Risk factors for injury in talented soccer and tennis players

van der Sluis, Alien

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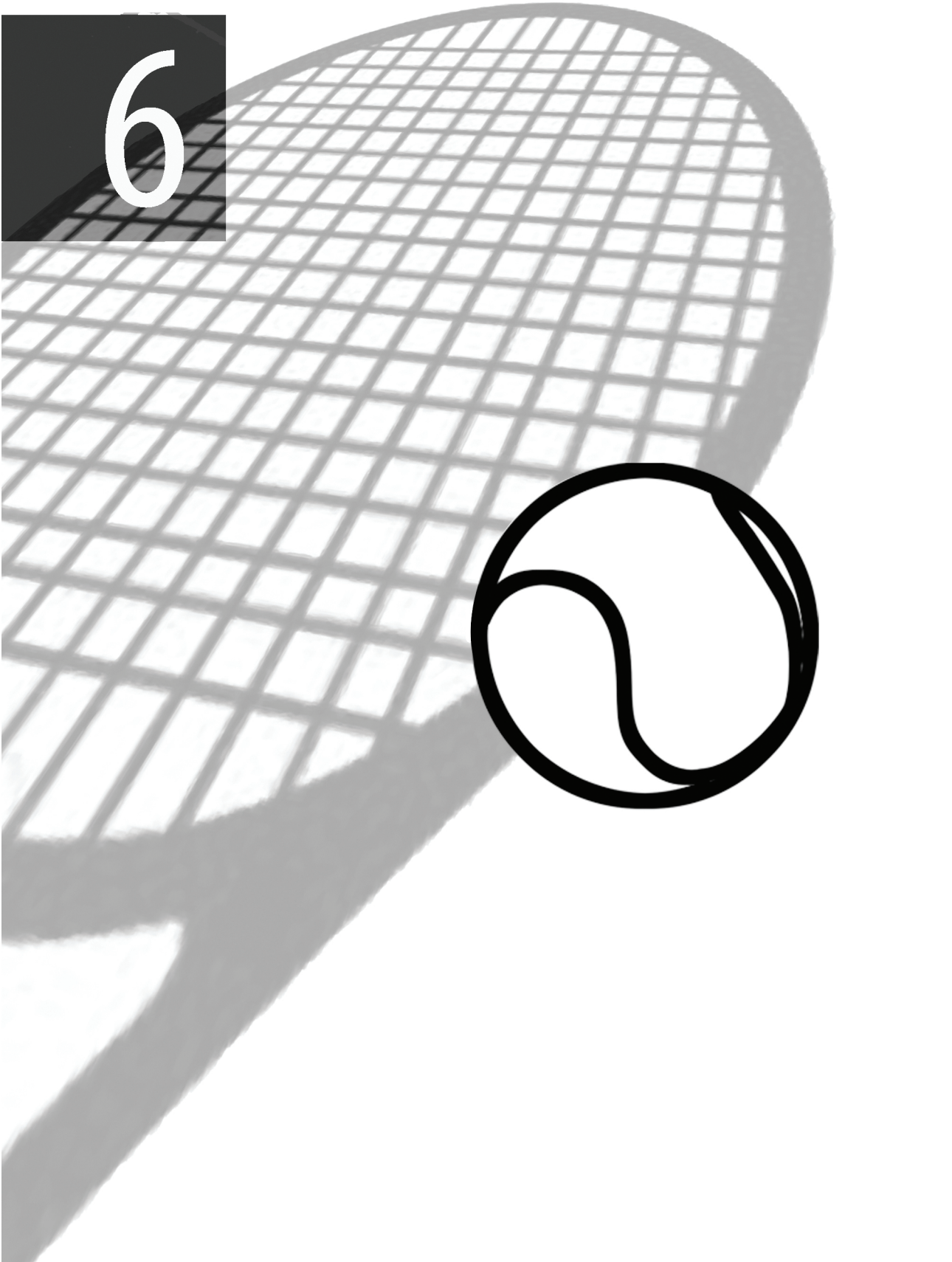

CHAPTER 6

SELF-REGULATORY SKILLS: ARE THEY HELPFUL IN THE PREVENTION OF OVERUSE INJURIES IN TALENTED TENNIS PLAYERS?

Alien van der Sluis, Michel S. Brink, Babette M. Pluim, Evert Verhagen, Marije T. Elferink-Gemser, Chris Visscher.

Submitted

ABSTRACT

Talented athletes use meta-cognitive skills to improve their performance. It is known that these skills are used in health management as well. The goal of this study was to identify the relationship between meta-cognitive skills and overuse injuries in talented tennis players. Meta-cognitive skills were measured in 73 talented tennis players (45 boys and 28 girls, age 11 to 14) at the start of the season, using the Self-Regulation of Learning Self-Report Scale. Overuse injuries were monitored for one season using the Oslo Sports Trauma Research Centre Questionnaire on Health Problems. Ordinal regression indicated that moderate or low self-monitoring skills (compared to high self-monitoring) (OR 4.555, CI 1.096-18.927, p=.037) and exposure time (OR 1.380, CI 1.106-1.721, p=.004) were associated with more time loss overuse injuries. A second analysis showed that this was the case in girls (OR 10.757, CI 1.845-62.714, p=.008), but not in boys. Linear regression revealed that higher reflection scores and exposure time predicted overuse severity (F(5,58)=2.921, p=.0.020, R2= .201). Possibly, self-monitoring can help athletes to prevent themselves from time loss overuse injuries. Coaches should be aware that athletes can differ in self-monitoring ability and thus in the ability to prevent overuse injuries. The role of reflection needs more research.

INTRODUCTION

Junior tennis players increasingly engage in early sport specialization: intensive year-round training in a single sport at the exclusion of other sports [15] and since there is only a restricted amount of time available to train and compete at the elite level, optimal performance development is crucial for talented athletes [11]. Injuries and any decrease in physical fitness and injuries can hinder performance progress and severe injuries can result in long-term health consequences [10, 24]. A recent study in elite youth tennis players showed that, at any given time, 1 out of every 8 players reported an overuse injury, that significantly hindered training or match performance [21]. Overuse injuries were even more problematic in girls than in boys [30] and injury prevention is therefore important.

We know that successful athletes are able to make more performance progress in the same number of training hours, when compared to less successful athletes, and are therefore better able to constantly improve their performance [16]. Self-regulatory skills play a crucial role in this process. Junior international players are better able to set and attain personal long-term goals, based on their experience and on their knowledge about their own strengths and weaknesses than their peers playing at national level [16]. The meta-cognitive components of self-regulation (reflection, planning, self-monitoring and evaluation) are particularly important. Elite athletes in individual sports (including tennis) score highly on all aspects of self-regulation [16] and reflection (the extent to which individuals are able to appraise what they have learned and adapt their past knowledge and experiences to improve performance) seems a crucial skill: junior athletes who reach the top score consistently higher on this skill [18]. Self-regulation is considered domain general and it is therefore reasonable to expect that athletes will use them in multiple aspects of their development [18].

In their goal to reach peak performance, athletes are often conflicted between protecting their health (to remain competitive), and pushing the limits of their bodies' capacities (to reach long-term performance goals) [8, 26]. This is even more of a problem in adolescent athletes, where the demands of their sport are superimposed on those of growth

and maturation [10]. An increased risk for serious overuse injuries has been proposed by several authors as a negative consequence of early sport specialization [1, 14, 20].

Although athletes expose themselves to health risks, this does not mean that they passively accept those risks. On the contrary, they are actively engaged in trying to manage the threats of injury [22, 28]. Athletes speak of a learning process, as a result of which they come to understand their bodies' limits and how to respond to these [28]. Elite runners use self-regulatory skills not only to improve performance, but also to monitor bodily sensations, pain and injury in order to reach a long-term goal [3]. This seems to point in the direction of the importance of the metacognitive components for health goals. Clark & Zimmerman [5] proposed a model on how people use these skills to self-regulate their health, and to prevent or control disease, and several studies have shown that self-regulatory skills benefit health behavior in adolescents, e.g. healthy eating [2, 19, 27].

However, as far as we know, no studies have focused on the relationship between self-regulatory skills and the incidence of overuse injuries. The goal of the current study is to investigate this relationship. We hypothesize that higher self-regulatory skills are related to lower rates of overuse injuries.

METHODS

Study design and procedure

The study was conducted with players participating in the national high performance program of the Royal Dutch Lawn Tennis Association (KNLTB, n=73, 45 boys and 28 girls, age 11 to 14 years, mean age 12.4 (±1.1)). Parents and players were verbally informed of the purpose and procedures of the study during a pre-season intake and testing day. Written informed consent was obtained from participating players and their parents and the medical ethics committee of the VU University Medical Centre, Amsterdam, the Netherlands approved the study. Participant characteristics are given in Table 1.

The prospective cohort study was performed during the tennis season (September 2012 – June 2013). At the start of the season, players completed a questionnaire on demographics, tennis experience and injury history, tennis exposure (number of training and match hours per week) and psychological characteristics, including self-regulation.
During the entire season players received a weekly email invitation (using online survey software, Questback, Netherlands) in which they were invited to report their training and match exposure during the previous week, as well as any health problems they had experienced over that time. An automatic reminder was sent to non-responders after three days, urging the player to complete that week's registration. If an athlete did not respond for three weeks, or if their answers to the questionnaire were unclear, they were contacted by telephone by a KNLTB physician. For the exact procedure, refer to Pluim et al. [15].

Table 1. Participants characteristics: age, tennis experience and tennis exposure.

	Total population	Boys	Girls
N	73	45 (61.1%)	28 (38.4%)
Age, years (SD)	12.4 (±1.1)	12.3 (1.1)	12.5 (1.2)
Tennis experience (years) (SD)	6.1 (1.7)	6.4 (1.5)	5.8 (1.9)
Training exposure (hours/week) (SD)	9.1 (0.6)	9.3 (0.7)	8.7 (0.7)
Match exposure (hours/week) (SD)	2.2 (0.7)	2.2 (0.7)	2.2 (0.9)

Measurement of self-regulation

The Self-Regulation of Learning Self-Report Scale [29] was used to measure the participants' self-regulatory skills. Only the subscales measuring the metacognitive skills were used in the current study (i.e., planning, self-monitoring, evaluation and reflection). Planning (8 items) and self-monitoring (6 items) were scored on a 4-point Likert type scale ranging from 1 (almost never) to 4 (almost always). Evaluation (8 items)

was scored on a 5-point Likert scale that ranged from 1 (never) to 5 (always). High scores on these subscales indicated more frequent use of these skills. The reflection subscale (5 items) ranged from 1 (strongly disagree) to 5 (strongly agree). High scores on this subscale indicated a low level of reflection. Scores on this scale were reversely scored in our analysis, so that high scores on this scale signify high reflection skills.

The SRS–SRL is reported to be reliable for adolescents between 11 and 17 years of age and its content and construct validity is supported [29]. The Cronbach's α's for the present study were considered sufficient and ranged between α = .78 and α = .86.

Injury registration

The Dutch version of the Oslo Sports Trauma Research Centre Questionnaire on Health Problems [9, 10] was included in the weekly online logs. The questionnaire had a high internal consistency, with a Crohnbach's alpha of .91 and good face validity (Clarsen et al, 2013). The OSTRC Questionnaire consisted of four key questions, that focused on the extent to which injury, illness, or other health problems had affected their (1) tennis participation, (2) training volume or (3) tennis performance during the previous week, as well as (4) the extent to which they had experienced other symptoms. Based on those four questions a weekly severity score was calculated for each player ranging between 0 and 100.

If a problem was reported in any of the four questions, the athlete was asked to specify the problem (illness or injury). In the case of an injuries, athletes were asked to specify the anatomical location of the injury, and number of days which resulted in complete time loss (total inability to train or compete).

Classification and diagnosis of reported problems

A sports physician of the KNLTB checked and classified all reported problems. Players or their physiotherapist were contacted in case of missing or unclear data. Overuse injuries were defined as those injuries that could not be linked to a single, identifiable event [13]. Injuries were

classified using the Orchard Sports Injury Classification System V.10 [23]. In order to get insight into overuse problems two outcome scores were calculated for each player:

1) Number of time loss overuse injuries (total number of overuse injuries in one season leading to absence from training and/or competition)
2) Overuse severity score (average weekly severity score related to overuse injuries).

Statistical analysis

Means and standard deviations were calculated for self-regulatory scores and for overuse injury severity scores, separately for boys and for girls, using SPSS 20.0. Because of the limited dispersion of number of time loss overuse injuries, players were categorized into one of three categories: (1) no time overuse injuries during the season, (2) one time loss overuse injury or (3) more than one time loss overuse injury.

Ordinal regression analysis was used to estimate odds ratios (ORs) and associated 95% confident intervals (CIs) for the association between self-regulation skills and the number of time loss overuse injuries (categorized into: no injury, one injury, and more than one injury). Exposure time (average of weekly match exposure and training exposure) and sex were added to the analysis. The variables were checked on linearity of the logits, and this assumption was met for weekly tennis exposure, reflection and monitoring, but not for planning and evaluation. Therefore, the self-regulation variables were divided into three categories: low, moderate, high. The cut off points for the categories were based on the study of Toering et al. (2009), identifying differences in self-regulatory skills between 440 elite and non-elite soccer players. The logistic regression that was used in this study resulted in different cut off points for each self-regulatory aspect (see table 2). This is in line with Jonker et al [16, 17], who studied self-regulation in over 1200 talented athletes. Tolerance and Variance Inflation Factor (VIF) statistics indicated no multicollinearity problems.

The ordinal regression was executed in two steps to decrease

the chance of a type 1 error. First, the main effects of the four self-regulation variables, exposure time and sex were tested. When a main effect was found for any of the self-regulation variables, a second ordinal regression analyses was executed to identify interaction effects between sex and the self-regulatory skill at hand.

Table 2. Self-regulation variables in categories in talented tennis players (n=73)

	Score range	n
Reflection		
Low	1.00-3.50	7
Moderate	3.51-4.00	21
High	4.01-5.00	43
Planning		
Low	1.00-2.00	7
Moderate	2.01-3.00	35
High	3.01-4.00	28
Self-monitoring		
Low	1.00-2.50	16
Moderate	2.51-3.00	18
High	3.01-4.00	36
Evaluation		
Low	1.00-3.00	5
Moderate	3.01-3.50	17
High	3.51-5.00	48

Multiple linear regression (method: enter) was done to predict overuse injury severity scores based on self-regulation skills, exposure time and sex [12]. Two cases turned out to be influential and were removed from

the analysis. To decrease the chance of type 1 errors, the regression was performed in two steps. First, a regression with the whole group was executed. When significant predictors were found, the linear regression was repeated separately for boys and for girls with only the significant predictors.

RESULTS

During the study period, the average response rate of the online logs was 80%. In the total group, 58 time loss overuse injuries were recorded in 44 players. 29 players had no time loss overuse injuries, 34 players had one time loss overuse injury, seven players had two time loss overuse injuries, two players had three time loss overuse injuries, and one players suffered from four different time loss injuries during the season. Shoulder and knee were the most affected areas (figure 1).

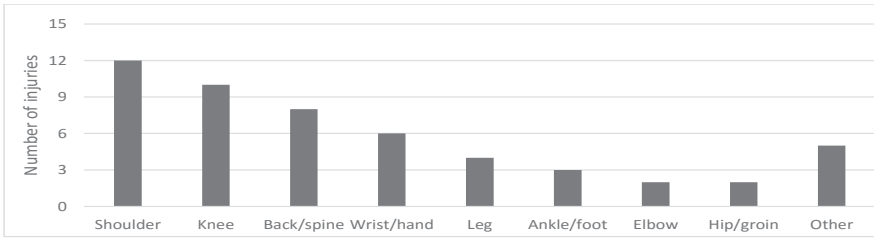

Figure 1. Affected area and number of time loss injuries .

Table 3 provides the average overuse severity score over the study period as well as the dispersion of players over the different number of time loss overuse injury categories. The average reported overuse related severity score per week was 3.98 for boys and 9.55 for girls. Of the total group, 34 players (46.6%) had one overuse injury leading to time loss from training and competition and 13.7% had more than one overuse injury resulting in time loss (17.9% of the girls and 11.1% of the boys, table 3).

Table 3. Number of tennis players per (time loss) overuse injury category and mean overuse severity scores.

Time loss overuse injuries				
	None	One	More than one	Total
Boys (n)	20 (44.4%)	20 (44.4%)	5 (11.1%)	
Girls (n)	9 (32.1%)	14 (50.0%)	5 (17.9%	28
Total (n)	29 (39.7%)	34 (46.6%)	10 (13.7%)	73

Overuse severity score (µ±sd)	
Boys	3.98 (±5.53)
Girls	9.55 (±12.37)
Total	6.12 (±9.14)

To illustrate the diverse development of the overuse injury severity score in different players over the study period of 31 weeks, figure 2 displays the course of this score for two different players, who do not differ a lot in their average weekly severity scores over the whole season.

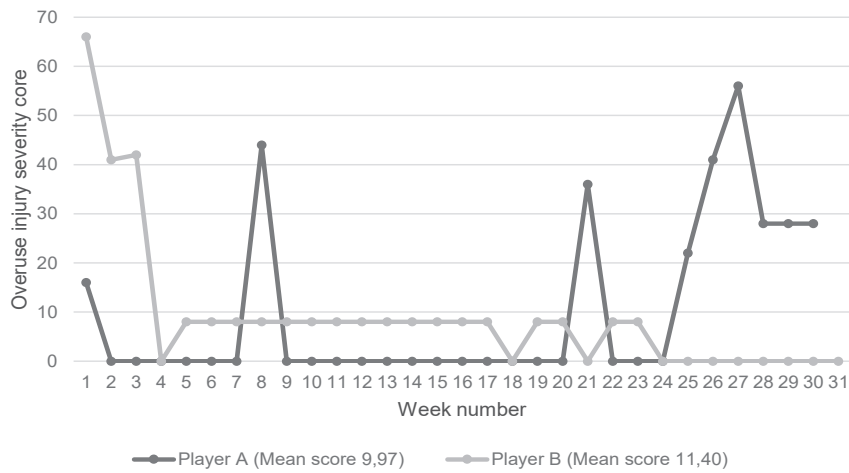

Figure 2. Illustration of development of the overuse injury severity score over 31 weeks of two tennis players period.

Time loss overuse injuries

The ordinal regression analysis showed that exposure time (OR 1.380, CI 1.106-1.721, p=.004) and moderate or low self-monitoring skills (OR 4.555, CI 1.096-18.927, p=.037) were associated with a higher category of time loss overuse injuries. Sex, planning, reflection and evaluation were not related to the development of time loss overuse injuries (table 4).

Table 4. Multiple ordinal regression analysis for the association between self-regulation skills, sex and exposure time with time loss overuse injuries.

	Odds ratio	95% CI	p
Exposure time	1.380	1.106- 1.721	.004*
Sex			
Male	.517	.175- 1.529	.233
Female	-		
Planning			
Low	.325	.043- 2.454	.276
Moderate	.778	.246- 2.461	.670
High (reference category)	-		-
Self-monitoring			
Low	5.088	.983- 26.346	.052
Moderate	4.555	1.096- 18.927	.037*
High (reference category)	-		-
Reflection			
Low	.587	.079- 4.333	.601
Moderate	1.072	.288- 3.989	.918
High (reference category)	-		-
Evaluation			
Low	.398	.039- 4.094	.438
Moderate	1.909	.420- 8.679	.403
High (reference category)	-		-

The second ordinal regression showed an interaction effect between sex and self-monitoring on time loss overuse injuries; having low or moderate self-monitoring skills (OR 10.757, CI 1.845-62.714, p=.008, table 5) was related to development of time loss overuse injuries in

girls, but not in boys (OR 2.968, CI: 0.523-16.845, p=.219).

Table 5. Multiple ordinal regression analysis for the association between self-monitoring skills and time loss overuse injuries in girls.

	Odds ratio	95% CI	p
Self-monitoring			
Low	10.757	.876- 132.101	.063
Moderate	10.757	1.845- 62.714	.008
High (reference category)	1.000	-	-

Overuse injury severity score

A significant linear regression equation was found, in which exposure time per week and reflection score significantly predicted overuse injury severity score (F(5,58)=2.921, p=.0.020, with an R2 of .201)(Equation 1 and table 6). Sex, planning, monitoring and evaluation were not related to overuse injury severity score:

EQ 1: Overuse severity score=-8.239 + .832 (exposure time) + 6.163 (reflection) in which exposure time is measured in average hours per week and reflection is the average reflection score.

Table 6. Multiple linear regression of exposure time and reflection score on severity of overuse injuries talented tennis players

	B	*SE(B)*	*β*	*t*	*p*
Constant	-8.239	9.604		-.858	.395
Exposure time per week	.832	.356	.281	2.338	.023
Reflection	6.163	2.303	.403	2.676	.010

When the linear regression was repeated separately for boys and girls, with exposure time and reflection as predictors, a significant linear regression equation was found for girls, but not for boys. In girls, only exposure time (but no longer self-reflection), predicted overuse injury severity score (F(2,22)=2.822, p=.04, with an R2 of .204 (Equation 2 and table 7). This was probably due to the relatively small sample size (26 players).

EQ. 2: Overuse severity score =-34.306+ 2.021(exposure time)+4.225 (reflection) in which exposure time is measured in average hours per week and reflection is the average reflection score.

Table 7. Multiple linear regression of exposure time on severity of overuse injuries in girls

	B	*SE(B)*	*β*	*t*	*p*
Constant	-34.306	24.936		-1.376	.183
Exposure time per week	2.021	.852	.478	2.371	.027
Reflection	4.225	4.597	.185	.919	.368

DISCUSSION

The goal of the current study was to investigate the relationship between self-regulatory skills and overuse injuries in talented tennis players. Knowledge on the role of these skills in relation to injuries can give coaches and athletes increased understanding on how they can be used in the prevention of injury, while striving for expert performance. High self-monitoring scores were protective for having time loss overuse injuries and this was specifically the case in girls. Higher scores on reflection were related to higher weekly severity scores for overuse injuries but no other relationships between the self-regulation skills and the overuse severity score were identified. We will discuss these results in the light of the usage of self-regulatory skills by these talented athletes, and from the perspective of the relatively new overuse injury measures that were used in the current study.

Self-monitoring turned out to have a preventative effect on time loss overuse injuries, at least in girls. Players with moderate or low self-monitoring skills have a significant higher chance on being in a higher time loss overuse injury category. The self-monitoring questions evaluated the awareness of the individual to his or her actions during execution (e.g.: 'During execution of a task, I ask myself how well I am doing'). Clark & Zimmerman [5] mentioned that people use 'self-observation' to manage their health. Self-observation is closely related to self-monitoring and refers to the attempt to perceive one's own health related behavior (e.g. asthma patients monitor their behavior and the responses in order to stay free from asthma attacks). Players with higher

self-monitoring skills, are possibly better able to keep track of their training load and their (bodies') response to it, and react in a manner that prevents injury. In this regard, Brick et al [8, 26] showed that elite runners monitor bodily sensations, pain and injury in order to achieve a long-term goal. They are able to appraise pain signals accurately, and use this information to optimize their running performance. Such monitoring skills could well be used in injury prevention. Brink et al. [4] have already shown that self-reported intensity scores are related to injuries in talented soccer players. The individual feedback players give to trainers is especially important to identify when a player has an increased risk of injury. This assumes that a player is capable of giving this feedback in an honest and meaningful way and our results show that do players do differ in this regard. Saw et al [25] looked at how Athlete Self-Report Monitoring (ASRM) is used to prevent athletes from injuries, overtraining and illness. One of their main findings was that for ASRM systems to be useful, they are highly dependent on the active engagement of all parties: coaches, athletes and other support staff. Athletes need to be highly engaged to use the system on a long-term, daily basis and need to be educated on how to use the systems.

Talented athletes use reflection to set attainment goals based on their experiences, strengths and weaknesses, thereby creating optimal performance development in the restricted time that is available to reach elite level [17]. Since overuse injuries can hinder performance development and self-regulatory skills are domain general, we expected athletes to use reflection in preventing overuse injuries. Contrary to our expectations, tennis players with higher reflection scores reported higher severity scores. In their goal to reach peak performance, athletes can be conflicted between protecting their health (to remain competitive), and increasing the risk of injury (by training to the limit) [8, 26]. The refection scale measures the extent to which individuals are able to appraise what they have learned and adapt their past knowledge and experiences to improve performance (for example: "I often reappraise my experiences so I can learn from them"). It is possible that the young athletes in the current study are mainly focused on short-term performance goals, because these goals are concrete and because they think performing at the elite level as a junior is essential in reaching the senior elite level. They might find it difficult to oversee long-term sport consequences of

for example overuse injuries. This might result in mainly using reflection for their performance goals, and not (yet) consider the importance of staying healthy. Theberge et al. [28] showed that senior athletes have learned the capacities and limits of their bodies and how to respond in the best way to manage (overuse) symptoms. However, they refer to this as a learning process, and mention that it takes time for the individual to gain this knowledge, and attain mastery over their body. This might not yet be the case in the young tennis players (11 to 14 year old) in the current study.

Another explanation relates to the meaning of the severity score. This score is based on four questions about the extent to which an overuse injury affected players' (1) tennis participation, (2) training volume or (3) tennis performance during the previous week, as well as (4) the extent to which they had experienced other symptoms. These four questions depend on the reflective skills of the player and it is possible that athletes with high levels of reflection report higher severity scores because they are more aware of the burden that overuse symptoms put on their tennis participation, training volume and tennis performance. Whether or not these reported overuse severity scores are also predictors for serious overuse problems, needs to be examined. It would be interesting to see if the players who reported higher average severity scores for a similar overuse injury, were able to prevent them from getting more serious. The fact that we did not find a relationship between reflection and time loss overuse injuries i.e. higher reflection scores do not go hand in hand with more injuries, could point into this direction.

One of the strengths of the current study is the fact that we were able to follow a group of talented tennis players on a weekly basis and gather detailed information on their overuse injuries by using the OSTRCQ. The questionnaire provides an excellent structure for monitoring overuse injuries prospectively, but the relevance of the mean overuse injury severity scores needs to be examined by comparing them in larger groups of athletes. The sample size of 73 players (with a small subgroup of only 26 girls) is a limitation of the study. This is the reason why we discussed the directions of the relationships between the metacognitive skills and overuse injuries, but were careful not to speculate about the strength of the findings and on concrete results.

We also needed to be cautious about proposing any linear relationship. Another point that needs to be addressed is the fact that we used a general self-report questionnaire for measuring self-regulation of learning. The questionnaire did not specifically ask about usage of the skills for the sake of the goal of staying healthy and athletes probably do not have these kind of goals in mind when filling out the questionnaire. However, self-regulation is said to be a domain general concept, and it was therefore interesting to see if these general skills are of use for prevention of overuse injuries. We only looked at the metacognitive aspects of self-regulation (reflection, planning, monitoring and evaluation), and did not take into account the motivational aspects (effort and self-efficacy). The reason for this is that we expected the metacognitive parts to have a protective effect on the occurrence of overuse injuries. With regard to effort and self-efficacy, we were unsure about the direction of the relationship. Self-efficacy (how someone judges his or her capability to organize and execute required actions) has been related to better outcome of rehabilitation processes of athletes [31], but especially effort (the willingness to attain a goal) might be negatively related to the occurrence of injuries, as an athletes' primary goal will often be his or her sports goal.

Perspective

Talented athletes use self-regulatory skills to improve their sport performance. Recently, authors have suggested that these skills are used in the management of health [5]. The current study was the first to study self-regulatory skills in relation to overuse injuries in a target group of talented junior tennis players. Having high self-monitoring skills is related to having less time loss overuse injuries and by self-monitoring, athletes can possibly prevent overuse symptoms from becoming time loss injuries. Educating talented athletes in self-monitoring overuse-related complaints might be a preventive strategy. Players high in reflection report higher weekly overuse injury severity scores but more research is needed to explain the meaning of this result. Coaches and trainers should be aware of the fact that players differ in self-monitoring skills and that this might play a role in the degree to which they are able to prevent themselves from injuries. Support staff should be aware of this when using athlete self-report measures for the prevention of

injuries and ensure that athletes are educated to develop these skills for optimal health management.

In conclusion: high self-monitoring scores seem protective for having time loss overuse injuries. This is mainly the case in girls. Higher scores on reflection are related to higher weekly severity scores for overuse injuries. The meaning of this result needs further study.

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