Work Fatigue in the Crosshairs

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Abstract *Examining work fatigue is vital for military organizations in order to maintain high levels of performance, occupational safety, and physical and mental health among military personnel. The aim of our research was to examine the consequences of the physical and mental stress associated with Camp Deployment Week (CDW) military training. According to the results of the nutrition analysis, the quality of the meals provided was inadequate, with too much fat and only fast-absorbing carbohydrates with a high glycaemic index. Regarding the micronutrients, the values of cholesterol, sodium, and phosphorus were particularly high. Regarding physical activity, the average number of steps was 118,000 steps/week, which is approximately 98 km/person/week. Based on the BMI value, 55% of the participants belonged to the overweight or obese category, and an elevated body fat percentage was measured in 65% of the participants. By the end of the training, we found a positive change in the body composition indicators of the soldiers with a high BMI. According to the Berlin questionnaire, 4 people are likely to suffer from sleep apnoea, 40% of the participants slept less than 7 hours a day and about 50% had inadequate sleep quality. The proportion of sleep disorders increased from the 3rd day of the training. The average heart function and cardiac stress values were appropriate (except for three and two people). According to our results, morning stress values were significantly lower as the sleep length increased. According to the score values of BDI-SF, it is probable that two people had moderate depression.*

INTRODUCTION

Work fatigue is a critical safety and well-being issue in military organizations. Numerous military research studies have focused on the effects and consequences of work fatigue within deployed combat settings, but less attention has been paid to non-combat, non-deployed conditions.[1] [2] [3] We believe that examining

1 Blais, Ann-Renée. et al.: *Work Fatigue Profiles: Nature, Implications, and Associations with Psychological Empowerment.*

2 Frone, Michael R., Blais, Ann-Renée: *Work Fatigue in a Non-Deployed Military Setting: Assessment, Prevalence, Predictors, and Outcomes.*

3 Weeks, Sharon R. et al.: *Physiological and Psychological Fatigue in Extreme Conditions: The Military Example.*

this topic in a non-combat, non-deployed context is vital for military organizations in order to maintain high levels of performance, occupational safety, and physical and mental health among military personnel. Therefore, the study was carried out during the training called "Camp Deployment Week" (CDW) among the soldiers of the HDF 205th Air Defence Regiment. CDW is a special training, the purpose of which is to maintain personal and unit readiness. Soldiers have to stay in the barracks all week long, where they take part in various training sessions from morning to evening. The aim of the research was to examine the consequences of the physical and mental stress associated with CDW military training. The advantages of the research:

– At the organizational level: The results and experiences obtained by examining the factors affecting the unit's adaptability and performance can be incorporated into the tasks related to the planning and implementation of training. It is possible to develop preventive interventions that allow soldiers to be healthy and fit, reach the maximum of their abilities, and are applicable at a specific time and place.
– At the individual level: Soldiers receive feedback on what physiological and mental consequences fatigue has on them and what they can do to maintain their health.

The investigation was based on a complex research plan consisting of two blocks: a psychological and a medical block. The research protocol includes nutrition analysis, physical activity and sleep monitoring, and subjective measurement of fatigue, depression, sleep apnoea and sleep length and quality. Furthermore, some instrumental examinations, such as cardiac function, stress load, body composition, and short-term memory are also included.

SAMPLE AND METHODS

A total of 76 people took part in the training, and a sample of 20 people was randomly selected from among them. The participants gave their written consent to participate and to the data being used for statistical purposes. The main socio-demographic characteristics of the sample can be found in Table 1.

Table 1. *The main socio-demographic characteristics of the sample*

Sample characteristics			
Number	20		
Gender (%)	Male: 90%	Female: 10%	
Mean age	31.5 years (Min.: 19; Max.: 56)		
Sporting activity	7.4 h/week (Min.: 3; Max.: 14)		
Education	Elementary school: 5%	Secondary school: 75%	College or university: 20%

FEATURES OF THE DEVICES USED

Omron BF511

To measure body composition, we used OMRON BF 511. This type of body composition analyser has been standardized in the HDF since 2015. The device also measures body weight, the ratio of body fat to visceral fat, the percentage of skeletal muscle structure, and is also capable of evaluating BMI classification value and resting metabolic rate (RMR).

Cardioscan

To test cardiac function and heart stress value, we used Cardioscan, which digitizes the pulses delivered by the heart through 4 electrodes and converts the ECG trace to ECP on a connected PC or laptop. The shape and colour of the image show the state of the heart immediately and traceably. From the digitized ECG registry, Cardioscan analyses heart rate variability (HRV), which changes with the stress on the heart, and can be used to detect the individual heart stress factor. The ECG as a function of time and the pulse rate spectrum provide information on the extent of the psychological and physiological load on the heart. For the reference range of values measured and calculated by Cardioscan, see Table 2.

Table 2: *Reference range of values measured and calculated by Cardioscan*

	Good	Normal	Worrying	Critical
Cardiac function	5.0–4.1	4.0–3.0	2.9–1.0	<1.0
Cardiac stress	<17%	17–50%	51–90%	>90%

Garmin Vivoactive HR

We monitored physical activity and sleep with the Garmin Vivoactive HR watch. Using heart rate data, the watch provides information on the calories burned and quantifies the intensity of the fitness activities. Garmin Connect™ was used to track and analyse the data. Sleep statistics, including total hours of sleep and sleep movement (such as deep sleep, light sleep, and periods of being awake), are displayed in the Garmin Connect™ account.

Berlin questionnaire

The Berlin questionnaire (11 items) was used for identifying subjects with obstructive sleep apnoea. The questionnaire consists of 3 categories related to the risk of having sleep apnoea. Patients can be classified into High Risk or Low Risk based on their responses to the individual items and their overall scores in the symptom categories. It is a simple, self-admin-

istered patient questionnaire and a validated predictive assessment tool designed to assess three OSA risk categories.[4]

Three-Dimensional Work Fatigue Inventory (3D-WFI)

The 3D-WFI (18 items) measured the level of physical, mental, and emotional fatigue of the participants. It measures tiredness experienced during and at the end of the workday. Each item loaded highly on its respective factor, thereby discriminating between Physical Work Fatigue (6 items), Mental Work Fatigue (6 items), and Emotional Work Fatigue (6 items).[5]

Beck Depression Inventory Short Form (BDI-SF)

The BDI-SF (13 items) was used for screening depression and measuring its severity in the case of participants. It is a relevant psychometric instrument, showing high reliability and a capacity to discriminate between depressed and non-depressed subjects.[6] [7]

The study started with a preparation phase we made the research plan and the nutritional analysis, which was based on the menu and the used raw materials. In addition, random sampling was carried out. Before the examination phase, the participants were informed about the study, consent forms and questionnaires were filled out, and body composition was measured. In the examination phase, instrumental tests and data collection from the smartwatch were carried out almost every day in the morning and evening hours.

We placed great emphasis on following the ethics rules in relation to data collection and analysis (informed consent form, analysis inadequate for personal identification), the results will be hereinafter communicated in compliance with the ethics rules.

RESULTS

In our lecture, we presented mainly descriptive statistical results, a deeper analysis is in progress, the results of which will be published later.

According to the results of smartwatch monitoring, 50% of the sample was in a caloric deficit during the training. The quality of the meals provided was inadequate, with too much fat and only fast-absorbing carbohydrates with a high glycemic index. There were very few vegetables on the menu and no fruit at all. Regarding the micronutrients, the values of cholesterol, sodium, and

4 Chamara, V. Senaratna et al.: *Validity of the Berlin questionnaire in detecting obstructive sleep apnea: A systematic review and meta-analysis.*

5 Frone, Michael R., Tidwell Marie-Cecile O.: *The meaning and measurement of work fatigue: Development and evaluation of the Three-Dimensional Work Fatigue Inventory (3D-WFI).*

6 Beck, A. T., Beck, R. W.: *Screening depressed patients in family practice. A rapid technic.*

7 Rózsa, S. et al.: *A Beck depresszió kérdőív rövidített változatának jellemzői hazai mintán.*

phosphorus were particularly high. In Table 3, the values marked in red show a deviation of at least 50% from the recommended amount.

Regarding physical activity, the average number of steps was 118,000 steps/week, which is approximately 98 km/person/week.

Based on the BMI value, 55% of the participants belonged to the overweight or obese category, and an elevated body fat percentage was measured in 65% of the participants.

By the end of the training, we found a positive change in the body composition indicators of the soldiers with a high BMI, their body fat percentage decreased, while their skeletal muscle percentage increased.

According to the results of the Berlin questionnaire, 4 people are likely to suffer from sleep apnoea. In assessing sleep, we used CDC recommendations as a basis, sleep was considered inadequate if it was shorter than 7 hours, and in terms of stages, if the proportion of deep sleep stages was less than 40%. According to the results of smartwatch monitoring, 40% of the participants slept less than 7 hours a day and about 50% had inadequate sleep quality. The proportion of sleep disorders increased from the 3rd day of the training.

Table 3: *Nutrition-related outcomes (micronutrients)*

	Needed value	Date				
		22.05.	23.05.	24.05.	25.05	26.05
Vit. B1 (µg)	900	3149	3957	3128	2108	2056
Vit. B2 (µg)	1300	1867	2376	2885	2030	1494
Vit. B6 (µg)	1300	4325	4549	4048	1808	4921
Vit. B12 (µg)	2.0	5.0	4.46	14	4.37	4.68
Vit. C (mg)	90	84	100	83	124	97
Retinol (mg)	0.8	0.4	1.2	5	0.47	0.45
Vit. E (mg)	15	27	55	27	37	35
Folic acid (µg)	200	151	118	410	196	129
Niacin (mg)	14	34	40	44	20	30
Panthotenic acid (mg)	5	5.1	3.9	10	5.2	3.6
Cholesterol (mg)	300	740	573	619	716	392
Fiber (mg)	25	28	38	40	24	34
Na (mg)	2000	10560	10277	9415	9485	9834
K (mg)	3500	3848	4563	3904	1948	4409
Ca (mg)	800	370	957	464	1206	402
P (mg)	620	1670	1947	1981	1699	1536
Mg (mg)	300	476	600	663	450	522
Fe (mg)	15	17	14.5	25	11	16
Zn (mg)	9	19	20	23	19	17
Cr (µg)	120	64	93	46	76	62

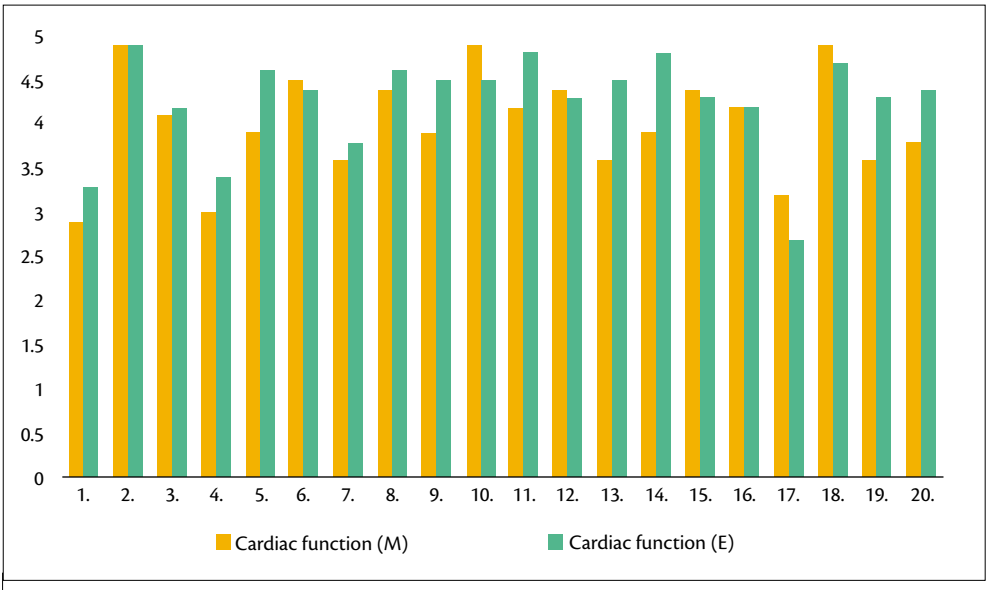

Figure 1: Average morning (M) and evening (E) cardiac function values

As for cardiac function, the average values ranged from 2.7 to 4.9. The average morning and evening heart function values were appropriate except for three people (No1, No4, and No17) (Figure 1).

When tested for cardiac stress, the average values ranged from 10% to 88%.

The average morning and evening cardiac stress values were appropriate except for two people (No4 and No17) (Figure 2).

We would like to point out that although these values are appropriate, they cannot be considered as good, especially if we consider the young average

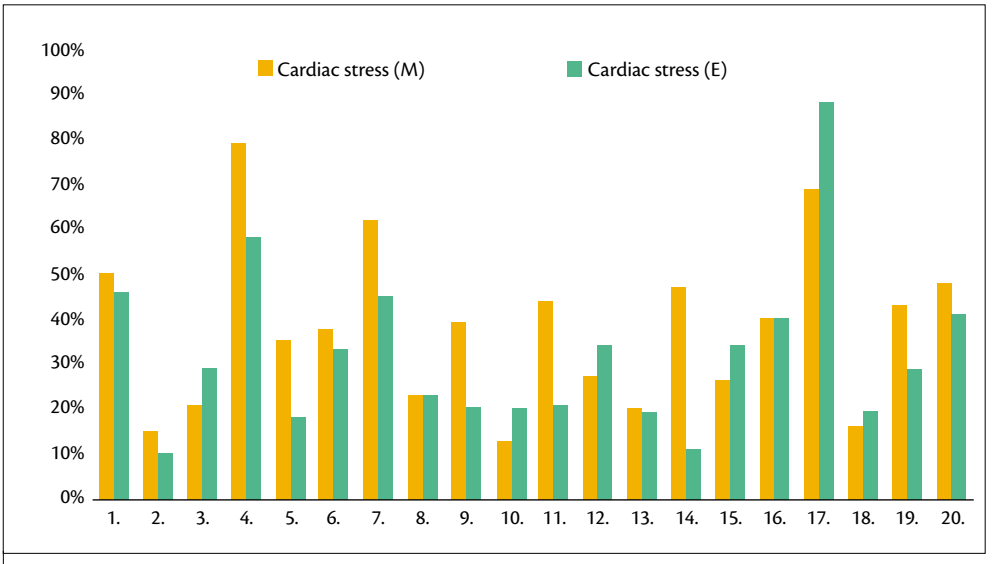

Figure 2: Average morning (M) and evening (E) cardiac stress values

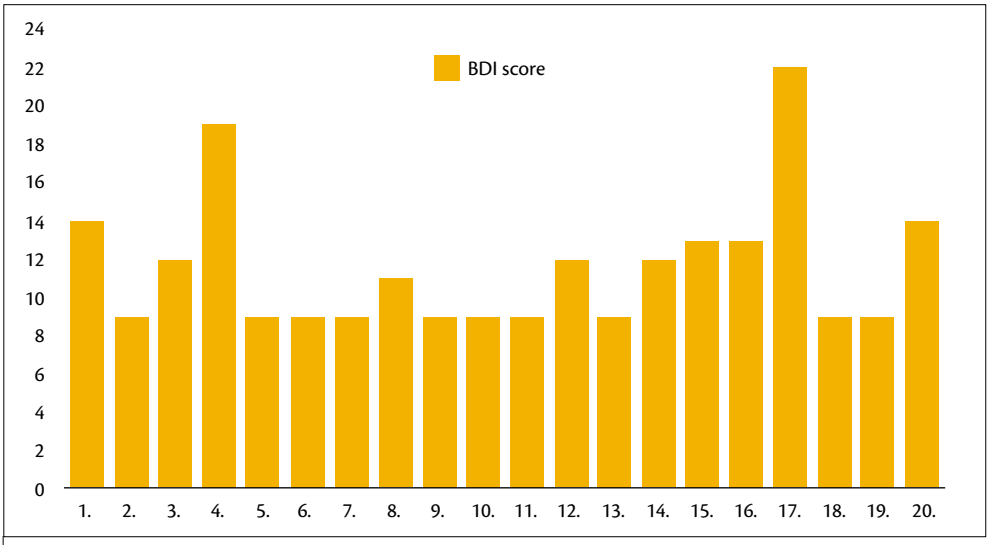

Figure 3: Score values of the Beck depression scale

age of the sample. This is especially true for cardiac stress values. Unfavourable values can also be caused by increased physical activity, but in our opinion, these results require further investigation.

A linear regression analysis was performed to analyse the relationship between sleep length and morning cardiac stress value. According to our results, morning stress values were significantly lower as the sleep length increased.

According to the score values of BDI-SF, it is probable that No4 and No17 had moderate depression (Figure 3).

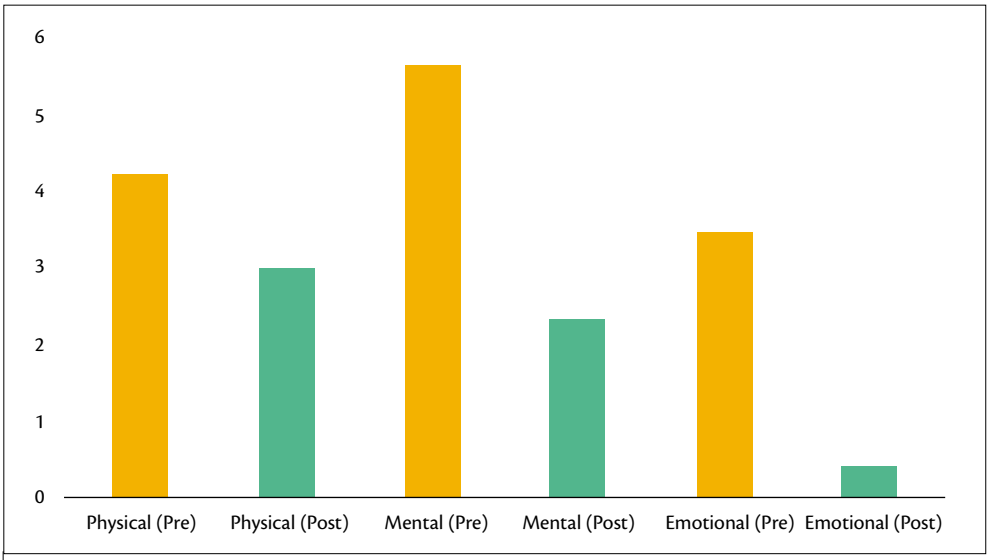

Figure 4: Average scores of the physical, mental, and emotional fatigue scales of the 3D-WFI

The average scores of the physical, mental, and emotional fatigue scales of the 3D-WFI can be seen in Figure 4.

We detected a significant decrease in the mental (t=2.58; df=14; p=0.021) and emotional (t=2.45; df=14; p=0.027) fatigue scores at the end of the training. It may seem a surprising result, but it agrees with what soldiers say after returning from deployment. This result draws attention to the importance of routine and everyday work stressors. The lower scores measured at the end of the training may be due to the fact that during the training the tasks and responsibilities are clearer, the tasks are more predictable, and the work is more plannable than on a routine workday.

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CÉLKERESZTBEN A MUNKAFÁRADTSÁG

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Kulcsszavak munkafáradtság, egészségügyi haderővédelem, táplálkozáselemzés, fizikai aktivitás, alvás

Absztrakt *A munkafáradtság vizsgálata létfontosságú a katonai szervezetek számára a katonaállomány magas szintű teljesítményének, munkabiztonságának és testi-lelki*

egészségének megőrzése érdekében. Kutatásunk célja a Tábori Kihelyezési Hét (TKH) katonai kiképzéssel járó fizikai és pszichés terhelés következményeinek vizsgálata volt. A táplálkozáselemzés eredményei szerint az étkezések túl sok zsírt és csak gyorsan felszívódó, magas glikémiás indexű szénhidrátot tartalmaztak. A mikroelemek közül különösen magas volt a koleszterin, a nátrium és a foszfor értéke. A fizikai aktivitást tekintve az átlagos lépésszám 118 000 lépés/hét volt, ami körülbelül 98 km/fő/hét. A BMI-érték alapján a résztvevők 55%-a tartozott a túlsúlyos vagy elhízott kategóriába, a résztvevők 65%-ánál pedig emelkedett testzsírszázalékot mértek. A kiképzés végére a magas BMI-vel rendelkező katonák testösszetételi mutatóiban pozitív változást tapasztaltunk. A Berlin-kérdőív szerint négy ember szenvedett alvási apnoéban, a résztvevők 40%-a aludt napi 7 óránál kevesebbet, és körülbelül 50%-uknak az alvásminősége nem volt megfelelő. A kiképzés harmadik napjától nőtt az alvászavarok aránya. A szívfunkció- és a szívstresszértékek átlaga (három, illetve két fő kivételével) megfelelő volt. Eredményeink szerint a reggeli stresszértékek szignifikánsan alacsonyabbakká váltak az alváshossz növekedésével. A BDI-SF pontértékei alapján valószínűsíthető, hogy két személy közepesen súlyos depresszióban szenvedett.