GÖTEBORGS UNIVERSITET

INSTITUTIONEN FÖR KOST-
OCH IDROTTSVETENSKAP

The Importance of Recovery to Prevent Injuries in Track and Field

A Quantitative Study on Swedish Elite Track and Field athletes' recovery

Johan Martinsson
Alexander Nilsson
Daniel Skatt

Bachelor degree essay 15 hp
Program: Sports Coaching
Vt 2017
Supervisor: Andreas Lundberg Zachrisson & Stefan Grau
Examiner: Peter Korp
Report number: VT17-04

GÖTEBORGS UNIVERSITET

INSTITUTIONEN FÖR KOST- OCH IDROTTSVETENSKAP

Bachelor degree essay 15 hp

Report number: VT17-04
Title: The Importance of Recovery to Prevent Injuries in Track and Field
Authors: Johan Martinsson, Alexander Nilsson & Daniel Skatt
Program: Sports Coaching
Level: Bachelor
Supervisor: Andreas Lundberg Zachrisson & Stefan Grau
Examiner: Peter Korp
Number of pages: 40 (including appendix)
Semester/year: VT2017
Keywords: Track and field, elite athlete, injury, recovery, CR10

Abstract

The balance between training and recovery is crucial for elite athletes to prevent injuries. Track and field is a sport that is practiced worldwide on all levels and the practice is associated with a risk of suffering an injury. The purpose with this study is to investigate how recovery factors in elite track and field athletes' recovery is associated with the development of injuries and if training when you're fatigued increases the risk of getting an injury. This is to get a better understanding of the importance of the recovery. The study has a quantitative approach were the data has been collected through an application on smartphones with questions to measure the athletes' recovery every day from September 2016 to April 2017. The answers have been analyzed as a part of a longitudinal study (2016-2020). The athletes who participated (n=36) are either top three juniors (18-22 years) or top six seniors (>22 years) in Sweden in their discipline representing sprint, jump, middle/long distance running or throwing.

The results show that you cannot see which factor(s) that affect the development of injuries ($p>0.05$). There is also no significant difference ($p>0.05$) between the non-injured- and the injured athletes in terms of fatigue to prevent an injury. More research needs to be done in track and field to investigate how the recovery process contributes to the development of injuries.

Sammanfattning

Balansen mellan träning och återhämtning är avgörande för att elitidrottare ska kunna förebygga uppkomsten av skador. Friidrott är en idrott som utövas över hela världen och är likt många andra idrotter förknippat med en risk för skador. Syftet med studien är att undersöka hur återhämtningsfaktorer i en friidrottares återhämtning ökar uppkomsten av skador samt om att träna när man är sliten är en större riskfaktor för skada. Detta för att få en bättre förståelse kring återhämtningens betydelse inom friidrott. Detta har undersökts genom en kvantitativ studie där data från september 2016 till april 2017 har analyserats som en del i en longitudinell studie (2016-2020). Idrottarna som deltagit (n=36) är antingen topp tre juniorer (18-22 år) eller topp sex seniorer (>22 år) i Sverige i sin respektive disciplin inom sprint, hopp, medel/långdistans löpning eller kast. Svaren från deltagarna registrerades dagligen via en applikation för smartphones med självskattningsfrågor om deras upplevda återhämtning inom sömn, kost & vätska, mental återhämtning och återhämtande fysisk aktivitet samt hur man känner sig just nu.

Resultaten visar att man inte kan se vilken(a) faktor(er) som påverkar uppkomsten av skador ($p>0.05$). Det är inte heller någon signifikant skillnad ($p>0.05$) mellan skadade och icke-skadade idrottare gällande trötthet för att förhindra en skada. Mer forskning behövs inom friidrott där skador är vanligt förekommande.

Acknowledgement

Table 1. Authors contribution

Task assignment	Percentage performed by the writers Johan/Alexander/Daniel
Planning of the study	35/30/35
Search of literature	40/25/35
Data collection	30/40/30
Analysis	35/25/40
Writing	35/25/40

We would like to thank our supervisors Stefan Grau and Andreas Lundberg Zachrisson at CHP at the University of Gothenburg for their knowledge, feedback and help in completing this study. We would also like to thank Elias Johannesson for his feedback and guiding in the statistical software program SPSS.

Table of Contents

Introduction

Track and field consists of several disciplines including walking, running, jumping, throwing and combined events with different characteristics and demands (Feddermann-Demont, Junge, Edouard, Branco & Alonso, 2014). It is a popular sport that is practiced worldwide (Alonso, Tscholl, Engebretsen, Mountjoy, Dvorak, & Junge, 2010) and both recreational- and elite athletes can practice the sport which increases the numbers of practitioners. Track and field is mostly an individual sport and every competition is measured with an individual result which can lead to a focus on continuous improvements and comparison of previous results. The track and field practice is associated, as many other sports, with a risk of suffering an injury (Feddermann-Dermont et al., 2014). Injury is a cause of concern regardless the level of the athlete (Edouard & Alonso, 2013) and the consequences of suffering an injury may lead to reduced performance, missing important competition(s), motivational problems and even drop-out of the sport where the latter one is especially of concern for recreational athletes. There are several definitions of injuries and one of them is "any musculoskeletal complaint newly incurred due to competition and/or training during the tournament that received medical attention regardless of the consequences with respect to absence from competition or training" (Junge, Engebretsen, Alonso, Renström, Mountjoy, Aubry & Dvorak, 2008, p. 414). There are two different types of injuries, acute and overuse where the latter one is most commonly reported in track and field. The lower limb is by far the highest injury location (60-100 % of all injuries) since every discipline includes major lower limb involvement (Edouard et al., 2013).

The incidence of injuries in track and field varies a lot in the literature. Feddermann-Dermont et al. (2013) studied the injuries in 13 international track and field championships between 2007 and 2012 and reported an incidence of 81,1±4,2 injuries per 1000 athlete. Alonso et al. (2010) studied the occurrence of injuries and illness during the 2009 IAAF (International Association of Athletics Federation) World Athletics Championships and reported an incidence of 135,4±16,2 injuries per 1000 registered athlete where almost 80 % of the injuries included the lower limb. A 1-year retrospective study of youth- and adult Swedish elite track and field athletes' reported an injury frequency of 36,9 % - 49,0 % of all the athletes with the dominant type of overuse injuries (Jacobsson, Timpka, Kowalski, Nilsson, Ekberg & Renström, 2012). A 1-year prospective study of Swedish youth- and adult elite track and field athletes' reported that 68 % of the Swedish elite athlete's reported one or more injuries during one season (Jacobsson, Timpka, Kowalski, Nilsson, Ekberg, Dahlström & Renström, 2013). Most of the previous research in track and field has focused on the type of injury/injuries that are common, the prevalence of injuries and the biomechanical- and clinical factors for the appearance of injuries but there are no study that have investigated how the recovery factors contributes to the development of injuries.

This study is included in a four year longitudinal study (2016-2020) at the Center of Health and Performance (CHP) at the University of Gothenburg, in collaboration with Göteborgs Friidrottsförbund (GFIF) where the goal is to reduce injuries including both overuse- and acute injuries in elite track and field athletes. The longitudinal study runs in different phases during the years including; screening, recommendation, evaluation and documentation

repeated times. Screening includes running analysis, strength- and mobility tests of the athletes. Recommendations are then made by the researchers based on the results from the screening. Evaluation is whether there have been any improvements from the last screening or not and the documentation is made by the coaches and athlete's which includes training log and the recovery protocols TQR (Kenttä & Hassmén, 1998) combined with the RPE scale (Borg & Borg, 1994). The focus of this study will be the recovery protocols – Are there any factors in the recovery process that increases the risk of suffering an injury?

This study will contribute with an increased understanding if any of the factors in the recovery process contributes to the development of injuries in elite track and field athletes. This will be of interest for both the coaches and the athletes when planning the training and recovery for the athletes.

Aim

The purpose of this study is to investigate if elite track and field athletes' recovery contributes to the development of injuries. Further, the purpose is to investigate if fatigue has any effect on the development of injuries. This is to increase the understanding of the importance of recovery in track and field where the physical and psychological demands are high. Further it is to help elite athletes and coaches in track and field to increase their understanding of the importance of recovery associated with injury prevention.

Research questions

1. What factors during the recovery process contribute to the development of injuries from training?

2. Does fatigue influence the development of injuries during the training process?

Background

The balance between training and recovery is crucial for elite athletes. Today, athletes not only do their training once a day, they regularly train twice a day. For a top athlete no simple general advice is given, other than it is important to "listen to your body signals" and modify the training intensity by how you feel. The aim of monitoring training and adequate recovery in elite athletes' is to reach a balance where training yields optimal increases in performance. Injuries in track and field are common (Alonso, Edouard, Fischetto, Adams, Depiesse & Mountjoy, 2012) and sometimes it may be due to inadequate recovery. Recovery in sport is defined as returning what was lost (e.g. reducing fatigue and muscle soreness), adapting to the stress and reaching a higher level of training tolerance, a process called super compensation (Sands, McNeal, Murray, Ramsey, Sato, Mizuguchi & Stone, 2013). Up to date there are only a few methods that help athletes investigate how recovery can influence the development of injuries but there are no clear advices of how the recovery factors influence the development of injuries and which of these recovery factors that are most important. However, there are several methods that measures the training process but few to match the recovery process against it.

Total Quality Recovery (TQR)

One framework to measure/monitor the recovery process is the Total Quality Recovery (TQR) scale (Kenttä & Hassmén, 1998). The main purpose of the TQR scale is to prevent the occurrence of the "staleness syndrome", injuries and to optimize the balance between training and recovery (Kenttä & Hassmén, 1998). The TQR scale might help athletes to stay injury free and capable of maintaining their training program (Kenttä & Svensson, 2008). The TQR scale is divided into two subscales; TQR perceived (TQRper) and TQR action (TQRact), where the first one is subjective and emphasizes the athlete's perception of the recovery while the latter one is objective and measures the athlete's recovery actions. The athletes are asked before bedtime to rate their recovery as an overall psychophysiological status from the previous 24 hours, including the previous night's sleep. Athletes simply score their actions and accumulate recovery over a 24-hour period from four main recovery categories; sleep, nutrition and hydration, mentally relaxed and regenerative physical activity. Thus, the maximum overall score of 20 points is equal to the highest ranking on the TQR(act) scale. TQR(per) is used in this study.

Ratings of Perceived Exertion (RPE) and CR10

To determine the level of effort for different types of physical work and activity the ratings of perceived exertion, (RPE) Borg (1970) is well-known and is evaluated on a scale from 6 to 20. The linear growth function of RPE data during an incremental work test has been confirmed in several studies (Ljunggren & Hassmén, 1991; Noble & Robertson**,** 1996; Borg, 1998). The RPE scale has also been updated to a shortened version, the CR10 (Borg, Hassmén & Lagerström, 1987) and utilizes the methodology for the more "true" growth with a positive increasing function (also the growth in lactic acid). The CR10 goes from 0 to 10 and can deliver a response that exceeds 10 (11 or 11+) if the experience is stronger than previously experienced. In sport science research, the TQR and CR10 scale has been used in both team related sports and individual sports with the purpose to monitor the recovery and reduce the risk of injuries. Thus, the results have varied, in track and field for instance, TQR and CR10 have been used to a very small extent and therefore the need to examine the recovery and injury in track and field is important considering the great numbers of injuries.

The training load is an important factor that for instance can be monitored by heart rate (HR). Session RPE scores is an alternative to heart rate monitoring and was first described by Foster (1997). The RPE method has also been shown to be a useful tool to estimate the training load during non–steady state exercise (Foster et al., 2001), to measure the average percent of heart rate during an exercise session (Foster, Hector, Welsch, Schrager, Green & Snyder, 1995) and to measure exercise intensity during resistance training (Day, Mcguigan, Brice, & Foster, 2004). The session CR10 scale have been successfully used together with kinesio tape to evaluate perceived pain and soreness in the calves for triathletes as an injury prevention (Merino-Marban, Fernández-Rodríguez, Iglesias-Navarrete, & Mayorga-Vega, 2011) and to decrease running-related injuries (Malisoux, Frisch, Urhausen, Seil, & Theisen, 2013).

Further, in team-related sport the CR10 have been used as an indicator of internal load of soccer training (Impellizzeri, Rampinini, Coutts, Sassi, & Marcora, 2004), thus, both TQR

and RPE during the same training session to monitor recovery did not contribute to the prediction of performance for soccer players (Brink, Nederhof, Visscher, Schmikli, & Lemmink, 2010; Osiecki et al., 2015). Suzuki, Sato, Maeda, & Takahashi (2006) did another study where they measured the training volume, fatigue, recovery and performance every day for one year on an elite 400m sprinter to see differences according to the training period using TQR. The results showed that the runner ran a personal best when the recovery was favorable (17-20). However, while there are some research on TQR in track and field, very limited research have been done to measure and understand the importance of sleep, nutrition and hydration, mental- and physical recovery in track and field, and therefore it is still an uninvestigated area.

Sleep

Sleep is an essential part of fatigue management, as persistent sleep loss can negatively impact on the quality of a training session and the general well-being (Robson-Ansley, Gleeson, & Ansley, 2009). Inadequate sleep can impact the mood state, the motivation to exercise and the ability to complete training sessions (Reilly & Edwards, 2007). It can also be associated with reductions in muscle glycogen, perceptual stress, reduced sprint performance and slowed pacing strategies during intermittent-sprint exercise (Skein, Duffield, Edge, Short, & Mundel, 2010). Prolongation of the sleep on the other hand has been shown to increase sprint running performance and the shooting accuracy for basketball players (Mah, Mah, Kezirian & Dement 2011). The subjects also reported improved overall ratings of physical- and mental well-being during practices and games.

Nutrition and hydration

As an athlete, nutrition is also an important factor, both for health and performance. The nutrition- and hydration intake overall and especially in training and competition will affect how well an individual can train and compete (Robson-Hansley et al., 2009). Training with inadequate nutrition intake may compromise immune function and lead to increased exposure of infections for athletes (Gleeson, Nieman & Pedersen, 2004), but on the other hand, good food choices can promote adaptations to the training stimulus, enhance recovery between training sessions, and decrease time for tissue repair from minor injuries (Hawley, Nieman & Pedersen, 2006). Moderate fluid loss is detrimental for endurance exercise performance (Cheuvront, Carter & Sawka, 2003) and athletes will perform below their best if they are not well hydrated when they exercise (Shirreffs, Armstrong & Cheuvront, 2004).

Recovery from physical activity

When intensity and volume is increased during the career a long-term imbalance of psychological stress including training, competing and non-training stress factors combined with inadequate recovery can lead to a state of overtraining (Lehmann, Foster, Gastmann, Keizer & Steinacker, 1999). Because of the high demands in elite athletes it is estimated that between 20 % and 60 % of athletes experience negative consequences as the result of overtraining at least once during their career (Nederhof, Lemmink, Visscher, Meeusen & Mulder, 2006). Endurance athletes that are overtraining indicate that they have more tensions, are more depressed, angry, fatigued and confused using the profile of mood state (Grant, Van

Rensburg, Collins, Wood, & Du Toit, 2012) that measure the psychological state (McNair, Lorr & Droppleman, 1992). Therefore, the psychological demands in elite sport can be noticed as detrimental.

Physical recovery includes different methods that help athletes recover from training or competition. The methods that has showed enhanced recovery is for instance dynamic stretches for sprint performance (running) (Fletcher & Anness, 2007), massage on repeated jump test performance (Viitasalo, Niemelä, Kaappola, Korjus, Levola, Mononen & Takala, 1985) and foam rolling on delayed onset muscle soreness (Pearcey, Bradbury-Squires, Kawamoto, Drinkwater, Behm & Button 2015). A meta-analysis (n=9 studies) about Cold-Water Immersion (CWI) showed that CWI have more positive effects than passive recovery in terms of immediate- and delayed effects from training (Machado, Ferreira, Micheletti, de Almedia, Lemes, Vanderlei & Pastre, 2016). Another review (Hill, Howatson, van Someren, Leeder & Pedlar, 2014) about compression garments indicate that compression garments had a moderate effect in reducing the severity of delayed onset muscle soreness (DOMS). These results indicate that different physical recovery methods can be used to enhance performance.

Research gaps

With all these studies in mind, it is obvious that there is a lot of research in each of these areas but insufficient research in track and field about the recovery to prevent injuries. The importance of sleep, nutrition, hydration, and both mental and physical recovery has been proven important in several other sports to increase performance and reduce the risk of developing injuries. Therefore, the same approach should be beneficial even in track and field to prevent injuries where the injury rate is as great as it is. Thus, this study fills an important purpose as these gaps are tangible and must be explored in a broader context to understand the importance of recovery to reduce the number of injuries in track and field.

Method

The method used for this study was analyzing quantitative data from a longitudinal study on elite track and field athletes in Gothenburg collected between September 2016 and April 2017. The longitudinal study is conducted at the Center of Health and Performance (CHP) at the University of Gothenburg, in collaboration with Göteborgs Friidrottsförbund (GFIF) and is running from year 2016 to 2020. This study was conducted during spring of 2017.

Design

The design of the study was explorative where factors in the recovery process for elite track and field athletes were investigated if it can be considered as risk factors for the development of injuries. The following recovery factors have been examined in research question number one; sleep (1), nutrition and hydration (2), the mental relaxation of the athlete (3) and how well they have experienced their physical activity recovery (4). These factors are based on the total quality recovery (TQR(act)) by Kenttä & Hassmén (1998) and have been translated from Swedish to English (see appendix 1 for original version). The variable condition (5) was used for the second research question and was developed by the researchers of the longitudinal

study and also translated from Swedish to English (see appendix 3 for the original version). These five questions below have all been translated from Swedish to English as following;

1. **Sleep** – How well have you slept today?
2. **Nutrition and hydration** – How well have you been eating and drinking today?
3. **Mentally relaxed** – How mentally relaxed have you been today?
4. **Regenerative physical activity** – Have you performed regenerative physical activity to recover today? My estimation of my regenerative physical activity.
5. **Condition** - How do you feel today?

All the athletes have submitted their answer for each of these questions every day on an application for smartphones. The application was developed by the researchers at CHP and it combines the questions from the Total Quality Recovery by Kenttä & Hassmén (1998) with the CR10 scale by Borg, Hassmén & Lagerström (1987). The CR10 scale has also been translated from Swedish to English (see appendix 2 for original version). On the first four questions (1-4) the athletes have submitted answers on a scale from 0 to "absolute maximum" (see table 2). To be able to measure and analyze the answer "absolute maximum" it was converted to number 12 which gave a scale from 0-12. For the fifth (5) question the athletes have submitted their answer on how they feel today on a scale from 1-10 (see table 3).

Table 2. CR10 Ratings - Variable 1-4

Rating	Description
0	
0,3	
0,5	Really bad
0,7	
1	Very bad
1,5	
2	Bad
2,5	
3	Ok
4	
5	Good
6	
7	Very good
8	
9	
10	Perfect "Maximum"
11	
	Absolute maximum

Table 3. Variable 5

Rating	Description
1	Too exhausted
2	
3	Exhausted
4	
5	Fatigued
6	Tired
7	
8	Well rested
9	
10	Recovered

Sample

The athletes who participate in the study are competing for clubs that are connected to Göteborgs Friidrottsförbrund (GFIF) and they have all been among top three for juniors (18-22 years) in the Swedish junior championships and/or among top six in the senior (>22 years) class. The participants in this study consisted of 36 athletes where 23 of them where women and 13 of them men. The average age was 23 years. The average height of the athletes was 1,75 meters and the average weight was 66 kg which give an average body mass index (BMI) of 21,48 (see table 4).

Table 4. Descriptive data with mean values ± standard deviations of the participants (n=36).

	Age (years)	Height (m)	Weight (kg)	BMI (kg/m²)
Women [a]	24 ± 4,20	1,71 ± 0,05	61 ± 8,39	21,11 ± 2,41
Men [b]	22 ± 1,88	1,83 ± 0,06	74 ± 7,47	22,13 ± 1,89
Overall [c]	23 ± 3,57	1,75 ± 0,08	66 ± 10,17	21,48 ± 2,27

[a] (n=23)

[b] (n=13)

[c] (n=36)

The participants of the study were representing the disciplines sprint, middle distance running, jump and throwing in track and field (see table 5). The distribution shows both the non-injured athletes (n=17) and the injured athletes (n=19). For athletes to be considered as injured in the study, athletes must have submitted that they have experienced pain due to their training and whether the pain affected their training. Athletes have then contacted the researchers for the longitudinal study for further consultation about their injury. Sprint runners (100, 200 and/or 400m runners) consisted of 13 athletes. Middle/long distance runners (800, 1 500, 5 000 and/or 10 000m) consisted of 13 athletes. Jump athletes (high jump, long jump and/or triple jump) consisted of 8 athletes and the throwing athletes (javelin, shot put, discus throw and/or hammer throw) consisted of 2 athletes. The discipline middle/long distance had most injured athletes (n=8) and throwing least injured athletes (n=1).

Table 5. Descriptive data of the disciplines and status of the participants (n=36).

Discipline	Non-injured [a]	Injured [b]
Sprint	9	4
Middle/long distance	5	8
Jump	2	6
Throwing	1	1

[a] (n=17)

[b] (n=19)

Data Collection

The data that has been collected during six months (September 2016 – April 2017) is quantitative and comes from the application for smartphones made by the researchers for the longitudinal study at CHP. The questions in the application are answered every day by the participants for a total of six months. The questions focus on how well they experienced their recovered that particular day. To collect weight of the athletes the dual energy X-ray absorptiometry (DEXA) measurement device has been used by the researchers, which is an accurate and fast way to also analyze fat, bone mineral content and fat free mass (Lang, Trivalle, Vogel, Proust, Papazyan & Dramé, 2015).

Data processing and analyze

The data from the application where first provided in Microsoft Excel (2013) files where it was restructured and then analyzed in the statistical software program SPSS Statistics 24.0 (IBM, 2016). To analyze the data (the answers that the participants submitted) it was translated into a mean value for each week. The Shapiro-Wilk test was used to test if the data were normally distributed ($p>0.05$). In addition to the Shapiro-Wilk test, an independent parametric test (T-test) was used to test the significance level for the normally distributed data and a nonparametric test (Mann-Whitney) were used to test the significance level of the non-normally distributed data. The significance for all tests (P-value) were set to <0.05.

Methodological considerations

The questions and the applications that the athletes have answered and used have not been chosen by the writers of this work. The questions asked, based on the previous work by Kenttä & Hassmén (1998), are established and well known, and are comprehensive enough to cover the most important aspects of recovery in an easy and understandable way. The questions have been used in many other studies which indicate that they are useful in monitoring the recovery process of the athletes.

The last question (5), about condition, is an important aspect to rise, since many athletes most likely feel sore and fatigued a lot of the time. If it shows that fatigue is a risk factor for suffering an injury, athletes may prioritize recovery in order to stay injury-free, which would most likely yield in better long term results.

Research ethics

The four ethical principles outlined by Vetenskapsrådet (2002) were taken into consideration when planning and performing this study. The first principle is the *informational* principle which is about giving the participants information about the purpose of the study. In this study all the participants where gathered in a meeting and the researchers presented the study and also handed out material with information about the study. The participants were informed that the participation in the study was voluntary and that they could at any time terminate their participation without any further questions. The second principle is the *consent* principle which means that the participants must agree to be a part of the study and they all agreed to participate in the study in writing on the informational meeting. The third principle is the *confidentiality* principle which is about the secrecy of the participants. All the information

about the participants has been kept in the longitudinal study and in this study only ID number of the participants were used instead of names when calculation the results. When presenting the results only median values has been used and this means that the individual answers of the participant can't be traced. The fourth ethical principle is the *utilization* of the information about the participants. The participants were informed that the collected information for this study is solely for the purpose of research.

Results

Research question 1

What factors contribute to the development of injuries during the recovery process from training?

Research question one was first investigated with the Shapiro-Wilk test to analyze if the data where normally distributed or not. At this test the significance level (P-value) for sleep were (p=0.834 for the non-injured & p=0.771 for the injured athletes), nutrition and hydration (p=0.157 for the non-injured and p=0,397 for the injured athletes), mentally relaxed (p=0.294 for the non-injured & p=0.000 for the injured) and regenerative physical activity (p=0.473 for non-injured and p=0,064 for injured athletes) For sleep, nutrition and hydration and regenerative physical activity the p-value where > 0.05 which means that the data is normally distributed. For the mentally relaxed – injured the P-value were 0.000 which means that the data were *not* normally distributed (see appendix 3).

To test the significance level (p-value) between the groups (non-injured and injured athletes) an independent parametric t-test were made for the normally distributed data (sleep, nutrition and hydration and regenerative physical activity) and a Mann-Whitney test for the non-normally distributed recovery factor (mental relaxation). For the independent t-test the significance level (p-value) did not indicate any significant difference (p>0.05) between the non-injured and injured athletes in sleep (p=0.971), nutrition and hydration (p=0.866) nor regenerative physical activity (p=0.365), see appendix 4. For the Mann-Whitney test the significance level (p-value) showed the same results, no significant difference between the non-injured and the injured athletes (p=0.692), see appendix 5. This means that there are no differences between the groups when it comes to see which of these four recovery factors that contributes to the development of injuries.

Sleep, nutrition and hydration, mentally relaxed and regenerative physical activity will each be presented with a table with the median, minimum- and maximum value, variance and the standard deviation (appendix 7, 8, 9, 10). A boxplot will also be presented to show how the non-injured athletes have rated their recovery factors compared with the injured athletes (figure 1, 2, 3 & 4).

The first recovery factor (sleep) shows that the injured athletes have a slightly higher median value (5,7769) than the non-injured athletes (5,4393). The standard deviation between the non-injured (1,07467) and the injured athletes (1,08902) is negligible (see figure 1 and appendix 7).

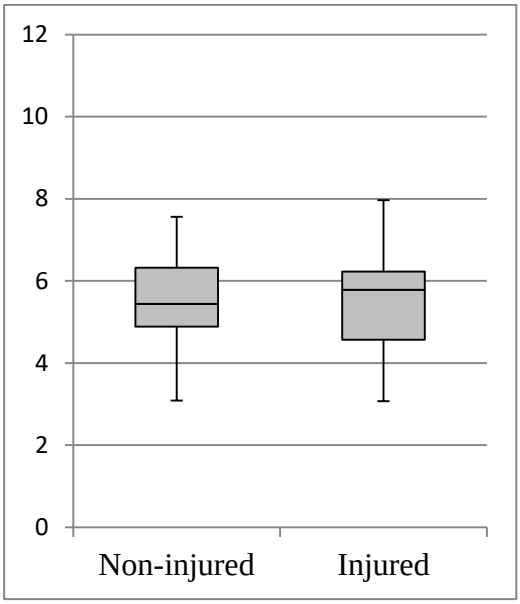

Figure 1. Boxplot for the recovery factor: sleep

The recovery factor nutrition and hydration have the same results, a slightly higher median value 5,8739 for the injured and 5,74 for the non-injured and insignificant difference in standard deviation between the non-injured (0,93846) and the injured athletes (0,93802), see figure 2 and appendix 8.

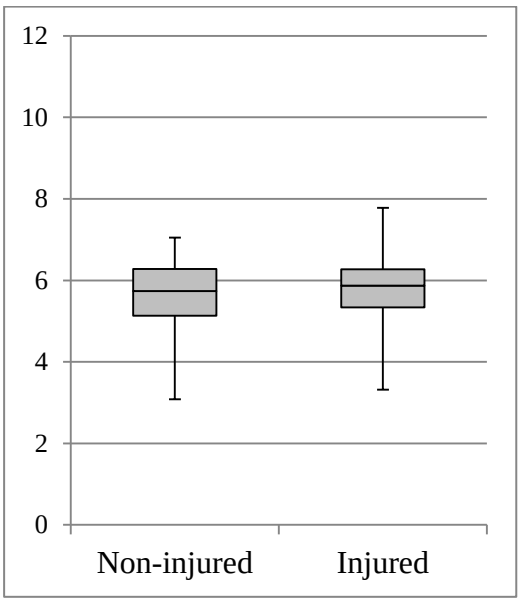

Figure 2. Boxplot for the recovery factor: nutrition and hydration

For the recovery factor mentally relaxed the injured athletes have a slightly higher median value (5,9783 for the non-injured and 5,5778 for the injured) and a considerably higher standard deviation (0,94767 for the non-injured and 1,74919 for the injured athletes), see figure 3 and appendix 9.

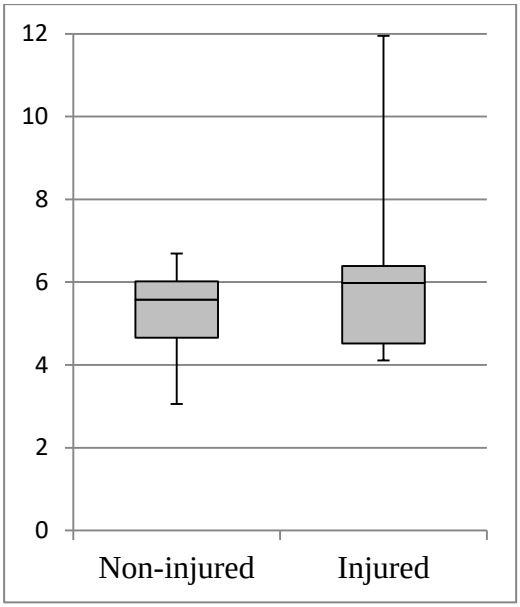

Figure 3. Boxplot for the recovery factor: mentally relaxed

The fourth recovery factor regenerative physical activity the median was almost the same for the groups (3,9107 for the non-injured and 4,076 for the injured athletes) and the standard deviation was almost identical (1,91159 for the non-injured and 1,8955 for the injured athletes), see figure 4 and appendix 10.

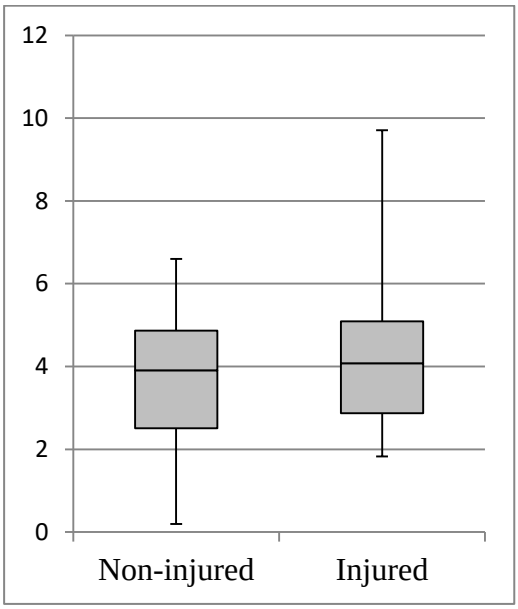

Figure 4. Boxplot for the recovery factor: regenerative physical activity

However, since the p-value is > 0.05 for all of the recovery factors no conclusion can be drawn.

Research question 2

Does fatigue influence the development of injuries during the training process?

The second research question was investigated with a Shapiro-Wilk test to analyze if the data were normally distributed or not. The data were normally distributed (p = 0.286 for non-injured and p = 0.347 for the injured) (see appendix 11). To test the significance level (p-value) an independent parametric t-test where tested. The results indicate that the difference is not significant (p= 0.621) which means that there is not a difference between the groups (see appendix 12).

The non-injured athletes have a slightly higher median value (7,04) than the injured athletes (6,72) which means that the non-injured athletes have rated higher on “how do you feel today?” than the injured athletes. There was also lower standard deviation for the non-injured athletes (0,64) compared to the injured athletes (0,82) but the variance for both groups where still small (see figure 5 and appendix 13).

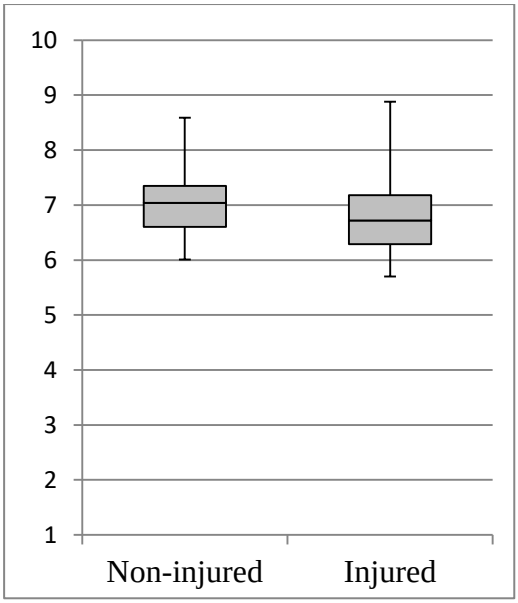

Figure 5. Boxplot for the variable: condition

Discussion

Method

The number of participants in this study could affect the results since they were divided into two subgroups which made the number participants in each of the groups small. The period of the study (six months) could also affect the results but this would probably be less likely than the number of participants. Each athlete answered the questions every day regardless if they trained or not which could be seen as a loading for the athlete and makes the answers less serious and thought through. For the question regenerative physical activity - Have you performed regenerative physical activity to recover today? My estimation of my regenerative physical activity, there were not a "no" answer which means that on recovery days with no practice they have to rate 0 which could lower the overall ratings for that recovery factor.

The answers from the application where translated into weekly mean values. This allows that occasional bad days does not influence the results too much in a week, but it can be argued that it doesn't give full understanding if the athletes are consistent or not during the weeks concerning the recovery factors that are looked for. One athlete that always rate a 5 can have the same mean value as an athlete that sometimes rates above 5 and sometimes rate below 5. This leads to that the difference between the athletes will be lower.

Another possible problem could be that the athletes have different perspectives on things regarding training and recovery, what e.g. is considered as good sleep by someone can be consider as not so good by someone else. To somehow challenge this potential problem it could be better to combine the subjective feeling of how good one has slept with the actual amount of time slept. That would give a broader understanding but on the other hand it would

mean even more things to keep in mind for the athletes, which could be negative in total. A possible scenario is also that the athletes want to appear serious without any low ratings so they submit higher ratings on the scales than they really should. Some athletes may also find it difficult to understand the questions and answers in the right way. Regarding our method one problem could be that we might not have enough data to draw any significant conclusions regarding the impact of the recovery factors on the development of injuries. Furthermore, since we got the quantitative data from the researchers we could not influence the questions asked and the specifics about the application but the question is supported by a lot of earlier researchers. Another drawback is that the disciplines in track and field vary a lot which means that the types of injuries also vary, a sprinter can typically have a more acute type of injury, e.g. pulling a hamstring while that is more unlikely for a long distance runner, where the injuries are more often in the category overuse injuries. Therefore some factors could possibly be more problematic for more acute type of injuries while other factors could be more important in preventing more "typical" overuse injuries. However, most injuries, both acute and overuse are developed with too much stress on the body with insufficient recovery, and therefore the study is useful in trying to find specific risk factors in the recovery process that can be seen on many of the athletes prior to an injury. While this study only looks for external risk factors, the longitudinal study looks for many more aspects, both external and training factors. A problem due to the number of participants was that all the data where used, even if some of it could be suspected as carelessly submitted. For example when some athletes have submitted answers very irregularly it is possible that the data is not so valid because it's hard to remember how one felt, ate or slept just that particular day or night several days ago.

The longitudinal study can be seen as very ambitious considering its longitudinal design and since it involves many participants. However, while it is good and necessary that the study is running for a long period of time, some potential ethical problems could also occur due to that the athletes are supposed to submit serious and thoughtful answers every day, during a long period of time. That could potentially lead to athletes only doing this kind of survey in order to do the physiological tests that are carried out every half year, since those tests otherwise often cost a considerable amount of money. Also the access to physiotherapists that the study gives if the athlete has injuries is worth a lot for many athletes who normally doesn't have that kind of medical support, and that could therefore be a motivational factor as well. However, because the athletes are very successful in their disciplines, you could suppose that they are also caring about their sport which perhaps could mean that they give thoughtful answers in the application. Also, the athletes may feel that they want to do their part in a proper way because they get this support by the researchers.

Result discussion

Since the result for both research question 1 and 2 did not gave any significant difference ($p>0.05$) between the non-injured and the injured athletes, it is not possible to draw any significant conclusions from the data. This means that the data from the recovery factors sleep, nutrition and hydration, the mental relaxation of the athlete and regenerative physical activity did not affect the development of injuries. The results were not significant ($p>0.05$) in research question one and the difference between the groups in the boxplots were negligible. In the four recovery factors the injured athletes tend to have a slightly higher median value

which means that the injured athletes rate their sleep, nutrition and hydration, mentally relaxation and regenerative physically activity better than the non-injured athletes. However, the standard deviation tend to be greater for the injured athletes, especially the mentally relaxation of the athlete and regenerative physical activity, which indicates that there were injured athlete who both rated high and low which means it is difficult to draw any conclusions from the results. For the second research question the non-injured athletes tend to rate their condition better than the injured athletes which could propose that the injured athletes have practiced even though they feel fatigued which could lead to the development of an injury. The median value for the non-injured was however only 0,32 higher (on a scale of 1-10) which means that there were only a small difference.

Even if the injured athletes had a slightly higher median value in all of the four recovery factors, it is very unlikely that none of these factors are important in the recovery process between the training sessions. It is generally accepted in previous research that all of these factors we studied plays important roles in the recovery process. For example persistent sleep loss can negatively impact the quality of a training session and the general well-being (Robson-Ansley et al., 2009). Therefore, it should be important to sleep well but obviously, it is difficult to know what ”good” sleep is and how many hours it includes, but the injured athletes may not experience this as a problem as they may have more times to sleep due to less training sessions and early morning training. The nutrition and hydration intake in training and competition affect how well an individual can train and compete (Robson-Hansley et al., 2009). This will also decrease the risk to be exposed of infections (Gleeson et al., 2004) which might lead to a better recovery and an earlier comeback to the sport. Something that could affect the injured athletes is the mentally relaxation of the athlete since they may score lower ratings than the non-injured due to less training sessions and competitions which should create an inner stress for the athlete. On the other hand competitions could also be seen as stressful and therefore the injured athlete who not compete could score higher ratings for mental relaxed. Since the results are not significant regarding to the recovery factors sleep, nutrition & hydration, mentally relaxed and regenerative physical activity, it is not consistent with previous research in sport science. Although, very little research has been done in track and field in case of these factors and therefore it is difficult to draw any connections to previous research.

According to previous research, endurance athletes that are over training indicate that they have more tensions, are depressed, angry, fatigued and confused (Grant et al., 2012). This shows that the psychological (mentally relaxed) factor can be very challenging for an over trained and possibly injured athlete. The injured athletes may perform more regenerative physical activity than the non-injured athletes since they may use more of alternative training methods (massage, foam-rolling, etcetera) in order to come back to the sport and in the purpose to recover after training or competition. If you once have been injured you will probably prioritize regenerative physical activity more than someone who has not been injured. Regenerative physical activity that has showed enhanced recovery is for instance dynamic stretches for sprint running performance (Fletcher & Anness, 2007). Thus, regenerative physical activity is important for both performance and recovery. Whether you are injured or not, you should prioritize these parts, which can often be slightly overridden as many think that it is only the main training or competition that is important for performance.

The variable “condition – how do you feel today” did not give any significant results ($p>0.05$) but could be important if an athlete constantly train while fatigued. Then the athlete should be at a higher risk of getting injured but this was not supported in this study. However, there were a little difference in the median values for the non-injured and the injured athletes where the non-injured athletes rated overall higher than the injured.

These types of studies show that the mentioned recovery factors above are of major importance for recovery in order to reduce the risk of injury, even though our results were inconclusive.

Conclusion and implications

Since our study did not show any significant results regarding the factors we were looking for, studies similar to this should be carried out but preferably with a larger sample. It is most likely that sleep, nutrition and hydration, mental relaxation, regenerative physical activity and condition all plays important roles in the recovery process also for track and field athletes since the literature shows this for other sports. The recovery process should correlate well between different sports if the demands on the body are similar. However, there are only a few or no studies at all that are looking for all of these factors simultaneously, and comparing which of them that has the greatest influence on recovery from training, which would be interesting to know. It is well established that all of the mentioned factors above are important in the recovery process for athletes, but not in which order of importance. For future research, we therefore recommend that researchers study the importance of recovery factors also in track and field, and furthermore examine which factors that is most important for recovery after different types of training.

As discussed above, it’s hard to draw any conclusions from our study other than it is important to have a larger sample and to reflect about the limitations that can occur when individuals have to submit answers in a thoughtful way for a long period of time. However, the researched factors of sleep, nutrition and hydration, mental relaxation, regenerative physical activity and condition are most likely important for track and field athletes, even if our results did not indicate that. More research is therefore needed in order to determine how important each of these factors is.

Track and field is a sport with a lot of injuries which makes this type of studies under an extended period of time on elite track and field athletes important. Better understanding about specific risk factors for injuries is desirable. Also, in order to prevent injuries, better longitudinal studies that consists more athletes are useful for the researchers to get information about which factors that are important for recovery. This will hopefully get a better understanding about recovery and also generate more healthy and performing athletes.

In conclusion, this study has been important and relevant in sports coaching work, as the authors of this work act as leaders and athletes in track and field. Therefore, the transferability from the study to the practical reality is rather high and can be useful in the future. Despite of the results, this study has generated an increased understanding of the recovery factors that

might be a risk factor(s) for an injury. Something that will benefit us in our future work as sports coaches.

References

Alonso, J-M., Edouard, P., Fischetto, G., Adams, B., Depiesse, F., & Mountjoy, M. (2012). Determination of future prevention strategies in elite track and field: analysis of Daegu 2011 IAAF Championships injuries and illnesses surveillance. *British journal of sports medicine*, bjsports-2012, *1*(1), 1-10. doi:10.1136/bjsports-2012-09100

Alonso, J-M., Tscholl, P. M., Engebretsen, L., Mountjoy, M., Dvorak, J., & Junge A. (2010). Occurrence of injuries and illnesses during the 2009 IAAF World Athletics Championships. *Br J Sports Med, 44*, 1100–1105. doi:10.1136/1100 bjsm.2010.078030.

Borg, G. (1970). Perceived exertion as an indicator of somatic stress. *Scandinavian Journal of Rehabilitation Medicin*e, 2, 92-8.

Borg, G., Hassmén, P., & Lagerström, M. (1987). Perceived exertion related to heart rate and blood lactate during arm and leg exercise. *European journal of applied physiology and occupational physiology*, *56*(6), 679-685.

Borg, G., & Borg, E. (1994). Principles and experiments in category-ratio scaling. Reports from the Department of Psychology (no. 789), Stockholm: Sweden

Borg, G. (1998). Borg's perceived exertion and pain scales. Champaign, IL: Human Kinetics.

Brink, M. S, Nederhof, E., Visscher, C., Schmikli, S.L., & Lemmink, K. A. (2010). Monitoring load, recovery, and performance in young elite soccer players. *Journal of Strength & Conditioning Research, 24*(3), 597-603.

Cheuvront, S. N., Carter, R., & Sawka, M. N. (2003). Fluid balance and endurance exercise performance. *Current Sports Medicine Reports*, *2*(4), 202-208.

Day, M.L., Mcguigan, M.R., Brice, G., & Foster C. (2004). Monitoring exercise intensity during resistance training using the session RPE scale. *Journal of Strength and Conditioning Research, 18*(2), 353-358.

Edouard, P., & Alonso, J-M. (2013). Epidemiology of Track and Field Injuries. *New Studies in Athletics, 1*(2), 85-92.

Feddermann-Demont, N., Junge, A., Edouard, P., Branco, P., & Alonso, J-M. (2014). Injuries in 13 international Athletics championships between 2007–2012. *British Journal of Sports Medicine, 48*, 513–522. doi:10.1136/bjsports-2013-093087.

Fletcher, I. M., & Anness, R. (2007). The acute effects of combined static and dynamic stretch protocols on fifty-meter sprint performance in track-and-field athletes. *The Journal of Strength & Conditioning Research, 21*(3), 784-787.

Foster, C., Hector, L., Welsch, R., Schrager, M., Green M.A. & Snyder, A.C. (1995). Effects of specific versus cross training on running performance. *European Journal of Applied Physiology, 70*, 367–372.

Foster, C. (1997). Monitoring training in athletes with reference to overtraining syndrome. *Medicine Science of Sports and Exercise*, 30, 1164–1168.

Foster, C., Florhaug, J. A., Franklin, J., Gottschall, L., Hrovatin, L. A., Parker, S., ... & Dodge, C. (2001). A new approach to monitoring exercise training. *The Journal of Strength & Conditioning Research*, *15*(1), 109-115.

Gleeson, M., Nieman, D. C., & Pedersen, B. K. (2004). Exercise, nutrition and immune function. *Journal of sports sciences*, *22*(1), 115-125.

Grant, C. C., Van Rensburg, D. J., Collins, R., Wood, P. S., & Du Toit, P. J. (2012). The Profile of Mood State (POMS) questionnaire as an indicator of Overtraining Syndrome (OTS) in endurance athletes. *African Journal for Physical Health Education, Recreation and Dance*, *18*(1), 23-32.

Hawley, J.A., Tipton, K.D., & Millard-Stafford, M.L. (2006). Promoting training adaptations through nutritional interventions. *Journal of Sports Sciences, 24*(7), 709–721.

IBM. (2016). *Release notes - IBM SPSS Statistics 24.0.* Hämtad 2017-04-24, från http://www-01.ibm.com/support/docview.wss?uid=swg27047057

Hill, J., Howatson, G., van Someren, K., Leeder, J., & Pedlar, C. (2014). Compression garments and recovery from exercise-induced muscle damage: a meta-analysis. *British journal of sports medicine*, *48*(18), 1340-1346.

Impellizzeri, F. M., Rampinini, E., Coutts, A. J., Sassi, A. L. D. O., & Marcora, S. M. (2004). Use of RPE-based training load in soccer. *Medicine and science in sports and exercise*, *36*(6), 1042-1047. Doi 10.1249/01.MSS.0000128199.23901.2F

Jacobsson, J., Timpka, T., Kowalski, J., Nilsson, S., Ekberg, J., Dahlström, Ö., & Renström P. A. (2013). Injury patterns in Swedish elite athletics: annual incidence, injury types and risk factors. *British Journal of Sports Medicine, 47*, 941–952. doi:10.1136/bjsports-2013-092676

Jacobsson, J., Timpka, T., Kowalski, J., Nilsson, S., Ekberg, J., & Renström, P. A. (2012). Prevalence of Musculoskeletal Injuries in Swedish Elite Track and Field Athletes. *The American Journal of Sports Medicine*, *40*(1), 163-169. doi: 10.1177/0363546511425467

Junge, A., Engebretsen, L., Alonso, J-M., Renström, P., Mountjoy, M., Aubry, M., & Dvorak, J. (2008). Injury surveillance in multi-sport events: the International Olympic Committee approach. *British Journal of Sports Medicine, 42*, 413–421. doi:10.1136/bjsm.2008.046631.

Kenttä, G. & Svensson, M. (2008). *Idrottarents återhämtningsbok.* Stockholm: SISU Idrottsböcker.

Kenttä, G., & Hassmén, P. (1998). Overtraining and recovery. *Sports medicine, 26*(1), 1-16.

Lang, P-O., Trivalle, C., Vogel, T., Proust, J., Papazyan, J-P., & Dramé. (2015). Determination of Cutoff Values for DEXA-Based Body Composition Measurements for Determining Metabolic and Cardiovascular Health. *BioResearch Open Access, 4*(1), 16-25. doi:10.1089/biores.2014.0056

Lehmann, M., Foster, C., Gastmann, U., Keizer, H., & Steinacker, J. M. (1999). Definition, types, symptoms, findings, underlying mechanisms, and frequency of overtraining and overtraining syndrome. In *Overload, performance incompetence, and regeneration in sport* (1-6). Springer US.

Ljunggren, G., & Hassmén, P. (1991). Perceived exertion and physiological economy of competition walking, ordinary walking and running. *Journal of sports sciences, 9*(3), 273-283.

Machado, A. F., Ferreira, P. H., Micheletti, J. K., de Almeida, A. C., Lemes, Í. R., Vanderlei, F. M., ... & Pastre, C. M. (2016). Can water temperature and immersion time influence the effect of cold water immersion on muscle soreness? A systematic review and meta-analysis. *Sports Medicine*, *46*(4), 503-514.

Mah, C. D., Mah, K. E., Kezirian, E. J., & Dement, W. C. (2011). The effects of sleep extension on the athletic performance of collegiate basketball players. *Sleep*, *34*(7), 943-950.

Malisoux, L., Frisch, A., Urhausen, A., Seil, R., & Theisen, D. (2013). Monitoring of sport participation and injury risk in young athletes. *Journal of Science and Medicine in Sport*, *16*(6), 504-508.

McNair, D. M., Lorr, M., & Droppleman, L. F. (1992). *EDITS manual for the Profile of Mood States.* San Diego: Educational and Industrial Testing Services.

Merino-Marban, R., Fernández Rodríguez, E., Iglesias-Navarrete, P., & Mayorga-Vega, D. (2011). The effect of Kinesio taping on calf's injuries prevention in triathletes during competition: pilot experience. *Journal of Human Sport & Exercise, 6(2),* 305-308. doi:10.4100/jhse.2011.62.1

Nederhof, E., Lemmink, K.S., Visscher, C., Meeusen, R., & Mulder, T. (2006). Psychomotor speed: Possibly a new marker for overtraining syndrome. *Sports Medicine ,36*, 817-828.

Noble, B.J., & Robertson, R.J. (1996). Perceived exertion. Champaign, IL: Human Kinetics.

Osiecki, R., Burigo, T., Rubio, G., Coelho, R. L., Novack, L. F., Conde, J. H. S., Alves, C. G., & Malfatti, C. R. M. (2015). The Total Quality Recovery Scale (TQR) as a Proxy for

Determining Athletes' Recovery State after a Professional Soccer Match. *Journal of Exersice Physiology*, *18*(3), 27-32.

Pearcey, G.E., Bradbury-Squires, D.J., Kawamoto, J.E., Drinkwater, E.J., Behm, D.G., & Button, D.C. (2015). Foam rolling for delayed-onset muscle soreness and recovery of dynamic performance measures. *Journal of athletic training*, *50*(1), 5-13.

Reilly, T., & Edwards, B. (2007). Altered sleep–wake cycles and physical performance in athletes. *Physiology and Behavior*, *90*, 274–284.

Robson-Ansley, P. J., Gleeson, M., & Ansley, L. (2009). Fatigue management in the preparation of Olympic athletes. *Journal of sports sciences*, *27*(13), 1409-1420.

Sands, W. A., McNeal, J. R., Murray, S. R., Ramsey, M. W., Sato, K., Mizuguchi, S., & Stone, M. (2013). Stretching and Its Effects on Recovery: A Review. *Strength & Conditioning Journal, 35*(5), 30-36. doi:10.1519/SSC.0000000000000004

Shirreffs, S. M., Armstrong, L. E., & Cheuvront, S. N. (2004). Fluid and electrolyte needs for preparation and recovery from training and competition. *Journal of Sports Sciences*, *22*, 57–63.

Skein, M., Duffield, R., Edge, J., Short, M. J., & Mundel, T. (2010). Intermittent-sprint performance and muscle glycogen after 30 h of sleep deprivation. *Medicie and science in sports and exercise*, *43*(7), 1301-11.

Suzuki, S., Sato, T., Maeda, A., & Takahashi, Y. (2006). Program design based on a mathematical model using rating of perceived exertion for an elite Japanese sprinter: A case study. *Journal of Strength & Conditioning Research, 20*(1), 36-42.

Vetenskapsrådet. (2002). Forskningsetiska principer inom humanistisk-samhällsvetenskaplig forskning. Stockholm:Vetenskapsrådet.

Viitasalo, J. T., Niemelä, K., Kaappola, R., Korjus, T., Levola, M., Mononen, H. V., ... & Takala, T. E. (1995). Warm underwater water-jet massage improves recovery from intense physical exercise. *European journal of applied physiology and occupational physiology*, *71*(5), 431-438.

Appendices

Appendix 1. TQR(per) – original version

Appendix 2. CR10 Ratings – original version

Appendix 3. Variable condition – original version ”Hur känner du dig just nu?”

Appendix 4. Research question 1: Shapiro Wilk test

Appendix 5. Research question 1: Independent T-test – normally distributed variables

Appendix 6. Research question 1: Mann-Whitney test - The non-normally distributed variable

Appendix 7. Descriptive data for the recovery factor: Sleep

Appendix 8. Descriptive data for the recovery factor: Nutrition and hydration

Appendix 9. Descriptive data for the recovery factor: Mentally relaxed

Appendix 10. Descriptive data for the recovery factor: Regenerative physical activity

Appendix 11. Research question 2: Shapiro Wilk test

Appendix 12. Research question 2: Independent T-test – normally distributed variable

Appendix 13. Descriptive data for the variable: Condition

Appendix 1

TQR(per) – original version

Sömn	Hur har du sovit för att återhämta dig den senaste dagen?
Kost och vätska	Hur har du ätit och druckit för att återhämta dig den senaste dagen?
Mentalt avslappnad	Hur mentalt avslappnad har du varit för att återhämta dig den senaste dagen?
Återhämtande fysisk aktivitet	Har du utövat återhämtande fysisk aktivitet för att återhämta dig den senaste dagen?

Appendix 2

CR10 Ratings – original version

0	Ingen alls
0,3	
0,5	Extrems svag
0,7	
1	Mycket svag
1,5	
2	Svag
2,5	
3	Måttlig
4	
5	Stark
6	
7	Mycket stark
8	
9	EXTREMT STARK
10	
11	
	Absolut maximum

Appendix 3

Variable condition – original version ”Hur känner du dig just nu?”

Rating	Description
1	Alltför utmattad
2	
3	Utmattad
4	
5	Sliten
6	Trött
7	
8	Utvilad
9	
10	Pigg

Appendix 4

Research question 1: Shapiro Wilk test

	Status	Statistics	df	Sig.
Sleep	Non-injured [a]	.971	17	.834
	Injured [b]	.970	19	.771
Nutrition and hydration	Non-injured [a]	.922	17	.157
	Injured [b]	.950	19	.397
Mentally relaxed	Non-injured [a]	.938	17	.294
	Injured [b]	.738	19	.000*
Regenerating	Non-injured [a]	.951	17	.473
physical activity	Injured [b]	.907	19	.064

[a] (n= 17)

[b] (n= 19)

* ($p \leq 0,05$)

Appendix 5

Research question 1: Independent T-test – normally distributed variables

		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Sleep	**Equal variance assumed**	0,031	0,862	0,36	34	0,971	0,01309	0,36132
	Equal variance not assumed			0,36	33,665	0,971	0,01309	0,36104
Nutrition and hydration	**Equal variance assumed**	0,000	0,996	-0,17	34	0,866	-0,05327	0,31323
	Equal variance not assumed			-0,17	33,556	0,866	-0,05327	0,31323
Regenerative physical activity	**Equal variance assumed**	0,111	0,741	-0,971	34	0,365	-0,58308	0,63552
	Equal variance not assumed			-0,971	33,497	0,365	-0,58308	0,63581

Appendix 6

Research question 1: Mann-Whitney test - The non-normally distributed variable

Mann-Whitney U	149,00
Wilcoxon W	302,00
Z	-0,396
Asymp. Sig. (2-tailed)	0,692

Appendix 7

Descriptive data for the recovery factor: Sleep

Non-injured [a]	Median	5,4393
	Variance	1,155
	Std. Deviation	1,07464
	Minimum	3,09
	Maximum	7,56
Injured [b]	Median	5,7769
	Variance	1,186
	Std. Deviation	1,08902
	Minimum	3,07
	Maximum	7,97

[a] (n= 17)

[b] (n= 19)

Appendix 8

Descriptive data for the recovery factor: Nutrition and hydration

Non-injured [a]	Median	5,74
	Variance	0,881
	Std. Deviation	0,93846
	Minimum	3,08
	Maximum	7,05
Injured [b]	Median	5,8739
	Variance	0,88
	Std. Deviation	0,93802
	Minimum	3,32
	Maximum	7,78

[a] (n= 17)

[b] (n= 19)

Appendix 9

Descriptive data for the recovery factor: Mentally relaxed

Non-injured [a]	Median	5,5778
	Variance	0,898
	Std. Deviation	0,94767
	Minimum	3,06
	Maximum	6,69
Injured [b]	Median	5,9783
	Variance	3,06
	Std. Deviation	1,74919
	Minimum	4,11
	Maximum	11,95

[a] (n= 17)

[b] (n= 19)

Appendix 10

Descriptive data for the recovery factor: Regenerative physical activity

Non-injured [a]	Median	3,9107
	Variance	3,654
	Std. Deviation	1,91159
	Minimum	0,2
	Maximum	6,6
Injured [b]	Median	4,076
	Variance	3,597
	Std. Deviation	1,8955
	Minimum	1,83
	Maximum	9,71

[a] (n= 17)

[b] (n= 19)

Appendix 11

Research question 2: Shapiro Wilk test

Status	Statistics	df	Sig.
Non-injured	.937	17	.286
Injured	.947	19	.347

Appendix 12

Research question 2: Independent T-test – normally distributed variable

		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Condition	**Equal variance assumed**	1,172	0,287	0,492	34	0,626	0,12119	0,24623
	Equal variance not assumed			0,499	33,456	0,621	0,12119	0,24288

Appendix 13

Descriptive data for the variable: Condition

Non-injured [a]	Median	7,04
	Variance	0,408
	Std. Deviation	0,64
	Minimum	6,01
	Maximum	8,59
Injured [b]	Median	6,72
	Variance	0,665
	Std. Deviation	0,82
	Minimum	5,70
	Maximum	8,88

[a] (n= 17)

[b] (n= 19)