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Training Monitoring and Effect of Training Variables on Wellness Score in Elite Male Fencers

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Abstract

Subjective measures such as well-being indices may be beneficial to balance fatigue and recovery on the fatigue continuum and awareness of well-being is considered a useful sign for identifying nonfunctional overreaching (NFOR) status. Recovery and neuromuscular fatigue process from training may be delayed because of the eccentric component during a stretch-shortening cycle (SSC) type activities and needs to be well monitored during fencing training and matches. The aim of the study is to investigate training monitoring of elite male fencing athletes aged 15-23 and to examine the variables that affect wellness during intensified training sessions. The study includes 16 elite men's saber fencers who train regularly and comprised of 139 data concentrated on training and 6 data engrossed on competitions. These data were examined throughout 2 different time sessions and an overall duration. Wellness scores, acute/chronic workload ratio (ACWR) and monotony scores were collected. The main findings of this study, in training loads a statistically significant difference was not observed between sessions, but in wellness scores, a significant difference was observed between sessions (acute load, p=0.861; hooper index, p=0.003). ACWR (p=0,6103) and monotony (p=0,4810) scores were not observed to be significant predictors of wellness both univariate and multivariate. In summation, this investigation concluded and reinforced the notion that the wellness score is a vital criterion in training and performance monitoring. It was discovered and noted that the continuity of the trainings and the increased intensity of the competition resulted in the wellness score to increase during the second session.

Keywords: Training monitoring, fencing, wellness, sRPE

Elit Erkek Eskrimcilerde Antrenman Takibi ve Zindelik Skoruna Antrenman Değişkenlerinin Etkisi

Zindelik indeksi gibi subjektif ölçütler, yorgunluk ve toparlanmayı dengelemek için faydalı olabilir. Ayrıca zindelik farkındalığı, işlevsel olmayan aşırı erişim (non-functional overreaching) durumunu belirlemek için faydalı bir işaret olarak kabul edilir. Antrenman kaynaklı toparlanma ve nöromüsküler yorgunluk süreci, gerilme-kısalma döngüsü (stretch-shortening cycle. - SSC) tipi aktiviteler sırasında eksantrik bileşen nedeniyle gecikebilir, dolayısıyla eskrim antrenmanı ve maçları sırasında iyi izlenmesi gerekir. Çalışmanın amacı, 15-23 yaş arası elit erkek eskrim sporcularının antrenman takibini ve yoğunlaştırılmış antrenman dönemlerinde zindeliği etkileyen faktörleri incelemektir. Çalışma, düzenli olarak antrenman yapan 16 elit erkek kılıç eskrimcisini kapsamaktadır. 139 antrenman ve 6 müsabaka verisi değerlendirmeye dahil edilmiştir. Bu veriler birinci, ikinci dönem ve genel dönem olarak sınıflandırılmıştır. Zindelik skorları, akut/kronik iş yükü oranı (Acute/Chronic Workload Ratio - ACWR) ve monotonluk skorları toplandı. Bu çalışmanın ana bulguları, antrenman yüklerinde dönemler arasında istatistiksel olarak anlamlı bir fark gözlenmezken, zindelik puanlarında dönemler arasında anlamlı bir fark gözlemlenmiştir (akut yük, p=0.861; hooper indeksi, p=0.003). ACWR (p=0,6103) ve monotonluk (p=0,4810) puanlarının hem tek değişkenli hem de çok değişkenli analizde zindelik durumunun kestiricisi olmadığı gözlemlenmiştir. Özetle, bu araştırma, zindelik puanının antrenman ve performans takibinde önemli bir kriter olduğu fikrini desteklemiştir. Antrenmanların devamlılığının ve müsabaka yoğunluğunun artmasının ikinci periyotta zindelik puanının yükselmesine neden olduğu gözlemlenmiştir.

Anahtar Kelimeler: Antrenman takibi, eskrim, zindelik, aAZD

INTRODUCTION

Fencing is an Olympic combat sport which includes both attacks and defensive movements between two athletes in regards to their respective weapons discipline and the rules regulated by the Fédération Internationale d'Escrime (FIE). During a fencing bout, lots of lunges, forward and backward change of direction (COD) occurs in a very short session of time and those high intensity explosive movements are interspersed with low-intensity mechanics (33). Over the years, the FIE has drastically altered the competitive nature of the rules governing each branches weapons. This has provoked elite level sportsman to perceive the importance of adopting superior footwork focused predominantly on explosiveness, speed, acceleration, and COD (2). As a result of these, the training load varied and it became important for trainer or researchers to calculate it in order to analyze both fitness and fatigue.

Recovery and neuromuscular fatigue process from training may be delayed because of the eccentric component during a stretch-shortening cycle (SSC) type activities and needs to be well monitored during fencing training and matches (16). Training load monitoring is a popular practice of today's sport science world and being used to observe whether an athlete is adapting to his/her training program. Acute:chronic workload ratio (ACWR) concept, introduced by Gabbett and Tim (14), aims to monitor an individual's response to training, assessing fatigue and the associated need for recovery, and minimizing the risk of nonfunctional overreaching (NFOR), injury and illness. These training-induced adaptations are associated with the internal training load which consists of the actual physiological stress imposed on the athlete's organisms. While heart rate (HR) and lactate are relatively poor tools for the measurements of internal load to monitor training stress for short duration high intensity or intermittent exercises. The rapid change in the rates of HR and oxygen consumption (VO2) during the exercises may not yield efficient results in determining the training intensity. Precise determination of training loads is of particular importance for annual planning. Therefore, the modified sRPE scale for resistance training started to be used in exercises (7). Session rated perceived exertion (sRPE; CR-10) is considered to be a valid and reliable tool with good internal consistency for both team sports and individual sports (7,28,29,35). Moreover, it has found that sRPE has a very strong relationship with internal (Edward and Bannister's TRIMP) and external (total distance, number of accelerations) training load parameters (1).

Given the complexity of team sports' intense training sessions, physical performance tests can be difficult to perform frequently. Due to various problems (material, logistical, physical etc.) it requires choosing cost-effective, non-intrusive devices that facilitate monitoring (23). Well-being assessment is a non-invasive, cost-effective, and convenient tool to assess readiness in team sports (32). The relationships between the perceived well-being of the athletes and the state of neuromuscular fatigue encourage the use of this method (19). The data show that perceived well-being exhibits some association with acute and chronic training loads. Subjective measures such as well-being indices may be beneficial to balance fatigue and recovery on the fatigue continuum. Awareness of well-being is considered a useful sign for identifying NFOR status. Hooper index is a well-being rating system, relative to fatigue, stress level, delayed-onset muscle soreness (DOMS) and sleep quality disorders. It is significantly vital that trainers take into consideration the subjective evaluations of their athletes while preparing a training schedule (21). Pre-season camp sessions are the intensified training sessions for a fencer and need to be well monitored with the wellness measures in order not to face with NFOR status.

In this line, training load and wellness monitoring has an important role because of the competitions which will be held consecutively. There are limited monitoring studies about fencing, which highlights internal training load (s-RPE) and wellness in the literature.

Therefore, in line with this information, the aim of the study is to investigate training monitoring of elite male fencing athletes and to examine the variables that affect wellness during intensified training sessions. It was hypothesized that ACWR and monotony would affect the Wellness score.

Materials And Methods

Participants

The study includes 16 elite men's saber (median age 16, 15.0-23.0 years; mean training age 6.88±2.45 years; height 177±52 cm; body mass 68.69±8.17 kg; body mass index 21.84±1.89 kg/m2) fencers who train regularly at the National Training Center. Participants were included and informed of the in-depth analysis conducted through their signatures of the designated consent form in accordance with the ethical standards of the Helsinki Declaration. This document was distributed to both those over the age of 18 who could legally give consent without permission from a guardian, as well as those under the age of 18, with the consent of a parent to participate.

Experimental approach and Study Design

The study is of an observational analytical nature and the data structure is longitudinal. No intervention was made on the participants, they were only monitored. The examination/analysis was conducted under the duration of 14 weeks, this applied to each athletic candidate enrolled in the experimentation. Throughout the time session of 14 weeks, both extensive and meticulous information was gathered, this comprised of 139 data concentrated on training and 6 data engrossed on competitions. Data of competitions were included to weekly load of training loads. The first 3 weeks weren't included in the statistical analysis as it was considered an adaptation session. The procedure had been scrutinized and examined throughout 2 different time sessions and an overall duration; weeks 4-8 being the first time session (61 trainings and 2 competitions), weeks 9-14 being the second time session (78 trainings and 4 competitions) and weeks 4-14 being the overall duration. During the study, the wellness scores were obtained via the Hooper index questionnaire (21). Acute load, chronic load, acute/chronic workload ratio (ACWR) and monotony values were taken by session rating perceived of exertion (sRPE) and duration of training (24). These values were collected every day and included to the statistical analysis. Afterwards, the differences between the first and second sessions were examined. Moreover, correlation of the variables between training monitoring dataset and wellness were examined, and the variables affecting wellness were examined (Table 1.).

Table 1. Schema of Study Design

SESSIONS			
1-3 Weeks	4-8 Weeks	9-14 Weeks	4-14 Weeks
Adaptation Session	First Session	Second Session	Overall Session
DATA COLLECTION			
sRPE		Wellness Scores	
After 30 minutes each training / bout		Every day - Wake up time	

sRPE: session rating of exertion.

Evaluation of Wellness Scores

Participants filled out the Hooper index questionnaire every morning and determined the values of sleep quality, muscle soreness, stress level and fatigue (34). The questionnaire is 7-point Likert type and "1" representing the best or the lowest level, while "7"represents the worst (e.g., sleep) or the highest (e.g., stress, muscle soreness) level. The wellness value is obtained by the sum of 4 sub-scales. The data gathered is than incorporated and implemented into each fencer’s own private page via Google Sheets where the results are evaluated meticulously. Thus, peer influence was avoided and tampering of the results.

Evaluation of Training Load, ACWR and Monotony Values

With the sRPE CR-10 Borg Scale, training intensity was evaluated subjectively 30 minutes after each training or each bout (34). Fencers answered the question on the Borg scale, "How tiring and physically exhausting was the training/bout?" to gather intel directly correlating and highlighting to sRPE guidelines and standards, dictating where the participant stands on the scale. The training load is obtained as a unit by multiplying the athlete's sRPE value by the training or bout duration (in minutes). Acute load, chronic load, ACWR and training monotony values were determined by training load in addition (25).

Acute load represents the intensity of the training and competition carried out in 7 days (1 week). Chronic load represents the average intensity of the trainings and competitions performed in 21 days (3 weeks). ACWR is calculated by dividing acute workload by chronic workload. In this study, exponentially weighed moving average (EWMA) method was used in the ACWR calculation. The EWMA cares about the physical fitness levels of athletes as it does not separate historical data from the average data. Accordingly, it was seen that EWMA gave better results than the rolling average (RA) model (18).

The monotony value is calculated by dividing the weekly average load by the standard deviation of the weekly load. While this value may be high as a result of continuing the training with similar loads, its value will be low as a result of performing with changeable loads (13).

Statistical analysis

The Shapiro-Wilk test of normality was used to evaluate the distribution of the data. Mean±standard deviation values were used for normally distributed variables. The median (minimum value-maximum value) was used for variables with skewed distribution. The "Paired Sample t Test" and "Wilcoxon Test" were used to evaluate the differences between the sessions. Generalized Estimation Equations (GEE) method, one of the common approaches to analyze longitudinal data. This was used to examine the effects of session (time), age, EWMA-ACWR and monotony on wellness of the fencers. The final model was selected using The Corrected Quasi-likelihood under Independence Model Criterion (QICC), and the working correlation structure was selected using the quasi-likelihood information criterion (QIC). Variables, which did not have a significant effect, were not included in the final model. In order to evaluate the predictive performance of the model, Root Mean Square Error (RMSE) was calculated. Significance level was set at 0.05. Box plots were created using R, reshape2, ggpub, ggplot2 packages. Statistical analyses were performed using IBM SPSS Statistics for Windows, version 23.0 (Armonk, NY: IBM Corp.).

RESULTS

The main findings of this study, in training loads (TL) a statistically significant difference were not observed between sessions, but in wellness scores, a significant difference was observed between sessions. When the sub-scales were examined, a significant difference was observed in muscle soreness, fatigue and stress scores while no significant difference was observed in sleep quality (Table 2 and Figure 1.)

Table 2. Comparison of the Score Distribution of Hooper Index and Its Subscales between Session Groups (n=16)

Variable	Session 1 (Week 4-8)	Session 2(Week (9-14)	p
Hooper Index[a]	77.306±26.1914	91.073±30.7711	0.003[#]
Sleep Quality[a]	21.615±7.291	23.365±7.972	0.181
Muscle Soreness[a]	16.731±7.8928	20.01±9.1616	0.040[#]
Fatigue[a]	21.804±10.589	23.667±10.6225	0.032[#]
Stress[b]	13.7 (7.6-43)	19.417 (9.167-49)	0.003[#]
Acute Workload[a]	2684.375±1298.694	2731.25±1345.868	0.861
Chronic Workload[a]	3131.1±1529.0036	2760.208±1374.3429	0.206
ACWR[b]	0.967 (0.258-1.84)	0.963 (0.272-1.148)	0.569
Monotony[a]	1.065±0.3279	0.973±0.307	0.200

[a]. Paired samples t test ; [b]. Wilcoxon test ; [#]. significant effect at the p<0.005 level

bold p values indicates that the difference between session groups is statistically significant at p<0.05

In Table 3, GEE is used to determine the predictors of the hooper index. GEE have been developed to obtain longitudinal, clustered, more efficient and unbiased estimations. And it can make predictions by making the assumption of normality and unrelated error terms unnecessary. The increase in the wellness score in the second session was statistically significant both univariate and multivariate. Age, EWMA ACWR and monotony scores were not observed to be significant predictors of wellness both univariate and multivariate.

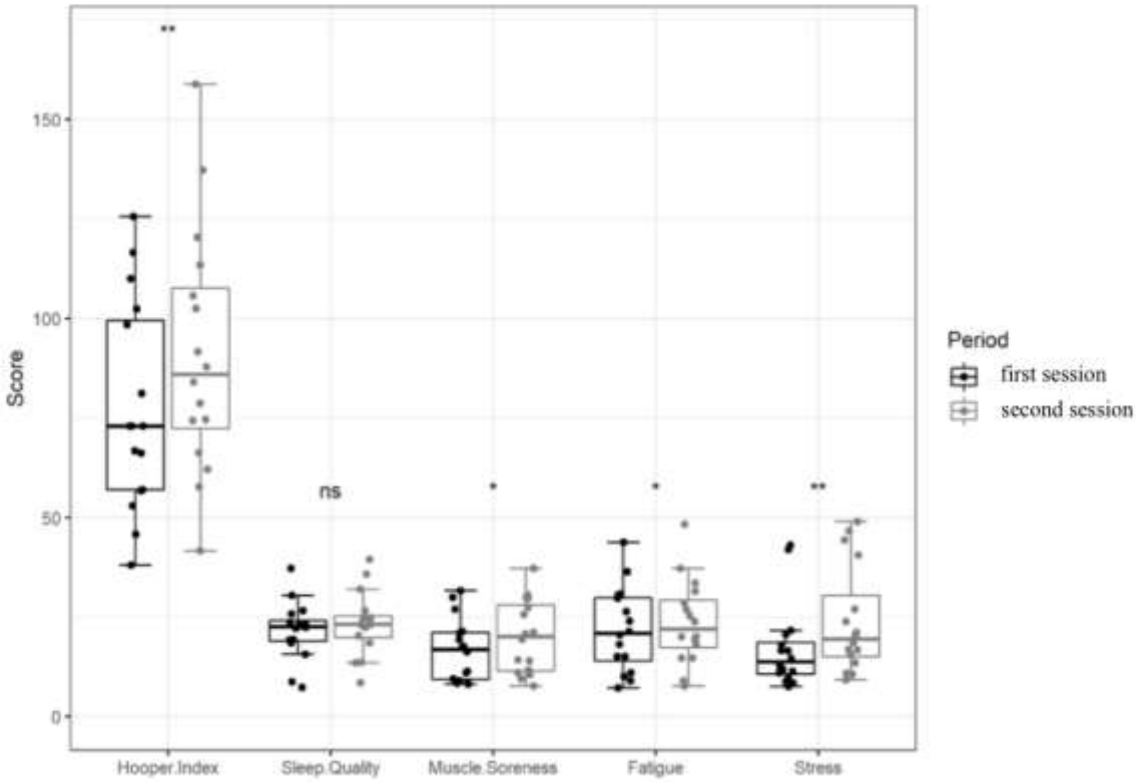

Figure 1. Plot of Hooper Index scale and its sub-scales in periods.

Table 3. Results of the Generalized Estimating Equation Models for Predicting Hooper Index

Variable	Univariate			Multivariate		
	Coefficient	p	RMSE	Coefficient	p	RMSE
Session 2 (Week 9-14)*	13.77	0.0003#	27.67	13.40	0.0009#	27.96
Age	-0.54	0.7235	28.48	-0.58	0.7601	
ACWR	-4.60	0.6103	28.54	-4.20	0.5580	
Monotony	-7.31	0.4810	29.06	-3.69	0.8453	

*Referance group is Session 1 group

significant effect at the p<0.005 level

Model residuals were normally distributed at 0.05 significance level in all univariate and multivariate models.

A moderate correlation (0.30-0.50) was observed between Hooper Index value and acute load for all sessions. A moderate correlation (0.30-0.50) was observed with acute load in the first session in sleep quality and fatigue sub-scales. In muscle soreness, the correlation level was small with all sessions of acute load. And for stress, the correlation level was trivial (-0.10 - +0.10) with second session and overall of acute load (Figure 2.).

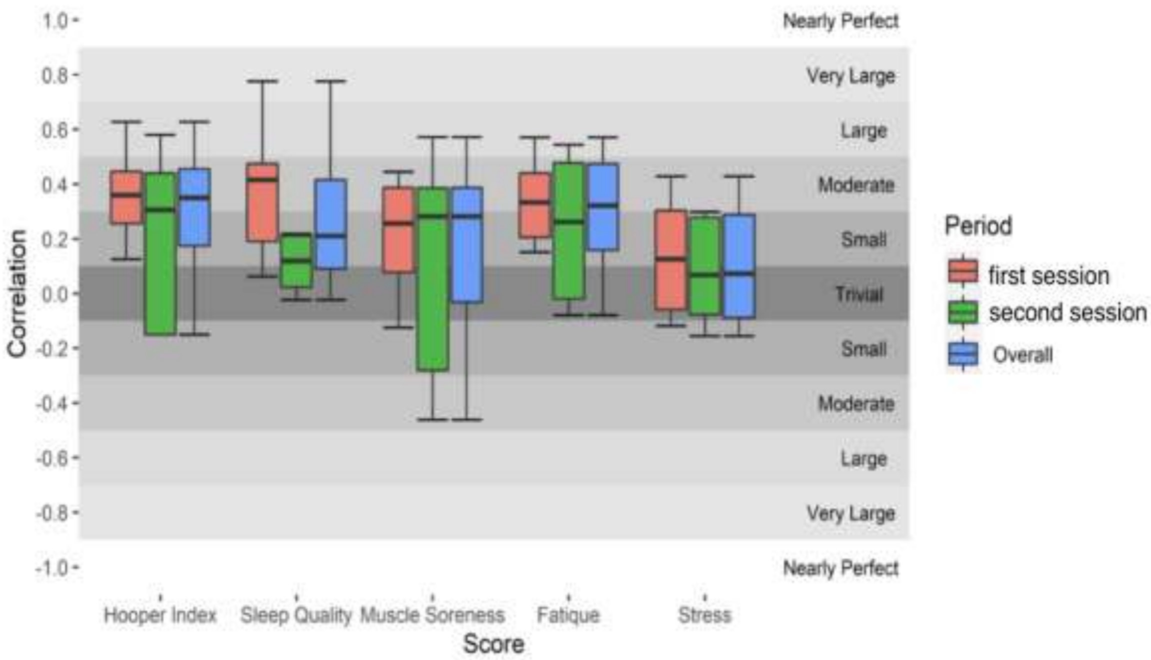

Figure 2. Correlations between Acute Load (AL) and Hooper Index scale and its sub-scales. First box plots represent the first session, second box plots represent the second session, and the last box represent the overall results.

A small correlation (0.10-0.30) was observed in the ACWR score in the second session of the hooper index, the second session of sleep quality, the second session of the fatigue score, the second session of the stress score. And correlation level was trivial between ACWR and first session of hooper index, sleep quality and overall of hooper index, sleep quality fatigue and stress (Figure 3.).

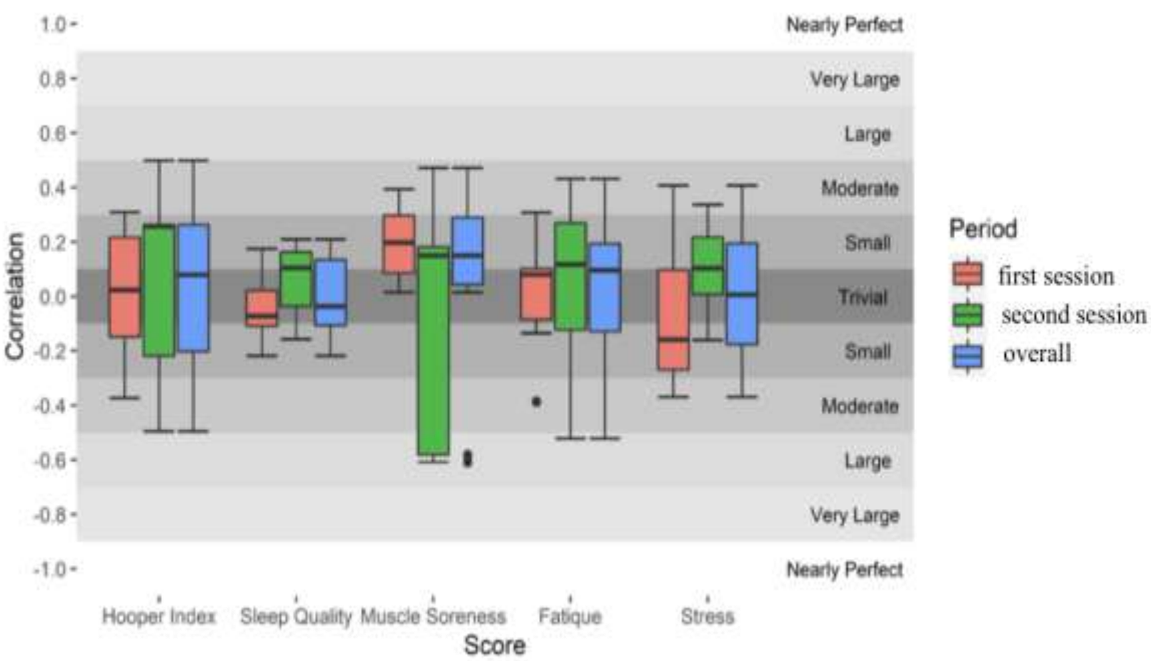

Figure 3. Correlations between ACWR and Hooper Index scale and its sub-scales. First box plots represent the first session, second box plots represent the second session, and the last box represent the overall results.

DISCUSSION

In this study, the experimentation meticulously examined training monitoring and the variables affecting the wellness score of elite male fencers. In this context, a significant difference was observed between the sessions of wellness among the fencers who participated in the study. Moreover, a significant difference was observed between sessions in muscle soreness, fatigue and stress scores, while no significant differences was found in sleep quality. No significant difference was observed between the sessions in the parameters of acute load, chronic load, ACWR, and monotony.

When the training monitoring data was examined, it can be said that the training load values were at the optimal level (14). Similarly, it was observed that the monotony values were far from the overtraining level (13). The training loads, acute and chronic workloads in this study were similar in studies performed in different sports branches (29, 30). In this line, Nobari et al. (29), observed similar values in acute load (pre-season:2269, mid-season: 2497, end-season: 2414), (pre-season: 2209, mid-season: 2507, end-season: 2469) and ACWR in their study on wrestlers (ACWR: Pre-season: 1.11, mid-season:1.00, end-season: 0.99). Paulauskas et al. (34), in their study on female basketball players, observed that there were similar results in acute load, chronic load, ACWR, and monotony values (30). Contrary to these studies Turner et al. (35), in their study on fencers, observed that the weekly training load was higher compared to this study. Again, Turner et al. supported this study with the finding that sRPE is a reliable scale in fencers.

The increase in the wellness score means the decrease of the fitness levels of the athletes. Therefore, compared to the first session, it can be said that the training and competitions in the second session affected the athletes both mentally and physically. Acute load and chronic load values support these findings. Recent studies in the literature have reported that there is a relationship between training load and well-being (sleep, stress, muscle pain) (10,17,26). In the second session, while the acute load value representing fatigue increased, the chronic load value representing the fitness level decreased. However, no statistically significant differences was observed. As a result of the study of Windt et al. (36) according to the importance of the match or event, the coaches suggested that they could reduce the training intensity in order to prevent poor performance and injury. The stress associated to an important competition or big organization such as the Olympic games can increase the stress level of the athlete and it is highly recommend that a plan should be implemented accordingly. In this study, the biggest increase occurred in the stress variable in the second session. It can be said that the stress level of the athletes are associated with the increase in the intensity of the competition and the increase of the importance of the competition during the season, each competition distributes different amounts of both prestige and points on the world ranking, distributing different amounts of stress on each individual fencer.

The change of well-being between sessions can be considered normal in sports teams. Well-being scores decreased during the intense, fast-paced and tiring sessions of the season (5). In a sport that includes repetitive explosive movements such as volleyball, the effect of training is generally associated with certain sessions of the season (8). For example, it has been reported that the monitoring of training load has a positive relationship with health before and in the middle of the season, while it has a negative relationship with well-being towards the end of the season (7). Considering the results of these research findings, the reason for the increase in the second session well-being score may be the accumulated fatigue and the increased number of competitions. It can be said that there are 2 competitions in the first session, 4 competitions in the second session and the increasing importance of the competitions affect the wellness scores of the athletes negatively. Similar to our study, Hills et al. (20) it has been reported that the accumulated fatigue and low rest towards the end of the season in rugby athletes at 12-week monitoring negatively affect well-being scores. Although the training load has similar values, the low monotony value may be due to the fact that the practitioners followed a planned and conscious training program. The fact that the ACWR value is also at an optimal level supports this interpretation. Nobari et al. (27) reported a significant increase in DOMS scores in wrestlers during the peak sessions of the season. Again, Clemente et al. (6) found that the wellness scores in basketball players was higher in the weeks with 2 games compared to the weeks with a single game. Considering these results in the literature, the decrease in the well-being of the current study during the busy weeks of the season supports the literature.

The sub-scales of the Hooper index are as important as the overall wellness score. There are numerous of studies in the literature that examine this situation individually. Govus et al. (17), stated that muscle soreness is associated with sRPE and stated that muscle soreness is important in the responses of the training given to the athletes. Similarly, Tavares et al. (31) stated that the muscle soreness monitoring of rugby athletes is more important especially in the lower body and depends on the training performance of the athletes. In this study, the increase in muscle soreness in the second session can be explained by increasing loads by continuing training and competitions without interruption. It is known that keeping sleep quality at a good level is one of the best recovery methods against fatigue. At the same time, it was seen in a study that sleep can be affected by many external factors like stress, environmental pressure, and anxiety (12). Driller et al. (11) in another study, which compared the sleep of athletes and non-athletes, and found that although athletes need more sleep, they sleep less than sedentary people. Parallel to this study, Ma et al. (22) concluded that knee injury due to overuse did not affect sleep quality in male fencers.

In this study, it was seen that while the Hooper index provided moderate correlation with acute load, it provided a small correlation with ACWR. Moreover, as a result of the GEE analysis, it was observed that the fitness score was not a significant predictor of age, ACWR and monotony values, except for the sessions. As a result of a comprehensive (n=14109) study on this subject, Campbell et al. (3) reported that both internal and external load were predictors of the wellness score to a limited extent and stated that practitioners should be careful when interpreting scores. Similar to the findings of this study, Delaney et al. (9) did not find a significant relationship between pre-training wellness scores, external load and sRPE. Nobari et al. (28) reported that the hooper index is the best predictor of acute load. In the same study, the sleep quality also stated a significant correlation with acute load. Clemente et al.(4) observed that the Hooper index was associated with acute load, chronic load, and ACWR. Gallo et al. (15) reported that pre-training wellness score is related to external load and internal load and can provide information about the training output that players can produce for a session. As a result of these findings, it can be said that the wellness scores of the athletes may be affected by other external factors as well as the training load. In addition, analyzes of well-being and training load can help make the management of trainers' training load more effective and prevent harmful acute reactions such as muscle pain, sleep, stress and fatigue. This study is limited to 16 fencers training at Turkish Olympic Training Center. It is also limited to male fencers and sabre fencers. Due to the small number of athletes in this training center, no calculation was made regarding the sample size and all athletes who volunteered to participate in the study were included in the study.

CONCLUSION

In summation, an in-depth carefully analyzed study was conducted exhibiting and portraying elite male fencers training monitored results. This investigation concluded and reinforced the notion that the wellness score is a vital criterion in training and performance monitoring. It was discovered and noted that the continuity of the trainings and the increased intensity of the competition resulted in the wellness score to increase during the second session. Nevertheless, it should be duly noted that the wellness score is a sensitive variable and may be affected by other factors such as education and social environment that were not included in the study. It is advocated and recommended that further training monitoring studies are crucial to evaluate fencers and their wellness score to alter the trajectory of future studies and analysis in order to foster more appropriate and effective training programs for recreational, competitive, national team, and Olympic level fencers.

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