Title

Prevalence of non-functional overreaching in elite male and female youth academy football players

Running Head: NFOR in academy football players

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Abstract

Purpose: The purpose of this study was to examine the prevalence of non-functional overreaching (NFOR) and overtraining (OT) in elite male and female youth football players. Methods: Two-hundred and forty-two youth football players (n = 138 boys and n = 104 girls) aged between 12 - 17 y completed a questionnaire to identify the occurrence of NFOR/OT and associated symptoms. Results: No players experienced OT. Significant sex differences for NFOR were found between girls 9% compared to boys 27% ($p < 0.05$). For players that experienced NFOR, 33% of girls and 60% of boys experienced multiple bouts. Compared to girls, boys completed higher volumes of football training (16.3 ± 4.5 versus 12.7 ± 5.7 hours per week, $p < 0.05$), but training load was not a significant predictor of NFOR for either sex. In both sexes NFOR was associated with tiredness, a lack of appetite, sore or heavy muscles, feeling in a bad mood, and feeling apathetic. Conclusion: Male and female elite youth football players engaged in high training volumes and experienced similar NFOR symptoms. However, there is a much higher prevalence of NFOR in boys and in those who have suffered previous bouts of NFOR.

Key words: wellness, training, performance, stress, mood.

Introduction

Since the year 2000, youth participation in football has increased by 7% with 18.7 million boys and 2.9 million girls regularly playing the sport (1). Although the chances of becoming a professional football player are estimated to be between 0.004 to 0.4% (2, 3), many professional teams have invested significantly in terms of finance, time and expertise in academy systems designed to scout, recruit and develop young talent. For example, the implementation of the Elite Player Performance Plan (EPPP) by the Premier League in England is one such example of the investment in the youth game (4). Although being selected for an academy results in the young player gaining access to expert coaching and accompanying sports science and medical support, it also brings associated burdens. These burdens include training and non-training related stressors such as high training volumes, long competitive seasons, coach and parental expectations, contract negotiations, and time away from family and friends. These strategies are known to be associated with the development of non-functional overreaching (NFOR) and overtraining syndrome (OTS) in youth athletes (5). NFOR is defined as a detriment or stagnation in performance, along with associated symptoms of chronic fatigue, which persist for between 2 weeks to several months (6, 7). Conversely OTS is deemed to have occurred when the performance detriment lasts longer, from several months to years.

In reviews of adult studies, using self-report questionnaires, prevalence rates for OTS/NFOR have been reported between 10-60%, with a predominance reported between 25-30% (7-9). In children, across a range of sports and from club to international standard, the prevalence rates of NFOR/OTS are approximately 30-35% (10-13), which are similar to studies with adults. However, specific studies assessing the prevalence of NFOR or OTS in youth football players are sparse. Previous large scale studies using self-report questionnaires did not report

data specific to any particular sports (11, 14), whilst only three studies provide any illustrative data from youth football. Specifically, Matos et al. (11) reported that 14% (12/83) of youth football players experienced NFOR or OTS and observed the incidence of NFOR/OTS was greater at the highest representative levels. Schmikli et al. (15) observed a performance decrement lasting more than one month in 10% of 77 elite youth football players who were followed over a competitive season. Compared to controls, the under-performing football players showed a higher submaximal heart rate during an incremental shuttle run test, significantly higher scores for anger and depression on the profile of mood states inventory, and an indication of an uncoupling of adrenocorticotropic hormone (ACTH) and salivary cortisol levels in the OTS football players (15).

Other work reported an association between perceived stress and impaired recovery in elite youth football players aged 15-18 years old (16). Those who became ill during the study reported higher levels of general and sport specific stress, lower levels of social recovery and more disturbed sleep prior to the illness manifesting. Finally, in a study of 167 English academy football players 25% of players reported symptoms of burnout at least once in their football careers (17). Therefore, knowing the prevalence and the context in which NFOR/OTS occurs is important. Recently, a joint position statement from the European College of Sport Science and the American College of Sports Medicine (7) stated that like suffering an orthopaedic injury, overtraining is just as debilitating and takes a substantial time for recovery to occur spontaneously. Thus understanding prevalence and risks factors associated with injury and overtraining can allow preventative strategies to be developed (18, 19).

There are even fewer data comparing if there are sex differences in the prevalence of NFOR/OTS. Some studies have shown the incidence of staleness and NFOR to be greater in girls (12, 13) however, others have reported no significant sex differences in prevalence rates (11, 20). With the increased popularity of football for girls (1), some clubs now have an academy structure for young female players, but as yet, there are no data about NFOR/OTS in this group of players, and thus warrants further investigation. Therefore, the aim of the study was twofold. Firstly, to determine the prevalence of NFOR/OTS in academy football players and secondly, given the scarcity of data for females, to examine any sex-related differences in NFOR/OTS incidence.

Method

In total 242 elite male (n=138) and female (n=104) youth football players competing in under 12 to under 17 age groups in two countries (England and Spain) volunteered to participate in the study. To be eligible for the study, all players must have been registered with their professional club football academies for at least one year. Players were recruited from English clubs (1 x Premiership; 1 x Championship; 1 x Division 2) and Spanish clubs (2 x La Liga). Female football players were only available from English academies. The study was approved by the Institutional Ethics Committee prior to commencement. Informed consent was obtained from parents and coaches and participant assent respectively.

Personal contact was made with all coaches before the questionnaires were completed, ensuring that standardised data collection procedures were agreed prior to their completion by the participants. These procedures included the place of questionnaire completion at the academies, appropriate time to complete the questionnaire anonymously and opportunities for player's clarification of questions. The questionnaire has been used previously (12) and was

translated into Spanish. The questionnaire included 6 sections related to the players' sports background, physical symptoms, psychological symptoms, psychosocial pressures, and NFOR/OT prevalence. A 5-point Likert scale was used to rate the strength of agreement or disagreement for statements relating to physical symptoms and psychosocial factors. Competitive level of the player was reported as county, regional, national or international standard. The questionnaire was completed in the latter third of the playing season 2014-2015.

The definition of NFOR/OT used to classify athletes was derived from previous literature (11), but adapted to be more conservative – "Have you ever experienced a significant decrement in performance that persisted for long periods of time (i.e. weeks to months) even though you kept training and you felt extremely tired every day?" Football players were categorized as NFOR (PAST) if the episode(s) lasted from 2 weeks to 6 months and OTS if the episode(s) lasted for more than 6 months. The players were requested to indicate how many episodes they had experienced in the past and the duration of each episode. Players were also asked if they were experiencing an episode at the time of answering the questionnaire, NFOR (PRESENT).

Statistical Analysis

Descriptive statistics are reported as mean (± SD). Differences between sex and players classified as normal (NORM: players who were not classified as NFOR/OT), players who reported previously experiencing NFOR/OTS (PAST) and players who reported that they were currently experiencing NFOR/OTS (PRESENT) were examined using a one way ANOVA. Tukey's post-hoc analyses were used when significant differences were found. An alpha level of $p < 0.05$ was set to accept statistical significance.

Results

The mean age of the sample was 14.1 ± 1.7 y (boys 14.7 ± 1.5 y and girls 13.4 ±1.7 y). The players were distributed evenly across the age ranges of under 12 (13%), under 13 (23%), under 14 (17 %), under 15 (22%), under 16 (13%), and under 17 (12%). Across the two countries involved, 37% of the male players were based at English clubs and 67% at Spanish clubs, while 100% of females were from English clubs.

No player reported an episode lasting more than 6 months and consequently all affected players were classified as NFOR. Accordingly, 196 (81%) players were classified as never having been overreached (NORM), 37 players (15%) reported having been NFOR (PAST) and 9 players (4%) NFOR (PRESENT). Prevalence of NFOR showed no significant differences between the English and Spanish boys (22 versus 29%, $p > 0.05$), consequently data for all boys was pooled with a combined prevalence in NFOR of 27%. There were no significant differences in training hours per day, number of days per week playing football, playing years between the NORM, NFOR (PRESENT) and NFOR (PAST) groups ($p > 0.05$). However, the duration of the episodes was significantly longer at 3-6 months in the PAST group compared to the NFOR (PRESENT) group (Table 1).

Table 1: Descriptive characteristics based on NFOR status

	NORM (n=196)	PAST (n=37)	PRESENT (n=9)
Training hours per day (h)	1-2	1-2	1-2
Days per week of training (n)	5	5	5
Years playing (y)	6-8	8-10	8-10
Episodes of NFOR (n)	-	2	2
Duration of episodes of NFOR (months)	-	3-6 *	1-2

* $p < 0.05$ significant differences between the groups

The NFOR (PRESENT) group reported significantly greater amounts of muscular stiffness in the morning, incomplete recovery, overall muscle stiffness and tiredness compared to the other two groups ($p < 0.05$) (Figure 1).

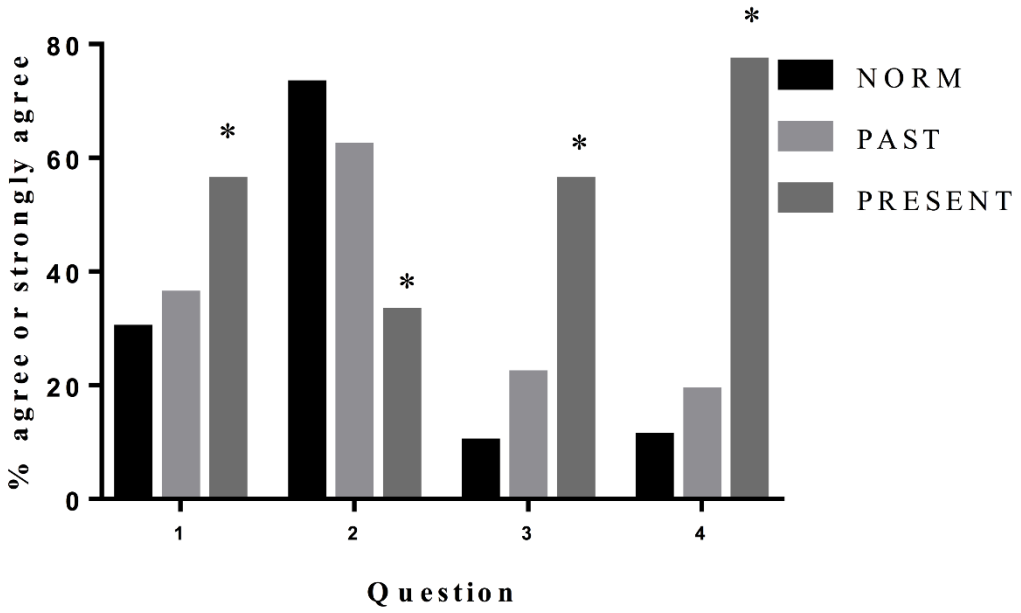

Figure 1: Percentage rating of 'agree or strongly agree' for perceptions of tiredness and recovery, where Q1: When I wake up in the morning I feel my muscles are heavy and stiff; Q2: I recover quickly after competition; Q3: I often feel that my muscles are heavy and stiff; Q4: I have periods of weeks where I feel extremely tired every day. * $p < 0.05$ significantly different to other two groups.

Only 11% of the NFOR (PRESENT) group reported to get enough sleep each night compared to 61% of the NORM group and 56% of the NFOR (PAST) ($p < 0.05$). During intensive training periods only 44% of the NFOR (PRESENT) group agreed they get enough sleep compared to 76% and 77% agreement by the NORM and the NFOR (PAST) groups respectively ($p < 0.05$) [data not shown].

In Figure 2 players who were currently NFOR (PRESENT) reported that they were more likely to lose their appetite during important competitions and had a greater perception of coach pressure compared to the other groups ($p < 0.05$). Both the NFOR (PRESENT) and

NFOR (PAST) groups indicated that they were frequently in a bad mood during a period of hard training and were significantly different to the NORM group ($p < 0.05$).

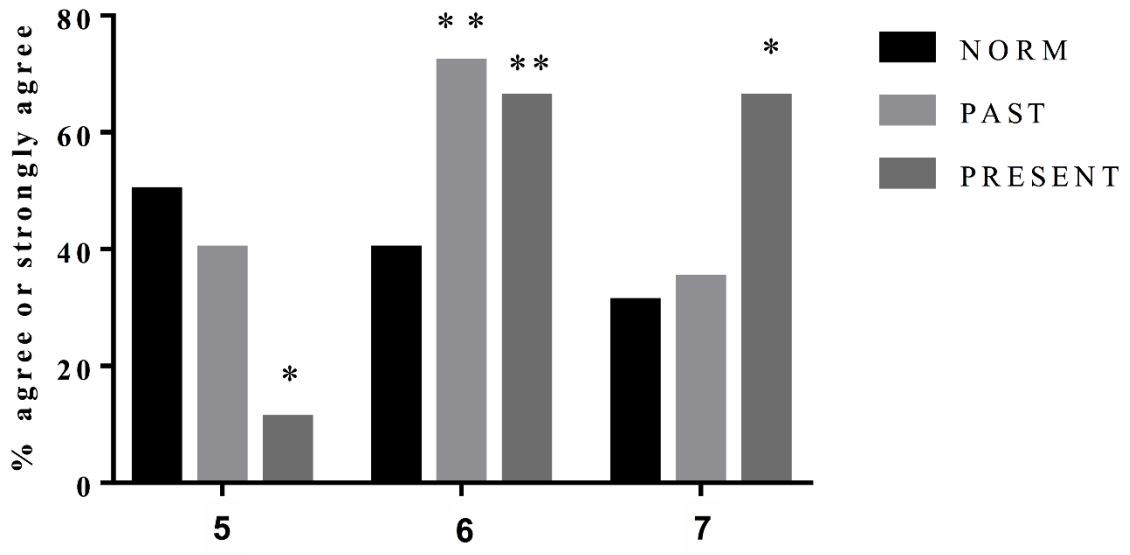

Figure 2: Percentage rating of 'agree or strongly agree' for appetite, mood state and coach pressure, where Q5: I never lose appetite when in a period of important competitions; Q6: I frequently feel in a bad mood when in a period of hard training; Q7: I have pressure from my coach about how well I do in my sport. * $p < 0.05$ significantly different to other two groups; ** significantly different from NORM group.

No significant differences between groups were found for frequency of illnesses, self-confidence in playing ability, motivation to continue playing, or perception of autonomy in decisions about their sporting goals ($p > 0.05$). For all groups spending time with family and friends was highly important to them, but playing football dominated their weekly schedules, with just 5-10 hours per week spent on other interests and hobbies outside of football.

Sex differences in NFOR

The prevalence of NFOR was significantly higher in boys (27%) compared to girls (9%) ($p < 0.05$). Thirty seven boys experienced a total of 79 bouts of NFOR, while nine girls experienced a total of 13 bouts of NFOR, equating to 60% of boys and 33% of girls experiencing multiple bouts of NFOR. The duration of NFOR episodes was significantly longer in the girls (1-2 months) compared to less than one month in the boys ($p < 0.05$). Within both sexes, there was no difference in the estimated weekly hours spent playing football between NORM and NFOR (PAST or PRESENT) groups, but boys spent significantly more time than girls playing football (16.3 ± 4.5 versus 12.7 ± 5.7 hours per week, $p < 0.05$).

The girls in the NFOR group, compared to the other three groups were characterised by significantly higher feelings of tiredness, muscle soreness, and more difficulty with sleeping (Figure 3). For boys in the NFOR group feelings of heavy muscles were significantly increased compared to the NORM players ($p < 0.05$).

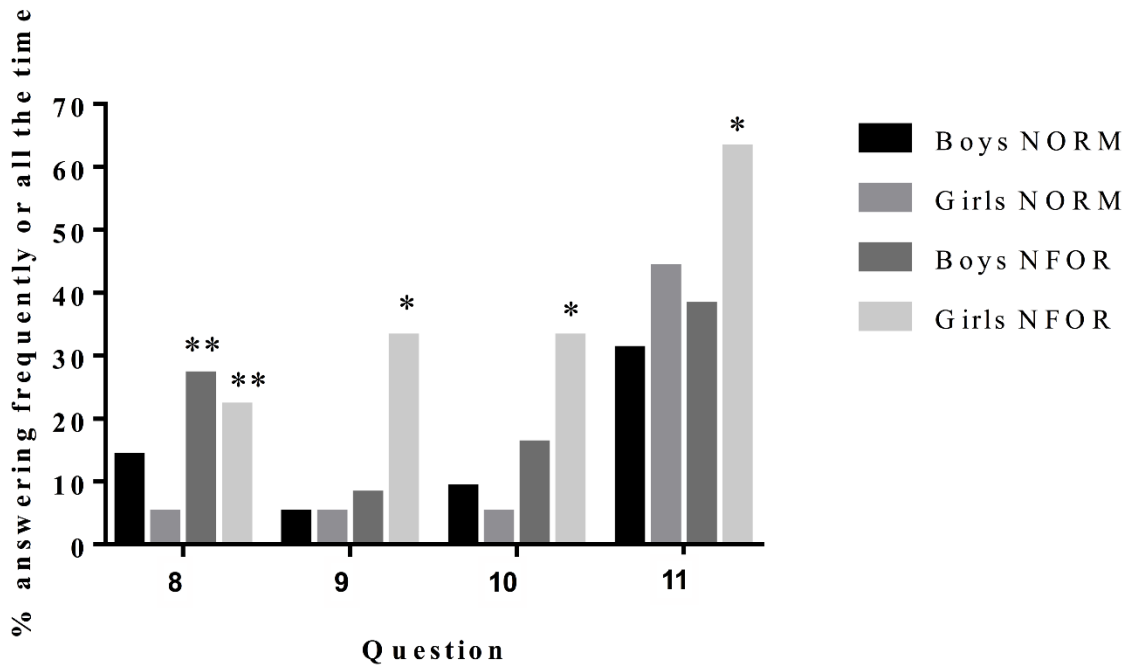

Figure 3: Percentage frequency of sex differences in perceptions of tiredness, muscle soreness, recovery and sleeping, where Q8: My muscles often feel heavy and stiff?; Q9: Do your muscles ever feel sore 12 hours or more after a training session?; Q10: Experienced periods of weeks where you feel extremely tired every day?; Q11: Do you have problems sleeping? * $p < 0.05$ significantly different to other three groups; ** significantly different to NORM boys and girls.

Both boys and girls NFOR groups reported frequently losing their appetite during important competitions (11% frequency), however 22% of NFOR girls also frequently lost their appetite during hard training, compared to just 8% of NFOR boys ($p < 0.05$).

Both boys and girls who had experienced NFOR showed a marked difference in anxiety and mood state as opposed to their peers who had never experienced NFOR (Figure 4). The NFOR girls also reported significantly higher feelings of apathy during high levels of training compared to NFOR boys and NORM players ($p < 0.05$).

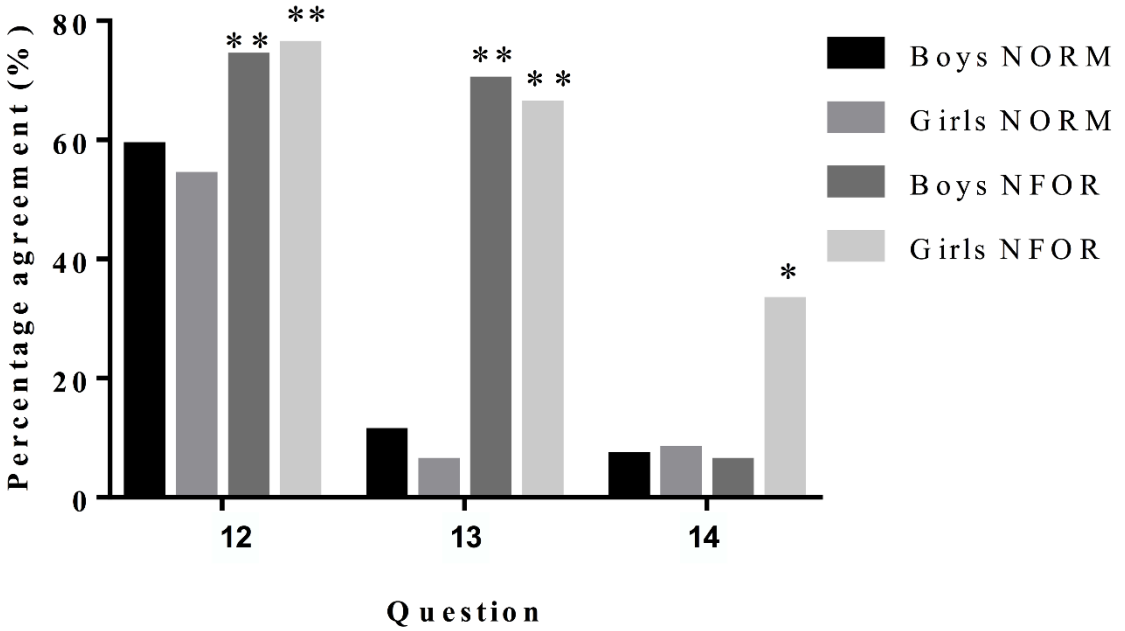

Figure 4: Percentage differences of sex differences in perceptions of anxiety and mood state, where Q12: Strongly agree/agree they feel anxious before important competitions; Q13: Always/frequently feel in a bad mood when in a period of hard training; Q14: Frequently feel apathetic when training a lot. * $p < 0.05$ significantly different to other three groups; ** significantly different to NORM boys and girls.

The perception of pressure from the coach was also significantly different between the sexes ($p < 0.05$). Boys compared to girls, regardless of having NFOR or not, were more likely to agree that they had pressure from their coaches (42% NORM vs 49% NFOR), whereas a similar level of perceived pressure was only observed in the NFOR girls (44%), which was significantly greater than the NORM girls (18%, $p < 0.05$). There were no other significant differences in the number of infections or perception of decision making autonomy between boys and girls ($p > 0.05$).

Discussion

The purpose of this study was to determine the nature and prevalence of NFOR and OT in youth male and female academy football players. While no players described experiencing OT, cases of NFOR were reported with an observed significant sex difference, with 9% of girls compared to 27% of boys experiencing NFOR. More interestingly, for those players that reported NFOR, 33% of girls and 60% of boys experienced multiple bouts of NFOR. This observation implicates a prior bout of NFOR as being indicative of a greater risk of a player suffering further bouts of NFOR. While time spent playing football did not distinguish between those who did and did not suffer NFOR, both girls and boys were exposed to high volumes of football play. Characteristic markers associated with NFOR were tiredness and incomplete sleep, a lack of appetite, sore or heavy muscles, feeling in a bad mood and feeling apathetic. Some of these markers were more pronounced in males and in those presently experiencing NFOR.

This is one of the few studies to examine NFOR in young elite male football players but is the first to make comparisons between different countries and the first study to investigate NFOR in young elite female football players. The elite young football player is exposed to high volumes of training, long competitive seasons, travel induced tiredness and increased injury risk exposure (4, 16, 21). In the U.K., the introduction of the EPPP has created an early specialisation model in the academy system, which has substantially increased the training volumes imposed on young players (4). While the present study found no differences in the prevalence of NFOR in boys based in English or Spanish academies, the overall levels of NFOR are above those previously reported for male youth football players (12, 15). The prevalence reported are also similar to levels of staleness in youth male team sports (11) and

in young swimmers (13), and comparable to reported levels of burnout in elite male youth football (17).

The prevalence of NFOR was much lower in girls compared to boys and may be due to factors such as age, training volume, training intensity and external pressure. In the present study girls were younger and spent significantly less time playing football than the boys. Comparatively, in a mixed sample of 11-18 year olds, Matos et al. (12) reported that youth who experienced NFOR/OT were older than those who had never experienced NFOR/OTS. In our current study, the time spent playing football did not differentiate between those who did and did not experience NFOR, which is in agreement with previous youth data (22). However, we found that boys were engaged in significantly more football than girls. In the UK this is indicative of the EPPP, whereby academies are structured toward the goal of young male players accumulating 8,500 total hours of training by the time they reach 21 y, and with players in the 12-16 y age range expected to complete 12-16 hours of training each week (4). It has been suggested that youth participating in more than 16 hours of organised sport per week, or more hours than their age in years will be at increased risk of negative outcomes (23, 24). In the current study, the girls were just below these thresholds whilst the boys were found to be above. There is also the added issue that elite male youth players perceive training to be harder than coaches intend (25), and it has been speculated that this may contribute to maladaptive responses (26). Whether such a mismatch between player and coach perception of intensity exists for young female players is yet to be elucidated.

More boys than girls reported experiencing external pressure from their coach possibly reflecting the highly competitive and financial climate of academy football for boys compared to girls. The added weight of expectation from those who coach boys may increase

stress and anxiety if a player feels they are not meeting expectations (5). However, as female football continues to grow and become more professionalised in the UK, prevalence rates for NFOR may rise. Therefore, it is worth monitoring in the future as participation rates increase.

This is the first paper to examine the reoccurrence of NFOR in youth. Twenty seven percent of boys and nine percent of girls experienced NFOR, and of those players 60% of boys and 33% of girls went on to experience multiple episodes of NFOR. Factors that lead an athlete to experience NFOR or OT are known to be individualised (7). However, it appears that some elite youth football players may be more susceptible to NFOR than others given the high prevalence of repeated episodes of NFOR in the current study. In this regard NFOR may be considered similar to injury; it has been shown that suffering an injury in the previous season almost doubles the likelihood of an elite adolescent football player sustaining an injury in the subsequent season (25). Identifying players who have previously experienced NFOR would be a simple method to find those who are at greater risk of suffering from NFOR in the future. Therefore, closer monitoring and proactive assessments from the start of player development appears critical to implement within the academy setting.

The presenting symptomology of NFOR varies widely between athletes, with over 90 different symptoms being reported (9). However certain symptoms are more frequently reported in both adults and children, including an increased perception of effort during exercise, feelings of muscle heaviness, frequent upper respiratory tract infections (URTI), persistent muscle soreness, mood changes, sleep disturbance and loss of appetite (12, 26, 27). Similar findings were reported in the current study, with NFOR players suffering from tiredness and incomplete recovery, a loss of appetite around important competitions, increased feelings of external pressure from the coach (for girls), sore or heavy muscles and

being in a bad mood. In reporting these symptoms for female players, the results also demonstrate that negative symptoms were often more pronounced in players currently experiencing NFOR. Psychosocial markers of stress and recovery can identify potential NFOR in elite youth male football players two months before performance decrements are able to formally diagnose the condition (28). This means it is important to educate players, parents and coaches to allow monitoring and early identification of symptoms associated with NFOR. Recently, Noon and colleagues (21) examined psychosocial well-being changes across the course of a season for elite English youth players. It was shown that as the season progressed, training exposure significantly increased while perceptions of well-being significantly deteriorated (motivation, sleep quality, recovery, appetite, fatigue, stress, muscle soreness). They also reported that while training volumes were high, they were short of those recommended by the EPPP, therefore if total exposure time were to meet the EPPP criteria, this might have negative effects on well-being.

Tiredness and incomplete recovery were associated with NFOR in the present study. This finding reinforces the belief that young elite athletes who are experiencing the process of growth and maturation, as well as trying to adapt to intensive training, need to be given additional recovery between training sessions (29, 30). Kellmann (31) described how OT results from incomplete recovery with increased stress, leading to an individual experiencing more stress. Increased stress can impair sleep, further limiting recovery, and this can have a cascade of negative consequences including decreased performance, increased anxiety, impaired cognition and supressed appetite (32, 33). Demanding training schedules can contribute to sleep deficiency in elite youth athletes and interventions to monitor and support adequate sleep should be implemented (29, 33). Academy players may be particularly at risk due to the need to travel long distances, train and play in evenings and then get up early for

school (33). Supporting this, it has been demonstrated that senior elite football players suffer disturbed sleep following matches played in the evening (34).

Finally, the control of the young player's life and considerable time demands of being part of the academy system means that the development of a unidimensional character is frequently observed (17, 20). These observations include limited friendship groups, minimal involvement in activities outside of football, and reduced coping strategies (35). These undesirable outcomes have been previously reported in youth athletes (12) and were observed in the present study, with elite youth players spending little time on hobbies and other activities outside of football. These observational findings indicate the importance of academies exposing players to a greater variety of games/sports, skills and friendship groups.

As with all studies limitations need to be acknowledged. This study was a self-administered survey, a subjective measure that is prone to participant bias and poor memory recall. However, these surveys are not only are common in medical research but also yield important information as long as questions are clear and respondents have the resources to answer (36), which we assessed through a pilot study. Poor memory recall was not evident because of the similarity in responses between the current and historical NFOR/OT athletes' responses. As with our previous work (11), we have adopted a conservative definition of NFOR and therefore have ensured we have not exaggerated its prevalence. The survey results are comparative to previously published works (11, 13), giving confidence to the validity of our findings**.** Finally, the sample is limited to the five academies involved in the study and therefore caution is warranted in extending findings across all football academies.

The current study identified symptoms and risk factors associated with NFOR in young athletes, which holds applied value to practitioners. Recent international consensus denotes that training prescription for young athletes should be complimented with relevant monitoring and assessment tools to identify acute changes or chronic trends in maturation, physical performance and psychosocial wellbeing (29, 37). An effective monitoring strategy is important to reduce the risks of excessive training and accumulated fatigue manifesting, which in combination have been linked with injury (24) and incidence of NFOR (11, 12, 22) in young athletes. With an understanding of the key determinants and likely signs of NFOR in youth populations from this study, awareness can be raised amongst key personnel surrounding the physical and psychosocial stressors that may result in a young athlete experiencing NFOR. Findings from the current study should be used to help inform integrated education programmes for coaches, parents, and young athletes, to firstly avoid young athletes experiencing NFOR/OT in the first instance, secondly identify those that are experiencing the condition for the first time, and finally to provide athletes and those responsible for young athlete health and wellbeing, with the tools to prevent re-occurrences of NFOR. Future research is now required to develop and evaluate interventions aimed at reducing the prevalence of NFOR in order to identify best practice for those responsible for the duty of care of young athletes within sport.

In conclusion, this study investigated the prevalence of NFOR/OTS in a group of talented young male and female football players attached to professional academies. While players had not experienced OT, NFOR was prevalent with higher rates in boys than in girls. Reported symptoms of those who had experienced NFOR were comparable between the sexes. As well as the high rates of NFOR, a particular concern is the even higher rates of recurring NFOR; players who had already experienced one bout of NFOR became two to

three times more likely to suffer repeated bouts. Therefore, the ability to identify players who have previously suffered NFOR will help categorise at risk players, who can then be targeted with appropriate interventions. Susceptibility and symptoms of NFOR are highly individualised but education, monitoring and relevant interventions should focus on appropriate training dosage and adequate recovery, the management of stress and expectations, and an emphasis on sleep quality, appetite and eating habits, mood and anxiety.

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