Enhancing Performance & Preventing Injuries in Team Sport Players

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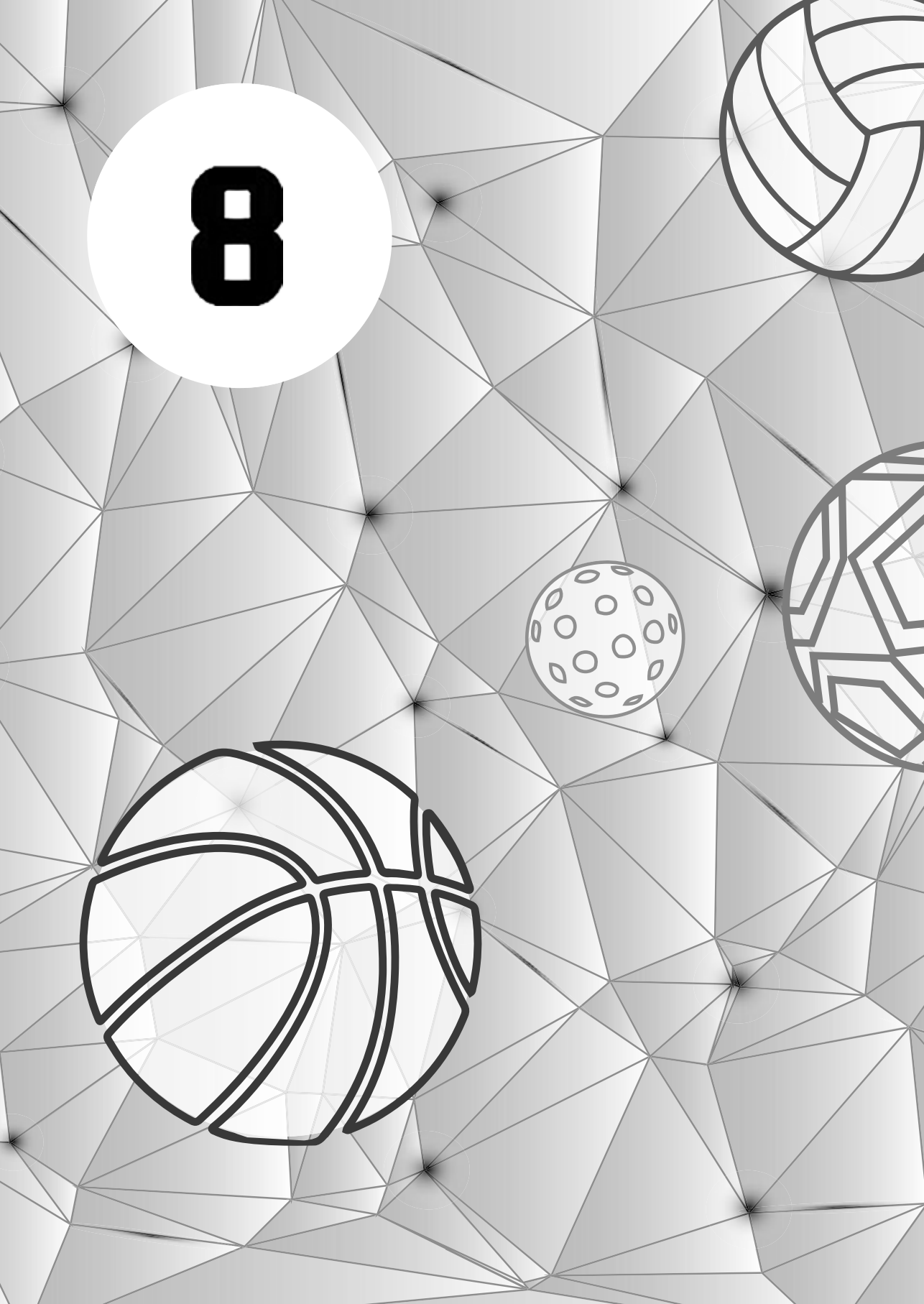
8

General Discussion

The aim of this thesis was twofold. First to investigate if changes in training load, recovery and psychosocial stress and recovery are related to (field-test) performance and injury occurrence during the season. Secondly, to provide more insight in the predictive value of movement technique measured at the start of season for injury occurrence during the season. In total 129 sub-elite and elite basketball, volleyball, korfball and floorball players were monitored over the course of two seasons.

MONITORING

In general, this thesis showed that more training load during the season was related to better agility. More psychosocial stress and less psychosocial recovery over the course of the season were associated with decreased intermittent endurance (Chapter 3). Furthermore, less psychosocial recovery was also associated with increased acute and overuse injury risk (Chapter 4).

To monitor the changes in field test performance over the course of a season a reliable and valid team sport specific field test is required. Game demands of all included types of sport showed the importance of well-developed energy systems and agile movements [5,16,21]. In Chapter 2 no strong relation was found between anaerobic and aerobic capacities and agile movements indicating that agility is an independent (sport specific) quality of players. Studies relating training load and recovery with agility of players are limited. Chapter 3 of this thesis showed that sport specific training was associated with meaningful changes in agility. Although no causal relation was proven, this suggests the importance of sport specific training to improve agility.

Psychosocial stress and recovery showed to be related to performance as well as injury risk. More specifically; General Stress and Recovery scales showed to relate to performance over 6 weeks, while for the Sport Stress and Recovery scales this was shown over 3 weeks. Along these lines, a decrease in the General Recovery scales over six weeks was shown before an acute injury while a decrease in the Sport Recovery scales over three weeks was seen before an overuse injury. The fact that both long and short-term psychosocial stress and recovery relate to performance and injury prevalence indicates the importance of monitoring this continuously over the course of a season. This way individual change can be detected and proper interventions can be implemented. Interventions can consist of learning the players a way of coping to manage the stress and/or enhance recovery like time management, meditation, relaxation etc. [31]. Tools like mental preparation and the use of routines have shown to be effective in coping with stressors like anxiety but also injuries [31].

MOVEMENT TECHNIQUE & INJURY

Players sustaining an ankle injury during the season showed less one-legged landing stability at the start of the season. Furthermore a suboptimal landing technique in terms of greater ankle dorsiflexion moment was present during two-legged jump-landing at baseline (Chapter 6 & 7). For overuse knee injuries a landing technique with smaller knee flexion moment and greater vertical Ground Reaction Force (vGRF) indicated an increased injury risk (Chapter 7). Finally chapter 4 showed some support for high leg stiffness being a risk factor for the development of a Jumpers Knee (JK).

Baseline measurements of physical characteristics seem to be important to assess injury risk. More specific landing stability and technique of indoor team sport players are of interest, since jumping is one of the primary game demands. This risk profile can guide the development of individual intervention programs more precise. Protocols measuring stability mostly just involve forward jumping [26,27,32], while during a game players jump from different directions. The results from this thesis show that using a protocol involving different jump directions is needed to determine a risk profile.

In both Chapters 5 and 6 landing stability for the Vertical and Anterior/Posterior Stability Index (VSI and APSI respectively) after a single-leg landing task showed to be less in players sustaining an acute ankle injury, while for Medial/Lateral Stability Index (MLSI) no results were found. These last results are in accordance with previous studies [27,32], and may be due to the poor test retest reliability of the MLSI [33,34]. Furthermore, in our studies jump-landing stability was investigated for different jump directions. The stability index (SI) in diagonal and forward jump direction were less stable in players with an ankle injury during the consecutive season while this was not the case for the lateral jump direction. These results seem to be contradictive to the ankle injury mechanism that is most of the time a lateral inversion of the ankle [9,17,29]. However this type of injury often occurs due to a forced inversion, such as hitting of or landing on another players foot [1]. Furthermore the lateral jump direction of the SLJ may not replicate the pure lateral direction of a lateral ankle inversion on the field since the protocol also involves landing from a certain height. Finally, the forward and diagonal jump directions are in accordance with the ankle inversion motion, involving a diagonal movement across anatomical planes with plantar flexion and supination of the ankle [1]. So, by using a more sport specific jump multi-directional landing protocol as in our study, a more specific risk profile can be determined to optimize prevention strategies.

Next to landing stability, landing technique showed to be a risk factor for lower extremity injuries (Chapter 6 & 7). The results found for high-risk jump-landing

patterns differ between individuals and studies. In some studies reduced range of motion (ROM) on the joints were shown due to for example already large dorsiflexion and hip flexion at landing [2,10], while others showed normal ROM and at landing a small knee flexion [3]. Individual landing patterns within and between measurement sessions show to be consistent for both kinematics and kinetics [13,20]. Also a normal range in landing patterns is found [14]. However these normal ranges have a wide variation, which may indicate the natural variability between individuals. This supports the importance to determine individual optimal landing patterns. Inevitable suboptimal landing patterns increase the load on the joints and therefore injury risk. This thesis showed that for overuse injuries in general, and specifically for JK, a suboptimal landing technique with reduced joint flexion indicates increased injury risk (Chapter 6 & 7). In the case of overuse injuries not only landing technique can be a risk factor, other factors such as number of jumps, playing position and training load play a role [30]. This emphasizes not only the need for baseline measurements of individual physical characteristics and optimal landing patterns but also monitoring of training load over the season.

To summarize, baseline measurement of physical characteristics can play an important role in creating an injury risk profile for players and develop prevention programs if necessary. It may be desirable to repeat these measurements after a prevention program or more often during the season to see whether an intervention program is beneficial to decrease the risk, and whether these physical characteristics change over the course of a season.

STRENGTHS, LIMITATIONS & FUTURE RESEARCH

This is one of the first studies that included large number of indoor team sport players on a high playing level. Physical characteristics were measured at baseline involving both landing stability and landing-technique. A prospective longitudinal design was used in order to detect changes in training load, stress and psychosocial stress and recovery in relation to injuries or changes in performance. The design and close interaction with the coaches and players makes this study valuable for both science and practice.

Next to the unique aspects of this study there are also limitations. The study design presented in this thesis is an observational design. Therefore the results found in Chapter 3 and 4 do not prove causation, but an association between training load, psychosocial stress & recovery, performance and injury occurrence. To get more insight in the cause and effect, experimental studies that manipulate stress and recovery are needed.

In this study, different indoor team sports were included. The physical game demands of basketball, volleyball, korfball and floorball all involve repeated sprint and change of direction speed (Chapter 2). In general the results found in this study should account for all indoor team sport involving repeated sprinting and quick changes of direction. As discussed in Chapter 2, 3 and 4 the results of these studies are comparable to results found in soccer [4,11,18], field hockey [12,19], volleyball [12,28], basketball [22] and rugby [8]. The physical performance tests used in this study are chosen to match the physical demands, however even more sport specific tests may give more detailed information about the sport performance for one type of sport.

Landing stability and technique to predict injury occurrence was measured with the use of a motion analysis system and force plates. These systems are very accurate, but not accessible to all coaches. Moreover, measurements and analysis take time and require specific knowledge. The financial recourses are often not available. So, it would be preferable to develop tools to measure landing technique and stability that are more practical in use and low in costs. A tool that has been developed to evaluate landing technique and is easy to use is the Landing Error Scoring System [24]. This tool has shown to be able to identify individuals at risk for ACL injury [23]. To measure landing stability a potential easy test to use was developed, however this test was purely based on stability [25] and did not include landing from a jump before stabilizing, which is more sport specific. This thesis showed the importance of landing stability measured from different jump directions and also landing technique as risk factor for both acute and overuse injury. Future research may focus on developing more accessible and sport specific tools to create injury risk profiles of players.

The injury registration was done by the physical therapist of the team according to the recommendations of Fuller et al. [15] . The physical therapist is part of the team and has therefore close contact with the players. This makes registration of injuries easier and increases compliance. However, only the medical attention injuries that were seen by the physical therapist were reported. So when a player has pain or a functional limitation but did not go to the physical therapist, this was not reported. These milder injuries or physical complaints may have been missed and can lead to an underreporting. Recently, Clarsen et al. [6] developed and validated a new method to register overuse injuries and get insight in these milder complaints. This method consists of a short questionnaire that is filled out each week by the players themselves to gain insight in their physical problems. This method showed to be sensitive and valid to register both overuse and acute injuries [6,7]. Future research could consider using this method to monitor injuries over the course of a season to get a more

accurate insight in these milder injuries and physical complaints. This method can help to clarify the development and incidence of overuse injuries.

In a longitudinal study design the compliance of the participants is important to avoid missing data. The compliance of the coaches and players depends highly on their motivation. One of the factors influencing this motivation is the feedback they receive. However, in our study the main goal was to observe the natural process. Providing feedback too often would interfere with this natural process. So the challenge was to find the right balance in providing feedback that is satisfactory to the coach and players but did not interfere. The importance of motivation was shown in the floorball team who showed high internal motivation and motivation from the coach resulting in an almost complete training log dataset (Chapter 3). Another factor that may influence the compliance is the presence of a member of the research team. In our study the RESTQ-Sport questionnaire was filled out online before the training session every three-weeks. At the training session a member of the research team was present to ask the players that didn't fill out the questionnaire online to fill it out on paper. As mentioned in Chapter 4 this method led to only 10.4% of the questionnaires missing over a ten-month monitor period. So in future research it is important to take the above mentioned factors for a good compliance into account. One of the key factors seems to be a person who is present at the training sessions to make sure the training logs and questionnaires are filled out adequately.

As described earlier the longitudinal design comes with missing data. To handle this adequately multilevel analysis was used assuming that missing data was random. Another advantage of multilevel analyses was that it took into account the relations between and within players. However, the relations in this analysis were assumed to be linear, while this may not be the case. The relations between process and outcome will probably be not as straightforward as assumed in these analyses. Furthermore it is expected that these relations differ for each individual player. So also a more individual approach in analyzing this data would be preferable. Further research is needed to explore the application of both individual approaches and non-linear approaches.

To conclude, this thesis shows that a higher training load is related to better agility and psychosocial stress and recovery are associated with aerobic intermittent endurance. Players who experience less psychosocial recovery have a higher injury risk. Furthermore, physical characteristics in terms of less landing stability and a suboptimal landing technique measured at the start of the season indicate an increased risk on ankle and knee injuries in indoor team sport players.

PRACTICAL IMPLICATIONS

Player monitoring systems should include not only the physical load of training and recovery, but also incorporate psychosocial stress and recovery factors. This appeared to be important in relation to both performance and injuries. To enhance agility sport specific training seems to play a role. However, for aerobic intermittent endurance psychosocial stress and recovery also needs to be considered. For the prevention of injuries players are advised to be aware of their recovery and find evidence based intervention strategies if necessary.

Movement technique of the players should also be screened at the start of the season. These measurements can include single-leg jump landing from forward and diagonal jump direction and the assessment of the two-legged repeated jump landing technique. More practical tools are still needed to make these measurements more accessible for sports practice.

By monitoring changes during the season and asses movement technique at the start of the season, tailor made intervention programs can be developed and applied on time. This can enhance performance and prevent injuries in indoor team sport players.

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