Prevalence of non-functional overreaching and the overtraining syndrome in Swiss elite athletes

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Abstract

Objectives: Fatigue and unaccountable underperformance are common for athletes, but there is a lack of empirical data regarding the prevalence of non-functional overreaching (NFOR) and the overtraining syndrome (OTS). Using the overtraining definition of the European College of Sport Science (ECSS), the present study aimed to explore the prevalence, symptoms and associated factors of NFOR/OTS across Swiss elite athletes in various sports.
Method: 139 Swiss elite athletes (63 males and 76 females, M_{age} = 23.6, SD_{age} = 5.6 y) from 26 different sports completed a1 7-item online survey about underperformance and symptoms of NFOR/OTS. 95% of the sample represented Switzerland in their sport. Athletes were classified as NFOR/OTS by according to the overtraining definition of the ECSS. Data were analysed using Mann-Whitney *U* nonparametric tests and ANOVAs.
Results: 9% of the athletes were classified as OTS and 21% as NFOR at least once in their career. The prevalence was significantly higher in medium-physical demand sports than in low-physical demand sports (p = .02). There were no significant differences in the NFOR/OTS prevalence between individual and team sports and female and male athletes. Competition level and training load had also no significant influence on the NFOR/OTS prevalence, although low-physical demand sports trained significantly less than medium- and high-physical demand sports. Injury/illness, loss of weight and sleep disturbance rates were significantly higher in the NFOR/OTS group. More than 70% of the NFOR/OTS athletes reported loss of motivation and emotional disturbances.
Conclusions: The NFOR/OTS career prevalence rate of Swiss elite athletes can be estimated at approximately 30%. NFOR/OTS is accompanied by biopsychosocial signs of maladjustment, e.g., emotional disturbances, loss of motivation, sleep disturbances, injury/illness and weight loss, but training load is not a predictor of NFOR/OTS.

Keywords:
staleness, performance maladaptation, training load, adjustment disorder, sleep disturbance

Zusammenfassung

Absicht: Müdigkeit und unerklärbare Leistungsschwächen treten bei Sportlern häufig auf. Dennoch fehlen empirische Daten bezüglich der Prävalenz von non-functional overreaching (NFOR) und des Übertrainingssyndroms (OTS). Ziel der vorliegenden Studie war es, unter Verwendung der European College of Sport Science (ECSS) Übertrainingsdefinition die NFOR/OTS Prävalenz, Symptomatik und begleitenden Faktoren bei Schweizer Spitzensportlern unterschiedlicher Sportarten zu bestimmen.
Methode: 139 Schweizer Spitzenathleten (63 Männer, 76 Frauen; M_{age} = 23.6, SD_{age} = 5.6) aus 26 Sportarten füllten einen 17-item Onlinefragebogen zu Leistungsschwäche und NFOR/OTS Symptomen aus. 95% der Sportler hatten die Schweiz in ihrer jeweiligen Sportart schon vertreten. Unter der strikten Verwendung der ECSS Übertrainingsdefinition wurden die Sportler als NFOR/OTS klassifiziert. Zur Datenanalyse wurden Mann-Whitney *U* Tests und Faktorenanalysen verwendet.
Resultate: 9% der Sportler wurden als OTS und 21% als NFOR klassifiziert. Die Prävalenz war in moderat-körperlich beanspruchenden Sportarten höher als in gering-körperlich beanspruchenden Sportarten (p = .02). Keine signifikanten Unterschiede in der NFOR/OTS Prävalenz bestand zwischen Individual- und Teamsportarten sowie zwischen männlichen und weiblichen Sportlern. Wettkampfniveau und Trainingsbelastung hatte keinen signifikanten Einfluss auf die NFOR/OTS Prävalenz, obwohl gering-körperlich beanspruchende Sportarten signifikant weniger trainierten als moderat-körperlich beanspruchende Sportarten. Verletzungen/Krankheiten, Gewichtsverlust und Schlafstörungen sind in der NFOR/OTS Gruppe signifikant höher vertreten. Mehr als 70% der als NFOR/OTS klassifizierten Sportler berichteten über Motivationsverlust und emotionale Beeinträchtigungen.
Konklusion: Die NFOR/OTS Karriereprävalenz von Schweizer Spitzensportlern kann in etwa auf 30% geschätzt werden. NFOR/OTS ist von bio-psycho-sozialen Fehlanpassungssymptomen wie emotionaler Beeinträchtigung, Motivationsverlust, Verletzungen/Krankheiten, Schlafstörungen und Gewichtsverlust begleitet. Die Trainingsbelastung ist kein Prädiktor von NFOR/OTS.

Introduction

Overtraining is a widely used term in sport sciences. A literature search on SportDiscus with the term overtraining revealed 813 articles published between 1960 and 2013. If the search is extended by the terms of staleness and overreaching, terms that are sometimes interchangeably used by sport scientists, the result list increases to 935. Conversely, in spite of wide spread interest in overtraining it seems to be one of the most misunderstood and misconceived phenomenon in sport sciences. One reason for the lack of understanding is the lack of common or consistent terminology used in the field of overtraining research (Halson and Jeukendrup, 2004). For example, to label the phenomenon with the term "overtraining" may be a confounding factor itself. As a verb it characterises an action, a process. In the case of "overtrain" it conveys a process of too much training. Too much that is, in the sense of, too much for a positive adaptation to the training load. Yet, overtraining as a phenomenon is a state, an outcome of the process of too much training in combination with not enough regeneration. It is generally caused through exposure to physiological stress, but developed in combination with psychological and/or social stressors (Kellmann, 2002; Meyers and Whelan, 1998). Essentially, athletes train to enhance and optimize performance. Performance increases are achieved when the intensity, duration and total workload of exercise are appropriate for the actual performance level and the workloads are followed by adequate periods of rest, which will lead to recovery. A positive training adaptation over time requires gradually higher training loads. However, a rigorous training schedule with insufficient recovery caused through other sources of non-training stress may lead to maladaptive responses in form of performance decrements along with other symptoms.

Following the definition of the European College of Sport Science position statement on the overtraining syndrome (Meeusen et al., 2006), such an accumulation of training and or non-training stress resulting in short-term performance decrement is labelled overreaching (OR). This form of short-term OR is often planned and necessary (e.g., when going to a training camp and intensified training results in a decline in performance). When these periods of short-term OR are followed by appropriate periods of rest and recovery, supercompensation follows, i.e., the athlete exhibits an enhanced performance compared to the baseline level. The needed rest time to recover and achieve such a beneficial effect may require days or weeks. Therefore, it is possible to recover from a state of short-term OR within a 2-week period (Halson et al., 2002; Kreider et al., 1998; Lehmann et al., 1999; Steinacker et al., 2000). Such short-term OR periods are generally not accompanied by other severe psychological or physiological symptoms albeit short-term performance decreases. Accordingly to the definition of the European College of Sport Science position statement on the overtraining syndrome (Meeusen et al., 2006) these necessary short-term periods of maladaptations are labelled functional overreaching (FOR).

However, when athletes do not sufficiently recover from the short-term performance decreases, because the appropriate balance between stress and recovery or other stress factors limited the recovery, then non-functional overreaching (NFOR) emerges (Meeusen et al., 2006). In a state of NFOR an athlete needs weeks or months to recover and a two week rest period or less will not result in a performance restoration. The key clinical symptom, prolonged performance decrement and fatigue, is often accompanied by psychological and hormonal disturbances, such as mood disturbances, (Hooper et al., 1997; Raglin, 1993), loss of motivation (Meeusen et al., 2006), loss of appetite, unexplained weight loss, and sleep disturbances (Armstrong and VanHeest, 2002; Kenttä et al., 2001; Lehmann et al., 1999; Meeusen et al., 2006).

The distinction between NFOR and the overtraining syndrome (OTS) is ambiguous. Recovery from an OTS will take months to years. Therefore in the definition of the European College of Sport Science position statement on the overtraining syndrome, Meeusen and colleagues (2006) emphasize the use of the expression "syndrome" to express the multifactorial etiology of OTS and that exercise is not the sole causative factor but several other factors such as inadequate nutrition, illness, psychosocial stressors (work-, team-, education-, family-related) are leading to the prolonged maladaptation, similar to the one that can be observed in an adjustment disorder (Jones and Tenenbaum, 2009).

Despite extensive literature on overtraining the prevalence of FOR, NFOR and OTS has not yet been clearly established (Kreher and Schwartz, 2012). Many of the studies lack a clear definition and classification of FOR, NFOR or OTS and are often based on small numbers of athletes. The prevalence ranges between around 60% in elite male and female distance runner (W. P. Morgan et al., 1987) and 10% in one single season (Hooper et al., 1997). The prevalence rate seems to be different in age groups, types of sport and competitive level. Among adolescent athletes the prevalence rate seems to be approximately 30%. Raglin and colleagues (2000) found in a cross-cultural study (Japan, United States, Sweden, and Greece) an incident rate of 35% in young swimmers (M_{age} = 14.8; SD = 1.4 yr). In slightly older Swedish athletes (M_{age} = 17.9 yr) Kenttä and colleagues (2001) reported an incidence rate of 37%. With a more restrictive definition of overtraining Matos et al. (2011) found most recently a prevalence rate of 29% in young English athletes (M_{age} = 15.1; SD = 2.0 yr). Prevalence rate in older elite athletes does however appear to be lower. Gould and colleagues (Gould and Dieffenbach, 2002; 2002) reported that 28% of American athletes at the Atlanta Olympic games and 10% of the Nagano Olympic Games stated they were overtrained in the 90-days period before the Games, resulting in significant underperformance at the Games. However, overtraining diagnostic criteria were very superficial. Koutedakis and Sharp (1998) reported lower incidence rates of 15% for members of the British National Teams and/or Olympic squads over a 12-month training season. In younger athletes, the prevalence of overtraining is significantly increased in individual sports, females, and low physical demanding sports (Kenttä et al., 2001; Matos et al., 2011). The findings that overtraining is more common in adolescent elite sport than in adult elite sport is somewhat contradictory (Kenttä et al., 2001; Matos et al., 2011). Whether overtraining is more common in elite individual sport, elite females and elite physical low demanding sport is not clear (Gould and Dieffenbach, 2002; Gould et al., 2002).

To date there is a lack of clear prevalence rates of FOR, NFOR and OTS in elite sports. More specifically, no data

exists regarding prevalence rates in Swiss elite athletes. The knowledge about the incidence of such performance maladaptations would help coaches, sport scientists and sports physicians to prevent, detect and treat NFOR and OTS. Therefore, the present study aimed to assess the prevalence, symptoms and associated factors of NFOR/OTS across a variety of sports in Swiss elite athletes.

Methods

Participants and procedures

One hundred thirty-nine Swiss elite athletes (63 males and 76 females) from 26 different sports and 31 different disciplines volunteered to complete an online survey, which was part of a bigger research project. Athletes received the link of the online survey from their national sport associations. The survey was conducted using the Unipark online research platform (see http://www.unipark.info). One hundred and thirty-two (95% of the sample) had represented Switzerland in their respective sport. A total of 28% of the athletes ranged their current competition level as international top, 16.5 % as European top and 52.5% as National top. A total of 3% of the athletes ranked themselves as competing on the second highest national level. Numbers of competition per year ranged between 6 and 60 with a mean of 25 (SD = 24.2) with curling and cycling reporting the most competitions per year. Mean training hours per week were 14.3 hours (SD = 6.2) and ranged between 6 hours and 30 hours per week. Mean age was 23.6 years (SD_{age} = 5.6, age range: 17–53). The research was conducted in accordance with APA ethical guidelines. All athletes provided informed consent.

Measures

To diagnose overtraining an adapted version of the Matos and colleagues' survey was used (2011). The survey consisted of typical diagnostic questions regarding unexplained periods of underperformance, periods of training reduction or periods of complete rest, both caused by underperformance, as well as clinically identified symptoms of overtraining such as loss of weight, loss of motivation, sleep problems, injury history and mood disturbances (Meeusen et al., 2006). If the item "Have you ever had a time when you felt very fatigued every day and your performance significantly decreased for long periods of time (e.g., weeks to months) even though you were training, beforehand you have not been sick or no illness was diagnosed?" was answered with yes, it was categorized as overreaching or overtraining. To classify an episode as FOR, NFOR or OTR we asked for the duration of the episode and if the athlete reduced training or even stopped training to cope with the unexpected underperformance. If the unexplained performance decrease lasted longer than two months we categorized it as OTS, except when rest or training reduction of less than two weeks induced an immediate performance restoration. In that case, we categorized the episode as FOR. If the performance decrease and the prolonged fatigue lasted less than one month and a rest period or training reduction led into performance restoration, it was also categorized as FOR. Additionally, episodes lasting less than one month with at least two out of four additional overtraining symptoms (mood disturbances, loss of motivation, sleep disturbances and unexplained loss of weight) were categorized as NFOR. But cases without these additional symptoms were categorized as FOR. By choosing this procedure a very conservative strategy to decide whether an athlete should be categorized as FOR, NFOR or OTS was adopted.

Statistical analysis

Descriptive statistics are reported as mean, standard deviation and percentages. Differences between the forms of overtraining states were determined using nonparametric tests (Mann-Whitney U) or analysis of variance (ANOVA). As a measure of the energy expenditure the MET rates of the Compendium of Physical Activities (Ainsworth et al., 2011) were used to classify the various sports in physical low, middle and high demanding sports (low physical demand = MET < 6; middle physical demand = MET between 6 and 12; high physical demand = MET > 12). If the Compendium did not provide a MET for a certain sport we relied on another reference source (Jette et al., 1990).

Results

Prevalence

Fifty-four athletes (39%) reported that they had experienced at least one period when they felt very fatigued every day and their performance significantly decreased for long periods of time (e.g., weeks to months). On average the athletes had experienced these episodes 1.8 times in their career (SD = 1.1, range 1–5). The majority of the athletes (a total of 32), reported a duration of these periods less than one month. Eleven athletes had a duration between one and two months, five between two and three months, four between three and six months and two over six months. Forty-three athletes (representing 31% of the sample) reported that they had faced periods in their training when they could not cope with the required training intensity/load. However, not all of the athletes experiencing longer periods of fatigue and performance decrements or reporting longer periods where they were not able to cope with the required training loads were categorized as NFOR/OTS. If athletes did have a training break or reduced their training for less than 14 days resulting in the restoration of the previous performance level, athletes were categorized as FOR. A total of 29 athletes did reduce their training volume and/or intensity and/or did have a training break as a consequence of the performance decrement. Twenty had a performance improvement after this break, but 14 needed a break longer than 14 days for performance restoration. Furthermore, nine athletes reported a training break not restoring their performance level, even though five out of this group had a training break for longer than 14 days.

In summary, 12 athletes stating they had a performance decrease and felt very fatigued for a long period have been categorized as having had at least one OTS in their past athletic career (9 % of the total sample). Therefore, 29 athletes (21 % of the total sample) have been classified as NFOR and twelve athletes (9% of the total sample) as being FOR. In total 61% have not been classified as overreached or overtrained so far in their career.

Sports categories

Table 1 gives an overview of the prevalence of NOR/FOR and NFOR/OTS across different sports, for low, medium and high MET and individual and team sports. The NFOR/OTS prevalence differences between the low MET (MET < 6), the middle MET (MET between 6 and 12) and the high MET (MET > 12) are marginally significant ($p = .056$). The NFOR/OS prevalence in low MET sports is significantly smaller than in middle MET Sports ($p = .02$). However, there are no significant differences regarding the NFOR/OTS prevalence between middle MET Sports and high MET sports ($p = .25$) as well as low MET sports and high MET Sports ($p = .18$). There are also no differences between individual (29%) and team sports (30%) athletes. Because of the small sample numbers we did not test for differences between various sports.

Table 1: Prevalence of NOR/FOR and NFOR/OTS across individual and team sports according to low, medium and high MET [absolute numbers and percentage presented].

Category and sports (MET)		**NOR + FOR**		**NFOR + OTS**	
	n	**Absolute**	**%**	**Absolute**	**%**
Low MET (< 6)	*29*	*25*	*86.2*	*4*	*13.8*
Curling (4)	16	15	93.8	1	6.3
Shooting (3)	9	7	77.8	2	22.2
Table tennis (4)	3	3	100.0	0	0.0
Athletics, throw disciplines (4)	1	0	0.0	1	100.0
Medium MET (6–12)	*66*	*41*	*62.7*	*25*	*37.3*
Floorball (10.3)	12	8	66.7	4	33.3
Judo (10.5)	8	3	37.5	5	62.5
Athletics, mixed (6–10)	8	4	50.0	4	50.0
Handball (12)	7	4	57.1	3	42.9
Trick cycling (8.5)	5	2	40.0	3	60.0
Horse riding (7)	5	4	80.0	1	20.0
Artistic gymnastics (7)	3	3	100.0	0	0.0
Badminton (7)	3	2	66.7	1	33.3
Ski jumping (7)	3	2	66.7	1	33.3
Fencing (6)	3	3	100.0	0	0.0
Volleyball (6)	3	3	100.0	0	0.0
Nordic combined (11)	1	0	0.0	1	100.0
Downhill/4Cross (8.5)	1	0	0.0	1	100.0
Beach Volleyball (8)	1	1	100.0	0	0.0
Climbing (8)	1	1	100.0	0	0.0
Tennis (7.3)	1	0	0.0	1	100.0
Wrestling (6)	1	1	100.0	0	0.0
High MET (>12)	*44*	*32*	*70.6*	*12*	*29.4*
Orienteering (19)	18	14	77.8	4	22.2
Cycling (16)	8	6	75.0	2	25.0
Athletics, middle-distance (18)	5	3	60.0	2	40.0
Rowing (12.5)	5	2	40.0	3	60.0
Athletics, marathon (14.5)	4	4	100.0	0	0.0
Canoe (12.5)	2	2	100.0	0	0.0
Figure skating (14)	1	0	0.0	1	100.0
Triathlon (13.8)	1	1	100.0	0	0.0
Individual Sports	*116*	*82*	*70.7*	*34*	*29.3*
Team Sports	*23*	*16*	*69.6*	*7*	*30.4*
Male	*63*	*48*	*76.2*	*15*	*23.8*
Female	*76*	*50*	*65.8*	*26*	*34.2*
Total	*139*	*98*	*70.5*	*41*	*29.5*

Note: NOR = No overreaching, FOR = Functional overreaching, NFOR = Non functional overreaching, OTS = Overtraining syndrome, Mixed = Sprint, hurdles, jump disciplines, decathlon, heptathlon. Sports are ranked according to sample size.

Training volume, number of competitions

There were no statistically significant differences regarding the training hours (NOR/FOR = 14.0 hrs per week; NFOR/OTS = 14.5 hrs per week; $F(1/137) = .18$, $p = .67$), trainings per week (NOR/FOR = 7.8 trainings per week; NFOR/OTS = 7.5 trainings per week; $F(1/137) = .09$, $p = .77$) and numbers of competitions per year (NOR/FOR = 26 competitions per year; NFOR/OTS = 22 competitions per year; $F(1/137) = 2.87$, $p = .09$) between the NOR/FOR and the NFOR/OTS groups.

Gender, competitive level

The prevalence of NFOR/OTS was higher in females (34.2%) than in males (24.8%), but the difference was not statistically significant ($p = .18$). Analysis of variance also revealed no significant difference between NOR/FOR and NFOR/OTS regarding the competition level ($p = .63$). However, the highest NFOR/OTS prevalence was present in the international top level group with 35% and the lowest in the European top group with 22%. The national top group revealed a NFOR/OTS prevalence rate of 27%.

Accompanying NFOR/OTS symptoms

The frequency of the most often reported accompanying NFOR/OTS symptoms are presented in *Figure 1.* Additionally it is also presented if the athletes maintained a training diary.

Seventy-one percent of the NFOR/OTS categorized athletes reported that they suffered a significant loss of motivation during the NFOR/OTS episode. Seventy-three percent of the NFOR/OTS group reported that they felt negative emotions, e.g. dejection, sadness, depression, moodiness, anger, frustration, anxiety, existential fear, helplessness, lack of self-confidence, lack of self-worth, self-doubt, fear of failure, weariness, loneliness, aggression, stress, fatigue, dissatisfaction and desperation.

Discussion

The aim of the present study was to explore the prevalence rate, symptoms and associated factors of overreaching/overtraining in Swiss elite athletes. Following the overtraining definition of the European College of Sport Science position statement on the overtraining syndrome (Meeusen et al., 2006), a more conservative strategy was adopted to categorize athletes into NOR, FOR, NFOR and OTS groups. The overall prevalence rate of NFOR/OTS in the investigated sample was 29%. The results are in line with findings in adolescent athletes (Kenttä et al., 2001; Matos et al., 2011) and elite athletes (Gould and Dieffenbach, 2002; Gould et al., 2002). Nonetheless, athletes in the above cited studies are much younger, and it can be expected that the prevalence rate should increase during an athletic career. For elite athletes Gould and colleagues (Gould and Dieffenbach, 2002; 2002) reported a three month incidence rate between 10 and 28% and Koutedakis and Sharp (1998) 15% in a twelve month cycle. In the present study, a life time prevalence rate was measured, therefore the presented incidence rates can be regarded as lower than in previous studies. This may be because of the use of a more restricted definition and categorization of FOR/NFOR/OTS. Thirteen athletes that have been categorized as functional overreached might have been categorized as NFOR in other studies. A less conservative NFOR/OTS categorisation would have increased the prevalence rate to 39%. Nevertheless, the OTS rate in our sample was close to 10%. The present research shows that almost one third of Swiss elite athletes experience NFOR/OTS issues sometimes during their career, which can have a serious effect on their health and well being.

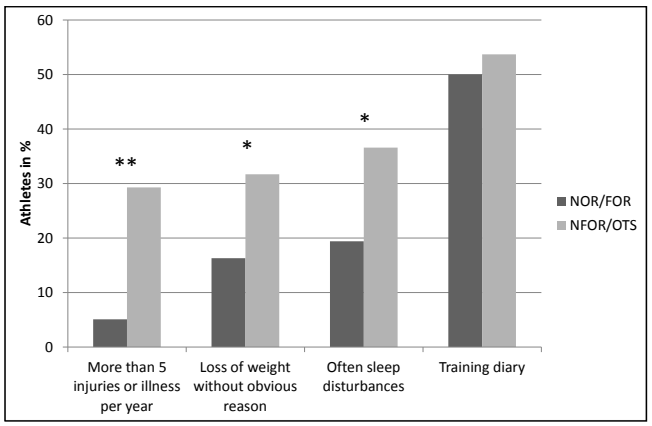

Figure 1: Accompanying symptoms of overreaching/overtraining for the NOR/FOR and NFOR/OTS groups. *Significant difference between groups ($p < .05$). **Significant difference between groups ($p < .01$).

The duration of the NFOR/OTS episodes ranged between several weeks and more than six months. However, the majority of the athletes with the symptoms of prolonged fatigue and performance decrement reported a performance impairment of several weeks but less than one month. Twenty-nine athletes reported that they reduced their training regime or even intervened with a training break. Some of them regained their performance level after this intervention, but only six were successful with a reduction of less than 14 days. It can be assumed that a reduction of the training regime of 14 days, as recommended by sport scientists (Halson et al., 2002; Kreider et al., 1998; Lehmann et al., 1999; Steinacker et al., 2000) for regaining an adequate performance level after functional overreaching, would help a significant number of athletes experiencing FOR to prevent them from developing a NFOR or OTS.

In contrast to other findings (Kenttä et al., 2001; Matos et al., 2011; Raglin et al., 2000), the rate of NFOR/OTS did not differ between individual and team sports in the present sample. However, we found that the prevalence rate of middle MET sports was significantly higher than in low MET sports. Although, the low MET sports trained significantly less ($M = 11.8$ hrs; $SD = 5.1$) than the middle MET sports ($M = 15.3$ hrs; $SD = 6.9$) ($F(2/136) = 3.45$, $p = .04$), no influence of the training volume per week, the number of trainings per week and the numbers of competitions per year on the NFOR/OTS incidence was observed. The reason for the observed prevalence difference between these types of sports seems not to stem from the higher amount of training volume or energy expenditure, but may lie in other factors inherent to medium MET sports, such as demands of the sports culture or pressure for financial rewards.

As expected, a greater percentage of females (34%) were categorized as NFOR/OTS compared with males (24%). Although, the results are not statistically significant, they are in line with findings of studies on young athletes (Kenttä et al., 2001; Matos et al., 2011). Currently, it is not clear if these findings reflect the conflicts female athletes face when they strive for excellence, which may lead to identity confusion

(Matos, et al., 2011) or if it is caused by differences between the various sports types. For instance, Kenttä et al. (2001) reported that 75% of figure skaters (a typical female sport) in their sample have been stale. In fact, the prevalence of NFOR/OTS differs considerably in different sports. In our sample judo players reported a NFOR/OTS prevalence of 63%, whereas curling players reported a prevalence of 6%. This mirrors findings from other researchers. Matos et al. (2011) reported incidence rates between 50% (swimming) and 7% (field hockey), Kenttä and colleagues (2001) between 94% (badminton) and 17% (golf), and Gould and Dieffenbach (2002) between 80% (synchronized swimming, another typical female sport) and 6% (shooting). The presented findings imply that the reason for the prevalence differences lies not primarily in the physical demand of a certain sport, expressed in energy expenditures, but in other psychological or psychosocial factors (Richardson et al., 2008). For example, orienteering as an extremely physically demanding sport with a MET of 19 has a moderate NFOR/OTS prevalence rate of 22%, whereas trick cycling with a moderate MET of 8.5 showed an incidence rate of 60%. Furthermore, Morgan and colleagues (W. P. Morgan et al., 1987) reported an incidence rate for elite female and male long distance runners of over 60%. The prevalence rate in the presented runner subsample was much lower. None of the four elite marathon runners reported signs of overreaching or overtraining syndrome. The prevalence in the middle distance runner was 40%. It can be assumed that these differences may be due to cultural differences, differences in the sports organisation, but also caused by the small sample size, where a specific coach motivational climate can influence significantly the group.

In accord with previous authors, we concur that NFOR/OTS is not the result of too much training, but an imbalance between training as well as non-training stress and recovery. If this imbalance exists for a longer period and the athlete is not able to cope with this disequilibrium a maladaptation with a wide range of clinically significant symptoms of poor adjustment such as fatigue, depression, bradycardia, immunological suppression (especially upper respiratory tract infection), loss of motivation, insomnia, irritability, agitation, hypertension, tachycardia, restlessness, anorexia, weight loss, lack of mental concentration, anxiety, heavy, and/or sore stiff muscles (Armstrong and VanHeest, 2002; Jones and Tenenbaum, 2009; Kreher and Schwartz, 2012). In fact, the NFOR/OTS athletes reported most of the above symptoms. Almost 30% of the NFOR/OTS athletes had more than five injuries or illness per year; more than 30% reported weight loss with no obvious reason and more than 35% described suffering often from sleep disturbances. This multifaceted nature of the athlete's maladjusted state has to be considered when treating NFOR athletes or athletes with an OTS.

The fact that more than 70% of the NFOR/OTS athletes reported emotional disturbances suggests that athletes may detect early signs of overreaching by themselves if they accept mood disturbances as a valuable warning sign. This would give them the chance to discuss a reduction of training intensity/load with their coach and/or increase their recovery actions to avoid performance maladaptation (Kenttä et al., 2001). The emotional aspect underlines the importance not only of an increased self-awareness, but more precisely the ability to read and interpret signs of physical and psychological stress. In this context, Birrer and colleagues (2012) underlined the possible value of mindfulness for elite athletes.

Fortunately sport scientists have realized that athletes encounter stress from sources that are not only physiological in nature, but also psychological and social in origin (Smith, 2003). To identify sports with a higher risk of developing states of NFOR/OTS factors inherent in the sport, the following points should be considered: sports culture within that sport, social economic factors, like professionalization, sport-school solutions, training demands (endurance, mixed demands, strength, metabolic system) (Birrer and Morgan, 2010), training times in the day, environmental factors (Henriksen et al., 2010), coach autonomy support, contextual motivation, situational motivation (Lemyre et al., 2008). For example, team sports on the highest level, which demand very high training loads, but cannot provide professional structures so that players do not need to have another occupation, e.g., Swiss handball or floorball players, may be more in danger to develop NFOR/OTS than fully professionalized team sports, e.g., football or ice hockey. To identify individuals with a higher risk to develop NFOR/OTS psychological factors like self-determined motivation, unidimensional identity, sports-life domain conflicts (G. Morgan et al., 2013) or mindfulness (Birrer et al., 2012) could be valuable constructs.

A number of limitations should be recognised. Although these participants provide excellent ecological validity for talented sports men and women in Switzerland, findings are limited by the sample size, the homogeneous competition level of the sample and the limited number of sports, (e.g. football and ice hockey are two of the most popular sports in Switzerland, which have not been studied). Another potential limitation of the study could be that overreaching was assessed through a self report measure, which may have influenced the results through participant's bias and poor memory recall. However, the words overreaching or overtraining were not mentioned in the questionnaire so as to reduce a possible bias.

Summary and conclusions

Adopting the definition of the European College of Sport Science position statement on the overtraining syndrome the NFOR/OTS career prevalence rates of Swiss elite athletes may be estimated at approximately 30%, with various sports differing significantly in their incidence rate. This may be due to specific demands of the different sports cultures. Coaches are well advised when suspecting NFOR/OTS to plan a training break or training reduction of 14 days in order to give their athletes enough time to recover from a possible FOR. Too much training is generally not the sole reason for NFOR/OTS. Usually it is a combination of biopsychosocial stressors, which lead to maladaptation or maladjustement, and if the athlete (and/or the coach) does not respect the appropriate balance between stress and recovery thus ignoring early signs such as prolonged fatigue, mood disturbances or loss of motivation, then overreaching will ensue. Therefore, athletes should enhance their self-awareness to detect such early signs of overreaching. When treating NFOR/OTS athletes, it has to be considered that the key clinical symptom, prolonged performance decrement and fatigue, will be accompanied by a multitude of biopsychosocial symptoms, which require assistance by relevant specialists, e.g., psychologists.

Future research should try to identify sports (culture), sports environments and individuals at risk for developing NFOR/OTS. Therefore, the present study should be replicated with a representative cross-cultural sample of different sports, age groups and competitive level.

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