

Research Article

Influence of Psychophysical Recovery and Stress on Physical and Technical Performance Parameters in Professional Soccer

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Abstract

We examined the role of stress and recovery for technical and physical performance parameters of 19 professional soccer players in a prospective non-experimental cohort design over the course of 2 consecutive seasons. We employed the Recovery-Stress Questionnaire for Athletes with 52 items (RESTQ-Sport 52) and collected 5 performance parameters with the computerised stationary tracking system Amisco. The general stress scales General Stress ($p=0.01$), Emotional Stress ($p=0.02$) and Lack of Energy ($p=0.04$), the general recovery scale General Well-Being ($p=0.04$) and the sport-specific recovery scales Personal Accomplishment ($p<0.01$) and Self-Efficacy ($p=0.02$) were significantly associated with the performance parameter loss of ball possession. The sport-specific recovery scale Personal Accomplishment was furthermore significantly related to the performance parameters won challenges ($p=0.03$) and successful distributions ($p<0.01$). The general and sport-specific stress scales of the RESTQ-Sport 52 together explained 21.3% of the variance in loss of ball possession, 8.9% of the variance in won challenges and 9.1% of the variance in successful distributions. The general and sport-specific recovery scales together explained 18.5% of the variance in loss of ball possession, 7.5% of the variance in won challenges and 8.1% of the variance in successful distributions. This supports the importance of the longitudinal assessment of a personal recovery stress profile for the performance of professional soccer players that could be supplemented by physiological data.

Keywords: Sport and Exercise Psychology; Psychological Measures; Football; Self-Efficacy

Introduction

In professional soccer, recovery and stress factors become more and more important due to the increased physical and psychological pressures related to this type of sport. Current

developments in football show that professional soccer players have an average number of 36 matches per season. Top players, who play international cup and national team games, have as many as 46 matches during a season [1]. In addition to

the large number of matches, permanent pressures related to travel, unfamiliar sleeping surroundings and disruption of circadian rhythms are present and make it difficult for the players to achieve physical and mental recovery [2]. Thus, professional soccer players seem to experience a high level of psychophysical stress and strain that may impact on their performance.

Stress is usually defined as both the stimulus that impacts on an organism and challenges its homeostasis and the adaptive response of the organism to stressful events that includes both psychological and physiological responses [3]. In the context of sports, not only stressors and stress responses but also adequate recovery periods, during which psychological and physiological parameters of the stress response can return to normal values, have been discussed as important modulators of performance [2,4,5]. To assess both, stress and recovery, Kellmann and Kallus [6,7] developed the Recovery-Stress Questionnaire for Athletes (RESTQ-Sport), which has been used to assess the current recovery-stress state of an athlete depending on his or her preceding activities.

Soccer includes many physical performance parameters such as endurance, sprinting, acceleration, changes of direction, challenges, as well as technical performance parameters such as dribbling, shooting and passing that need physical capacity and psychological abilities [2]. In recent years the number of studies concentrating on performance analysis increased [8-15], however, most of them either focused on performance parameters or on physical variables such as training intensity or weather conditions rather than psychological variables.

Outside of soccer, the relationship of recovery and stress and the performance of athletes have been addressed in some detail. Most studies examined the effects of training on performance capacity. If there is a lasting imbalance between recovery and stress factors, health problems that include the main symptoms reduced performance, permanent fatigue, reduced well-being, impaired reproductive function and altered immune function have been observed [4,16-18]. Specifically, the topic of recovery and its association with performance needs further research, since there is an imbalance of scientific research related to recovery and stress processes [2,19]. Most of the studies on the topics of stress and recovery focused on general medical and psychological aspects of stress rather than on recovery [19]. In professional soccer, a reduction of stress is almost impossible, since the game plans are made by the respective league. Thus a potential change can only be brought about by the increase of recovery aspects in order to reduce the imbalance of recovery and stress.

Over the last years, several research projects have been conducted that have examined performance and performance-related parameters in young elite and professional soccer players. For example, Filaire, Lac, and Pequignot [20] showed that increased emotional distress such as depression, tension,

fatigue and anger and poor performance in matches were related. Schmikli, de Vries, Brink and Backx [21] examined the relationship of decrements in performance and performance-related stress hormones and emotional well-being in young performance-oriented soccer players. Players with a lower level of performance showed psychological and hormonal changes that were comparable to the state of nonfunctional overreaching, i.e. a state of prolonged reduced performance, often coupled with other symptoms such as increased fatigue or poor sleep. Specifically, they reported higher depression and anger scores and lower growth hormone and adrenocorticotropin hormone levels after maximal exercise. In addition, Brink et al. [22] reported that overreaching was related to a dysfunctional recovery and stress balance in the time prior to the performance decrement in this group of athletes. In a related study they observed a close association between recovery and stress variables and illness as well as injury, which was also related to physical stressors [23].

Brink et al. [22,24] proposed that the amount of recovery may be important in order to improve performance, however, a scientific evaluation of this relationship in professional soccer players is still rare [25]. Thus, the goal of this study was to examine the relationship of recovery and stress and performance parameters in professional soccer players over two consecutive seasons. We hypothesized that both high stress and low recovery values in the general as well as sports-specific scales would contribute to lower performance.

Materials and Methods

Participants

We used a prospective non-experimental cohort design to assess 19 professional soccer players in the highest German Football League (1. Bundesliga). The size of the team was 26 players in the 2009/10 season and 25 players in 2010/11. The three goal keepers were not considered for this study since the performance parameters for goal keepers are different from those of field players. Six players refused to participate in 2009/10 and three in 2010/11. Thus, a total of 17 players participated in year one and 19 players in year two. A total of 15 field players took part in the study over the entire two-year assessment period. The mean age of the players was 24.3 ± 4.8 years, all were male. The players signed informed consent and the club consented to the use of the recovery, stress and performance data in anonymous versions for research purposes. The ethics committee of the Medical Faculty Mannheim of Heidelberg University approved the study, which adhered to the Declaration of Helsinki.

Materials

The Recovery-Stress Questionnaire for Athletes (RESTQ-Sport)

assesses the current stress and recovery levels of athletes and provides a comprehensive picture of the stress level and the potential for recovery an athlete could experience. We used the RESTQ-Sport version with 52 items (RESTQ-Sport 52) and an introductory item that is not used in the analysis. The recovery and stress level of the players was assessed in monthly intervals in the two seasons 2009/10 and 2010/11. All players completed the questionnaire in their own language two days before the observed games. The RESTQ-Sport 52 is comprised of 19 general and sport-specific scales. The 7 general stress scales with 2 items per scale are General Stress, Emotional Stress, Social Stress, Conflicts/Pressure, Fatigue, Lack of Energy, Physical Complaints. The 5 general recovery scales include also 2 items per scale and assess Success, Social Recovery, Physical Recovery, General Well-Being, Sleep Quality. The 3 sport-specific stress scales with 4 items per scale are Disturbed Breaks, Emotional Exhaustion, Injury. The 4 sport-specific recovery scales that involve also 4 items per scale are Being in Shape, Personal Accomplishment, Self-Efficacy, Self-Regulation.

Each player indicated on a verbally anchored seven-level discrete frequency scale ranging from 0 = never to 6 = always, how often a specific event mentioned in the item occurred in the last three days/nights. High values on the stress scales indicate a high level of stressful activities whereas high levels on the recovery scales indicate a high level of activation that enhances the regaining of resources and recovery from stress [6,7].

The scales have good internal consistency (0.67 to 0.89) and high test retest reliability (>0.79). The test retest reliability coefficient decreases with increasing time distance in line with the construct of recovery-stress that addresses changes in function and short-term changes in general well-being [6,7]. The correlations among the items and the recovery and stress tests are positive, whereas the recovery and stress tests are negatively correlated. Principal component analyses yielded the general and sport-specific stress and recovery factors described above.

Match Performance Parameters

We used the computer-assisted stationary tracking system of Amisco (Amisco Pro®, version 1.0.2, Sport Universal Process, Nice, France), which permits a quantitative match evaluation in team sports. The computerized video tracking systems is reliable and valid [26,27]. The coaches of the investigated club concentrated on 5 performance parameters to interpret the physical and technical performance of a player in a game. The parameters were total distance covered, distance in sprints ($>24 \text{ km} \cdot \text{h}^{-1}$), loss of ball possession (percentage of lost balls/number of individual ball possession), won challenges (percentage of number of won challenges/number of all challenges) as well as successful distributions (percentage of successful distributions/number of all distributions played with foot

or head).

Since not all clubs used such an analysis system in the 2009/10 season, in 10 away matches only the total distance covered and distance in sprints variables were assessed. In the 2010/2011 season, all Bundesliga teams but one had established such a system.

Statistical Analysis

From August 2009 until April 2011 a total of 172 assessments of stress and recovery data and match performance parameters were included in the analysis. The average number of games played were 9.1 per player (SD 5.2) ranging from 1 to 17 games. Only players who completed the RESTQ-Sport 52 two days before the game and who participated in the league game two days later were included. The RESTQ-Sport 52 was filled out every 4 weeks, thus not covering all the games but only the games preceded by the assessment. The hypotheses were tested by the use of bivariate and simultaneous regression analyses. Since the players did not all perform in the same number of matches, the varying repeated measures were taken into account in the analysis using the Genmod procedure of the analysis system SAS 9.3. (SAS Institute, Inc., Cary, NC), which permits the use of repeated measures of varying length. This uses the Generalized Estimating Equations (GEE) method [28]. Dependent variables were the performance parameters loss of ball possession, won challenges, successful distributions, total distance covered and distance in sprints. The independent variables comprised the 19 general and sport-specific stress and recovery scales from the RESTQ-Sport 52. The hypotheses for the regression coefficients were tested with z-tests (Proc Genmod). The sign of the regression coefficient (B) permits the determination of the direction of an association. P levels were set at <0.05 for significance.

Results

The general hypothesis was that high stress values would decrease performance and high recovery-related values would improve it. The influence of the general stress scales General stress ($p=0.01$), Emotional Stress ($p=0.02$), Lack of Energy ($p=0.04$), the influence of the general recovery scale General Well-Being ($p=0.04$) and the influence of the sport-specific recovery scales Personal Accomplishment ($p<0.01$) and Self-Efficacy ($p=0.02$) on the variable loss of ball possession were significant. All signs of significant coefficients were according to the prior hypotheses. The influence of the sport-specific recovery scale Personal Accomplishment ($p=0.03$) on the variable won challenges was also significant. The same was true for the influence of Personal Accomplishment ($p<0.01$) on the variable successful distributions. Again, all signs of the regression coefficients were in the predicted direction. Table 1 shows the results of the bivariate regression analyses.

Table 1. Predictors for the Technical and Physical Performance Parameters.

	Performance Parameters														
	loss of ball possession			won challenges			successful distributions			total distance			distance in sprints		
	B	test	p	B	test	p	B	test	p	B	test	p	B	test	p
General Stress	0.05	2.65	0.01*	-0.03	-0.93	0.35	-0.02	-0.95	0.34	0.27	0.22	0.83	0.08	0.15	0.88
Emotional Stress	0.04	2.24	0.02*	-0.02	-0.88	0.38	-0.02	-1.74	0.08	-0.01	-0.01	1.00	0.32	0.85	0.39
Social Stress	0.03	1.55	0.12	-0.01	-0.30	0.76	-0.02	-1.30	0.19	0.00	0.00	1.00	-0.05	-0.17	0.87
Conflicts/Pressure	0.02	1.57	0.12	0.00	0.13	0.90	-0.01	-1.24	0.22	-0.75	-0.70	0.48	-0.06	-0.24	0.81
Fatigue	0.03	1.68	0.09	0.00	0.06	0.95	-0.02	-1.13	0.26	-0.53	-0.45	0.65	-0.14	-0.31	0.76
Lack of Energy	0.07	2.04	0.04*	-0.05	-1.07	0.28	-0.04	-1.34	0.18	-1.26	-0.53	0.59	0.42	0.82	0.41
Physical Complaints	0.04	1.09	0.27	-0.08	-1.83	0.07	-0.03	-1.18	0.24	0.61	0.37	0.71	-0.52	-0.62	0.53
Success	-0.02	-1.96	0.05	0.03	1.16	0.25	0.01	1.52	0.13	-0.44	-0.54	0.59	-0.03	-0.06	0.95
Social Recovery	-0.01	-0.61	0.54	0.01	0.39	0.70	0.02	1.47	0.14	0.05	0.03	0.98	0.22	0.46	0.65
Physical Recovery	-0.01	-1.09	0.28	0.01	0.38	0.71	0.02	1.65	0.10	-0.79	-0.75	0.45	-0.35	-1.22	0.22
General Well-Being	-0.04	-2.05	0.04*	0.02	0.70	0.48	0.02	1.29	0.20	-1.01	-1.00	0.32	-0.27	-0.78	0.44
Sleep Quality	0.00	-0.11	0.91	0.05	1.00	0.32	0.01	0.67	0.50	0.31	0.14	0.89	0.77	1.12	0.26
Disturbed Breaks	0.04	1.64	0.10	-0.02	-0.58	0.57	-0.03	-1.32	0.19	-1.85	-1.29	0.20	0.02	0.02	0.98
Emotional Exhaustion	0.05	1.69	0.09	0.01	0.19	0.85	-0.03	-1.30	0.19	0.98	0.93	0.35	0.13	0.16	0.87
Injury	0.01	0.99	0.32	0.05	1.59	0.11	-0.01	-0.91	0.36	-1.73	-1.07	0.29	0.36	1.05	0.29
Being in Shape	-0.03	-1.41	0.16	0.02	0.59	0.56	0.02	1.15	0.25	-0.31	-0.28	0.78	-0.18	-0.51	0.61
Personal Accomplishment	-0.03	-2.98	<0.01**	0.05	2.23	0.03*	0.02	3.62	<0.01**	-0.03	-0.03	0.97	-0.22	-0.49	0.62
Self-Efficacy	-0.05	-2.33	0.02*	0.04	1.53	0.13	0.03	1.70	0.09	-0.16	-0.12	0.91	-0.34	-0.69	0.49
Self-Regulation	-0.05	-1.81	0.07	0.05	1.56	0.12	0.03	1.58	0.11	-0.69	-0.47	0.64	-0.60	-1.65	0.10

Notes. * $p < 0.05$ ** $p < 0.01$.

The influence of the other general and sport-specific RESTQ-Sport 52 scales on the physical and technical performance parameters total distance covered, distance in sprints, loss of ball possession, won challenges and successful distributions was not significant and smaller than expected. The regression analyses that were performed with one independent variable at a time do not consider that the recovery and stress tests are mutually positively correlated [6,7]. Thus, we complemented the bivariate regression analysis with a simultaneous regression analysis. The physical and technical performance parameters total distance covered, distance in sprints, loss of ball possession, won challenges and successful distributions remained the dependent variables. The general and sport-specific RESTQ-Sport 52 scales were the independent variables of these analyses.

The general and sport-specific recovery scales Success, Social Recovery, Physical Recovery, General Well-Being, Sleep Quality, Being in Shape, Personal Accomplishment, Self-Efficacy and Self-Regulation together explained 18.5% of the variance in loss of ball possession, 7.5% of the variance in won challenges and 8.1% of the variance in successful distributions. For total distance covered and distance in sprints less than 2.5% of the variance were explained. The general and sport-specific stress scales General Stress, Emotional Stress, Social Stress,

Conflicts/Pressure, Fatigue, Lack of Energy, Physical Complaints, Disturbed Breaks, Emotional Exhaustion and Injury together explained 21.3% of the variance in loss of ball possession, 8.9% of the variance in won challenges and 9.1% of the variance in successful distributions. For total distance covered and distance in sprints less than 6.0% of the variance were explained.

Discussion

Recovery, Stress and Performance

The goal of this study was to determine to what extent recovery- and stress-related variables would predict the physical and technical performance parameters of professional soccer players. The data were assessed using the RESTQ-Sport 52 and the computer-assisted stationary tracking system Amisco and included data of two played seasons in the years 2009/10 and 2010/11 on 19 professional soccer players of a club in the highest German league (1. Bundesliga). The main results of this study were significant associations of some general and sport-specific stress and recovery scales (General Stress, Emotional Stress, Lack of Energy, General Well-Being, Personal Accomplishment, Self-Efficacy) and the performance parameter loss of ball possession. The influence on the performance parameters won challenges, successful distributions, total distance covered and distance in sprints was smaller than expected and in general not significant. Only the influence of the sport-specific recovery scale Personal Accomplishment on the performance parameters won challenges and successful distributions was significant.

These results suggest that sport-specific recovery has a relevant association with loss of ball possession and successful distributions. The sport specific recovery scales Personal Accomplishment and Self-Efficacy include factors such as accomplishing worthwhile things in the sport, understanding how the teammates feel about things, being convinced to have trained and performed well, to achieve performance at any time and convinced to achieve set goals during the performance. These recovery factors can counteract stress experiences and seem to be important for improved handling of the ball and successful distributions. Less balls were lost when the players were relaxed, content, felt themselves as part of the team and were convinced to have trained well and to be optimally prepared. As shown previously, ball possessions during running are a good predictor of overall won games and this relationship may therefore be important for the team success in general [29].

The general stress scales General Stress, Emotional Stress and Lack of Energy also had a significant relation to loss of ball possession. Thus, factors like feeling down, being depressed, anxious, in a bad mood or unable to concentrate all appear to be associated with more ball losses. Both soccer training and matches involve cognitively demanding tasks such as sustained concentration, perceptual skills and decision making that can lead to mental fatigue and therefore to reduced performance [2]. This might explain why the general and sport-specific recovery and stress scales have an influence only on the variables loss of ball possession and successful distributions. These tasks seem to be more technical and therefore more cognitively demanding than tasks such as total distance covered, distance in sprints that need more physical capacity. Further-

more, sport-specific recovery, which turned out to be a significant predictor for these more cognitive tasks, is a variable that can be actively influenced, because it comprises personal accomplishment, self-efficacy and self-regulation skills.

The general and the sport-specific recovery scales together explained 18.5% and the general and sport-specific stress scales together explained 21.3% of the variance in loss of ball possession, which is rather high for a non-experimental cohort design and the fact that only psychological variables were included. Brink et al. [22] showed that young elite football players with the diagnosis of overreaching showed a dysfunctional recovery score in the RESTQ-Sport two months before the diagnosis and the scales Emotional Stress, Physical Recovery, General Well-Being and Sleep Quality showed a significant difference to the control group. Our results support and extend these findings to adult professional players. Our study is also in line with studies outside of professional soccer, which also showed that poorer performance, severe fatigue, mood disturbance and immune system deficits are among the effects of a negative recovery stress balance [4,16-18,30,31].

Limitations

The disadvantage of a non-experimental cohort design and an applied setting is the large number of factors that cannot be controlled such as how many matches were won or lost, away versus home matches, weather conditions, strength of the competitors, or tactical instructions of the coach. The relatively small number of players who were assessed and the relatively small number of matches limit the generalizability of the study. In addition, the study relied exclusively on self-reports, which are prone to social desirability and false reporting [5].

Conclusion and Future Directions

This study prospectively addressed recovery and stress processes over an extended period of time (two playing seasons) in professional soccer players. An advantage of this study is the longitudinal assessment of the recovery and stress variables prior to the athletes' performance in real match situations and the use of differentiated performance measures as dependent variables. The repeated measures design improves the power of the study.

Our study showed that the recovery and stress variables have an effect on performance parameters in professional football. Some general stress scales of the RESTQ-Sport 52 appears to be an important stress-related predictor of the performance parameter loss of ball possession. Some general recovery and sport-specific recovery scales seem to be important recovery-specific predictors of the performance parameters loss of

ball possession and successful distributions. The positive associations between the psychophysical recovery stress balance and some performance parameters of the professional soccer players is an important message to the medical and psychological staff as well as to the coaches and managers of the clubs suggesting that a better control of stress and recovery phases in their players may improve performance at least in those performance parameters that depend on cognitive skills. Meyer et al. [5] noted that there is no single, reliable, valid and objective method that evaluates all aspects of the recovery state. Thus, future research should use multimodal assessments that involve psychological and physiological stress and recovery measures. In addition more frequent (e.g., weekly) assessments would be desirable. This would be facilitated by a short or screening form of the RESTQ-Sport, which may be too long for weekly use in professional sports.

In summary, the long-term evaluation of recovery and stress processes seems to be useful to predict alterations in performance of professional soccer players. This would suggest an interdisciplinary approach, where psychologists, physicians, physical therapists, fitness coaches and soccer coaches are integrated to create optimal conditions for professional football players in order to obtain a positive recovery-stress balance and to enable constant, long-lasting optimal performance.

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