test phase was 19.9% higher than the control group, which was not statistically significant. Generally, the response of testosterone is a function of the characteristics of the activity (type, intensity, and duration).

The ratio of testosterone to cortisol is an important index to show the balance between anabolic and catabolic processes and the pressure on the organism. If the testosterone to cortisol ratio decreases to 0.30, overtraining syndrome occurs, and symptoms such as increased heart rate at rest, weight loss, decreased libido, disturbed sleep patterns, increased susceptibility to infectious diseases, and mood disorders (Martin and Gaddis, 1981). In this study, this ratio did not change significantly between the two groups, which shows that insomnia used in this study did not disturb the anabolic-catabolic balance; or probably, the characteristics of this type of sleep deprivation that the subjects did in the present study caused no change in testosterone concentration.

The third finding of this study showed that insomnia caused by military guarding does not significantly affect the subjects' performance. Agility performance based on time in the insomnia group was 5.6% weaker than in the control group. The balance performance of the insomnia group compared to the control group was 1.1% in 60 seconds and 05% in 30 seconds. Selective reaction time was 13.47%, simple reaction time was 2.75% more in the insomnia group than in the control group, and these differences were not statistically significant.

In studies of sleep deprivation, it has been found that the subjects who were deprived of sleep, after a few days of deprivation, showed the phenomenon of compensation, and if they were given a chance to sleep naturally, they would sleep for a more extended period of time. This return indicates that humans need a certain amount of sleep (Martin and Chen, 1984). Long-term sleep deprivation (up to 65 hours) causes disturbances in the person's mood and causes the person's cognitive function to decrease; This decrease increases with prolonged sleep deprivation (Horn, 1978 and Murrock, 2002).

Therefore, it seems that sleeping is affected by physiological needs and is necessary to maintain optimal conditions in the body (Vining, McGinley, Maksvtisoy, 1983; Reilly and Piercy, 1994), but losing sleep for up to 60 hours does not impair the ability to work physically (Symons, VanHelder, and Myles, 1988). It was assumed that insomnia caused by military guarding would cause physical and mental fatigue in the guards, and as a result, the guards would have weaker performance than the other group; However, the results of the current research were contrary to the prediction. It seems that the pressure caused by this pattern of insomnia was not to the extent that it could affect the nervous and muscular system and cause fatigue in the guards and affect their performance. Agility, balance, and reaction time tests may not be sensitive to the harmful effects of short-term sleep deprivation on performance. Since the stages of sleep are organized in a cycle of 90 minutes, there is a possibility that the research subjects were able to complete their sleep cycle in each period. As a result of the non-significance of the effect of insomnia on the performance variables, it is probably due to Completing this cycle is relevant. Therefore, more research is recommended in the stages and sleep cycle field. In general, while agreeing with previous studies, the results of the present study point to the ineffectiveness of one night of sleep deprivation on the performance of guards.

5. Conclusion

This study showed that insomnia caused by military guarding has no effect on salivary cortisol and testosterone concentration; this type of insomnia is not stressful. Also, the factors of agility, balance, and reaction time were not affected by sleep deprivation. From this, it can be concluded that in military guards, a sleepless night with a pattern of 2 hours of guarding, 2 hours of standby, and 2 hours of sleep does not create a limitation for daily duties. Based on this, it can be recommended that people who are sleep deprived with this pattern can be used for regular activities on the day after being on guarding duty.

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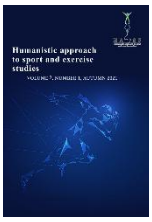

تأثیر بی خوابی ناشی از نگهبانی نظامی بر عملکرد حرکتی و غلظت کورتیزول و تستوسترون بزاقی

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چکیده: این پژوهش به بررسی تأثیر بی خوابی ناشی از نگهبانی نظامی بر عملکرد حرکتی و غلظت کورتیزول و تستوسترون بزاقی پرداخت. تعداد ۲۴ سرباز مرد فعال به طور تصادفی انتخاب و در دو گروه بی خوابی و کنترل قرار گرفتند. بی خوابی شامل دو ساعت نگهبانی با تجهیزات نظامی، دو ساعت آماده باش، و دو ساعت خواب بود که از ساعت ۱۶ شروع و تا ساعت ۶ صبح روز بعد ادامه داشت. چابکی، تعادل و زمان واکنش به عنوان شاخص های عملکرد موتور اندازه گیری شد. نمونه های بزاق صبح دو روز قبل، صبح بعد از اعمال بی خوابی و بعد از اندازه گیری عملکرد حرکتی جمع آوری شد. نتایج نشان داد که عملکرد چابکی در گروه بی خوابی ضعیف تر از گروه کنترل بود. عملکرد تعادلی گروه بی خوابی تفاوت معنی داری با گروه کنترل نداشت. زمان واکنش در گروه آزمایش در مقایسه با گروه کنترل کندتر بود. اگرچه زمان واکنش به طور قابل توجهی تحت تأثیر قرار گرفت، یافته های این تحقیق نشان داد که غلظت کورتیزول و تستوسترون بزاقی و همچنین چابکی و تعادل تحت تأثیر این میزان/نوع محرومیت از خواب قرار نمی گیرند

واژه‌های کلیدی: بی خوابی، مراقبت، چابکی، تعادل، زمان واکنش، کورتیزول بزاق، تستوسترون ؛

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