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On what coaches, scientists, medical staff and managers in competitive and professional sport must do in light of the increased frequency and intensity of sports events, matches and competitions

POSITION PAPER

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Dealing with a dense and intense schedule of competitions and matches in professional and competitive sports

Purpose

Introduction of possible solutions on dealing with higher frequency and intensity of competitions and matches in professional and competitive sports.

Subjects:

Organizational-professional recommendations

- Professional supporting staff for the athletes, regarding scientific, medical, rehabilitation and physical subjects
- Desired pool of athletes
- Organizational methods for athletes' training (personal programs/rotations)

Professional training plan recommendations

- Transitional and vacation periods
- Rest periods and load reduction
- Off days
- Methods and means for planning loads, recovery and regeneration

Competition, matches and training program recommendations

- Optimal number of competitions and matches
- Density, Rest and distribution of competitions and matches

Recommendations are based on models, professional experience of coaches, studies and tests performed by scientific and medical professionals.

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Foreword

The 1990s ushered in a new era in competitive sports. For the last 30 years, significant changes have occurred for various reasons, mainly relating to the media and commercial interests. Sporting events have become more spectacular, more expensive and more profitable. The aspiration for better achievements and better results than in the past has changed the worldview of how to prepare athletes. Event and championship programs have been changed due to commercial interests which often clash with professional principles and impinge on the athletes' achievements and health. As a result, athletes, coaches, sport scientists, medical personnel and managers who engage in competitive and professional sport have been forced to adapt professionally in terms of planning training programs, in periodic divisions, methods, means, training stages and recovery processes and have created a need for special actions to deal with the emotional and physical consequences. These include a different life style, unique nutrition and adapted training conditions, facilities, equipment, monitoring and regulation, and appropriate clothing and footwear. To illustrate the changes in elite sport we will refer mainly to the significant increase in the number of events, competitions and games in which athletes must compete, and mainly the fantastic – bordering on inhuman – frequency and intensity of events. Modern competitive sport is promoted in most countries. In some cases, the motive is to use representative sport as a political showcase. This was first done by Eastern bloc countries but has percolated down to many others as well. Another motive is to use competitive sport as a role model for sport for all. Thus, competitive sport should serve to improve health, despite doubts about the health value of the training processes and competitions in the lives of elite athletes. Nurturing and promoting elite sport also entails increasing social esteem for sport and athletes, and their prominence in the media. Television is especially active in this regard, and with television comes the commercial aspects and economic considerations.

This introduction will detail the purpose of the position paper, its authors, as well as a concise breakdown of the changes that have taken place in worldwide competitive sports, which are the background for the recommendations and proposals of this position paper.

1. Purpose of position paper

The purpose of the position paper is to present **recommendations and conclusions** to athletes, trainers, managers and officials as well as to sports organizations, clubs and national and international associations, which will help them prepare for the changes that have taken place in competitive sports. The conclusions and recommendations will be based on a summary and analysis of data that reflect the latest current situation, on scientific and methodical principles and on practical organizational options.

Recommendations and conclusions will focus on:

- Physiology
- Orthopedics
- Mentality

Also, practical suggestions will be presented to deal with these matters:

1. The recommended **maximal number** of international and national games/competitions during the year, including recommended **frequency** over the year.
2. Recommended actions for **athlete's recovery and regeneration** to prevent overload and injuries.
3. Required **rest** (active and passive) during various time periods to cope with the loads of games/competitions and training sessions.
4. Required preparation**,** duration and emphases for promoting athletes' abilities during game/competition schedule.
5. Integration or avoidance of **high intensity training units** in the game/competition program.
6. Means, methods and ways to **monitor and regulate** the intensity of loads and their physiological and psychological effects.
7. **Concentrated training days and training camps** – extent, emphases and placement in the training programs.

2. Creators of position paper

Jelena Obradovic, PhD,

An expert in biochemical and physiological aspects of sports as well as in impact research of the physical load on the athlete's ability to gain achievements. Obradovic is a professor of motor development in the Department of Sports Science and Physical Education at the University of Novi Sad in Serbia, researching the development of strength and endurance. Until 1985, Obradovic was a fitness and personal fitness coach, and until 2001, she served as an international judge in aerobic gymnastics and fitness competitions.

Lukasz Bortnik

Has a lot of experience in professional football, served as a performance coach in different continents (North Latin America, Europe, the Middle East). Bortnik has a master's degree (MSc) in exercise science at the California University of Pennsylvania in the United States, as well as S&C (Strength and Conditioning) certificates from prestigious organizations and federations. He is currently studying for a professional doctorate at the University of Central Lancashire in the UK, researching physical demands in transitions and high-pressure activities in football

Dr. Yitsik Ben Melech

Specialized in training and competition/game methods. Ph.D. degree in Sport Science at the University of Leipzig and the Academy of Elite Trainers in Cologne/Koln. Established and managed the Unit of High-Achieving Sports that was responsible for the preparations and performance in the Olympic Games. Managed Professionally the Israeli delegation at 4 Olympic games. Served as a professional consultant in South Africa and Kenya. Director of the Training School for Coaches and Center of Sports Medicine and Methodology.

Prof. Patrik Drid

Expert in training theory and sports science in martial arts (Serbia). Received a bachelor's degree, a master's degree and a doctorate in sports science at the faculty of sports and physical education at the university of Novi Sad in Serbia. Today works as a full professor in the sport of martial arts. In 2018/2019 was appointed as visiting professor at the University of Travnik, and at the University of Montenegro. His current research focuses on physiological responses to maximal and submaximal exercise in judo and martial arts. In addition, in recent years he has focused on molecular hydrogen delivery on biomarkers of acid-base homeostasis and post-exercise recovery in judo athletes, as well as on effects of oral acetic acid in the human diet.

Dr. Georgios G. Ziogas

Dr. Georgios G. Ziogas from Greece is an exercise physiologist, who received a Master of Science degree from the Pittsburg state university in the United States, and a doctorate (Ph.D.) in sports science and exercise physiology from the University of Missouri-Columbia. Since 2000, Ziogas has been the head of the physical activity and human performance laboratory in Thessaloniki, worked with elite football players, coaches and with teams such as PAOK, Olympiakos, Apoel Nicosia, Maccabi Tel Aviv, Dynamo Moscow and the Hellenic Olympic rowing team.

Juan Torrijo

Graduated from the University of Valencia with a degree in Physiology and Master of Physical Training for football players in 1996. Later on, he worked for 16 seasons at the Valencia football club. He first worked as a physiologist in the youth departments and later as the club's second fitness coach. He was a partner in winning two championships, two cups, two Spanish Super Cup titles, a UEFA Cup and a European Super Cup. In addition, he worked from 2012 for several seasons as the fitness coach of Maccabi Tel Aviv Football Club.

Dr. Nenad Trunic

Trunic is a basketball professor and coach of national basketball teams. He used to be a player in Serbia. He acquired his academic education at the University of Belgrade: in 1992 he completed his studies for a bachelor's degree, in 2004 he completed his studies for a master's degree and in 2006 he received his doctorate. His doctoral thesis was "Prediction and Strategy for Creating Top Basketball Players."

In 2011 Trunic was appointed a lecturer at the FIBA Europe Coaching Clinics, and in 2013 he was appointed as a lecturer at the FIBA Europe Coaching Certificate program. Since 2014, Professor Trunic is a senior lecturer at the Faculty of Physical Education and Sports Management at Singidunum University in Belgrade. During his academic career, Trunic was involved in coaching basketball teams. In 2009, he was appointed as the head coach of the Serbian men's under-16 team, which won a bronze medal at the FIBA European Men's Under-16 Championship in Kaunas, Lithuania. In 2017, he was appointed as the head coach of the Serbian men's under-17 team at the FIBA World Championship. in Hamburg, Germany.

Dr. Marios Christou

Marios Christou is a physical fitness trainer, physical therapist and sports injury researcher at the University of Nicosia in Cyprus. He is a sports science lecturer and special scientist at the University of Cyprus. In addition, he serves as a consultant for fitness training in professional football teams, and was an instructor at the coaching school by the Cyprus Football Association (CFA) that qualifies UEFA diplomas. Dr Christou has a bachelor's degree in physical education and sports science, a master's degree (MSc) specialized in team sports training and a doctorate (PhD) where he specialized in exercise physiology. The scientific fields he researches are "physical fitness assessment and football training" and "strength training". Dr Christou participated in research projects, published articles with collaboration with other researchers in scientific journals, and was invited to scientific conferences and workshops where he gave speeches lectures and presented his scientific research.

Renaud Longuevre

French athletics coach, served as manager of French athletic teams. Since 1996 serves as the national athletics coach at INSEP (National Institute of Sport, Expertise and Performance), specializing in jumps and sprint events. Renaud Trained the long jumper Eloyse Lesueur, the world champion in running 110m hurdles in 2005, as well as Ladji Doucoure and Muriel Hurtis. In addition, he also wrote several books on training methods.

Karl Gunter Lange

Karl Gunter Lange is the mentor of the track and field coaches of the Ugandan athletics team. His Team won several Olympic medals, and he is an expert in training theory. Lange is an experienced coach in the field of applied sports science and an expert for sports development. He has global experience in managing ventures in the sports industry based on high intercultural skills, communication skills, leadership, presentation skills and implementation strategy. Lange is a prominent professional in the field of social and community services. Lange has a DOSB coaching diploma and a degree in Sports and Education focusing on SPORTS MADE IN NN"".

Prof. Marko Stojanovic

A “full professor” at the University of Novi Sad in Serbia.
His areas of expertise are "exercise tests and prescription" at the Faculty of Sports and Physical Education, and "physical activity prescription within Rehabilitation" at the Faculty of Medicine.
Stojanovic has written more than 50 scientific articles published in influential journals, and was working as a fitness trainer in Maccabi Tel Aviv football club.

Yuval Cassuto

A nutritionist and a lecturer in exercise physiology, sports nutrition and anatomy at the training school at the Wingate Institute. He is also a lecturer in anatomy, physiology and nutrition at the Kibbutzim Seminary College. Cassuto studied at the University of Buffalo in New York; In 1988 he received a bachelor's degree B.Sc. in

physical training sciences, and in 1992 he received his second degree (M.Sc.) in nutrition sciences specializing in nutrition and sports.

Grzegorz Ryś

Ryś is a volleyball coach from Poland. Ryś was an assistant coach and coach of Various Polish national teams. He was also coaching various teams and served as a head coach of youth division in the Polish volleyball union. In 2010 and 2015 Ryś was a member of the European Coaches Committee (CEV), and in 2015 he served as head coach of the Egyptian national u-23 team. Between 2016-2019 Ryś served as head coach of the Israeli national team, and between the years 2017-2019 he served as head coach and as the technical director of the international men's teams of Israel. From 2021 Ryś serves as head coach of the Israel Volleyball Association for the national u-22 team, and as the head coach of the Wingate Academy Union.

The following have presented recommendations regarding participation in matches or competitions:

Jelena Obradovic, PhD,

Lukasz Bortnik

Dr. Yitsik Ben-Melech

Dr. Georgios G. Ziogas

Dr. Nenad Trunic

Renaud Longuevre

Karl Gunter Lange

Grzegorz Ryś

Additional professionals have also participated in writing the position paper:

- Basketball, football, gymnastics, judo, swimming and athletics coaches in Israel and other national teams.
- Experts in the fields of physiology, psychology and orthopedics from the University of Leipzig in Germany and the University of Nicosia in Cyprus
- Physical fitness trainers and senior trainers in various sports

Summary

Along with significant changes in different aspects of elite athletes' achievements and abilities, stands out the increase of competitions and matches that international teams and athletes are coping with

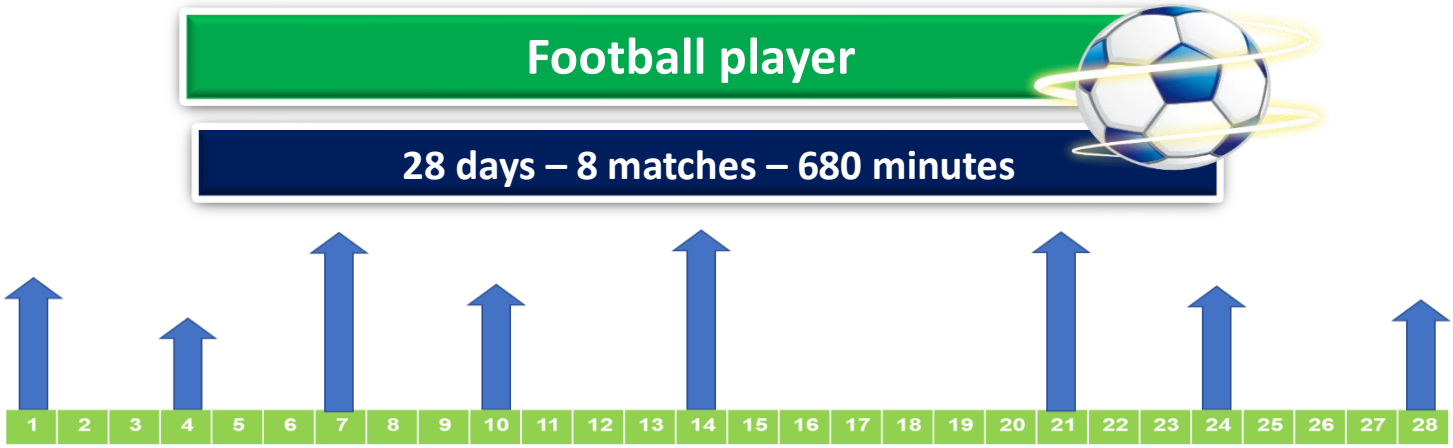
1. Examples

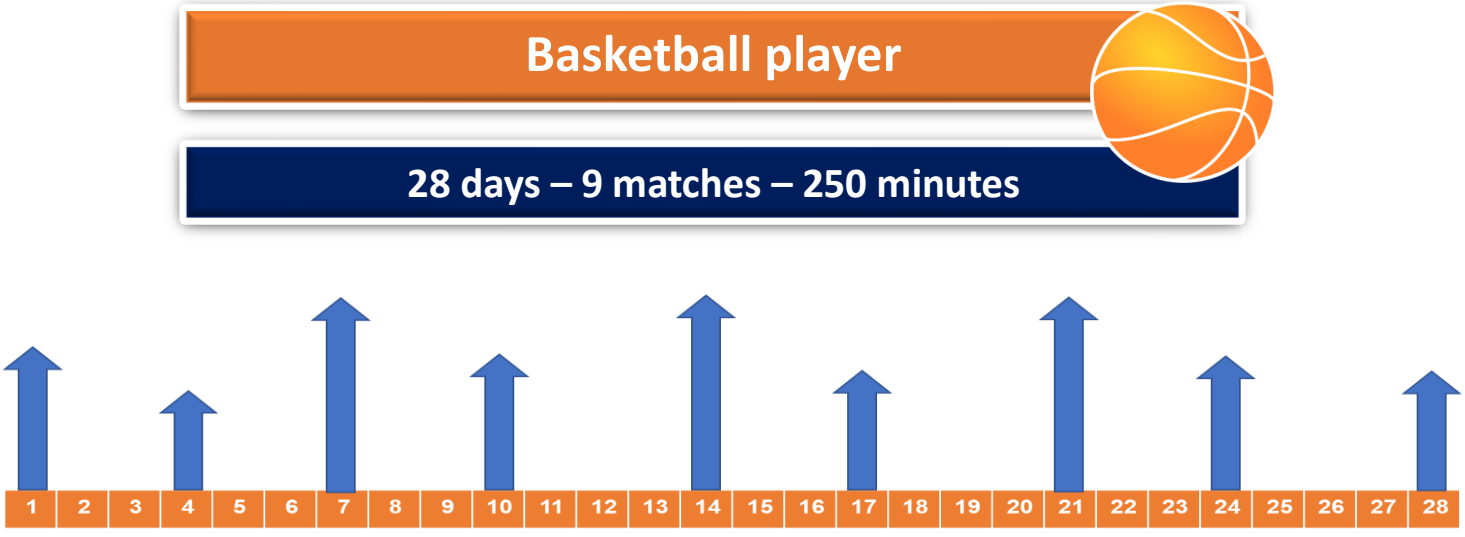
Football player in one year (in Europe)

60 matches, 4600-5000 minutes

Basketball player in one year (in Europe)

80-95 matches, 2300-2750 minutes





As a result of increasing competitions and matches, frequency and the intensity of the loads, the athletes and coaches are facing physiological, orthopedic, and mental consequences.

2. Effects and consequences

- • **Physical - Physiological**
- • **Orthopedic**
- • **Mental**

Physical - Physiological effects

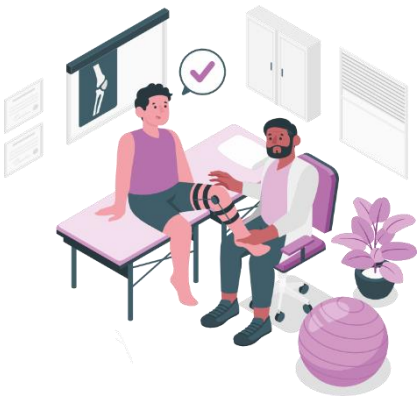
- **Fatigue - calories**
- **Biochemical changes**
- **Recovery rate**
- **Decisions making**
- **Neuromuscular control**
- **Coordination**

Orthopedic effects

2 games a week: 21% more injuries

- ➢ **Bones**
- ➢ **Joints**
- ➢ **Tissues**

An average of 6 injuries in a team per month



Mental effects

- Depression
- Motivation
- Lack of concentration
- Arousal level

3.Monitoring and control measures

Internal

- Heart rate
- Lactic acid concentration
- Blood composition
- Urine composition

External

- Documentation, summary and analysis
- Volume
- Intensity
- Frequency
- Density

The recommendations include alongside tables including the volume, density and frequency of games and training, below are the main points of the recommendations:

4.Recommendations

- Medical-scientific staff
- Training and personal programs
- Methodical - scientific monitoring and control
- Planning training, matches and competitions methodically and scientifically

Experienced and knowledgeable in training professional athletes.

Emphasis on a medical – health team that will guide the athletes, take care of prevention, treatment and recovery, finding quick and usually unconventional solutions in all orthopedic, internal and physiological aspects, but also in dental problems, inflammations, warts, ingrown nails, etc.

In addition, a mental-social treatment is necessary.

Additional emphasis should be given to individual training, in the training process of professional competitive athletes, at least 50% of loading, recovery, prevention and rehabilitation planning must be personalized

5. Recommendations in training planning

Recommendations for optimal loading and recovery.

1

A break period of 2.5-3.5 weeks during the year.

Breaks can be held in two or three times.

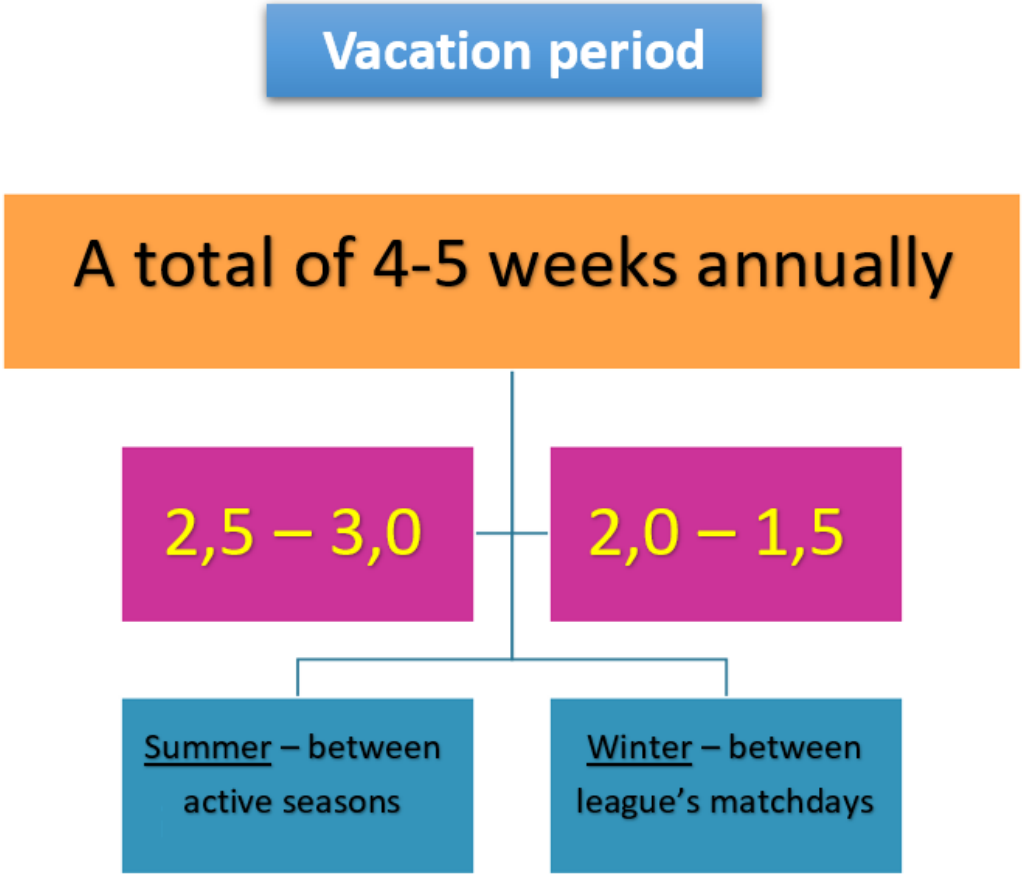
e.g.:

A – 2-2.5 weeks between one active season to another

B – 1-1.5 weeks between cycle 1 and cycle 2 (in winter)

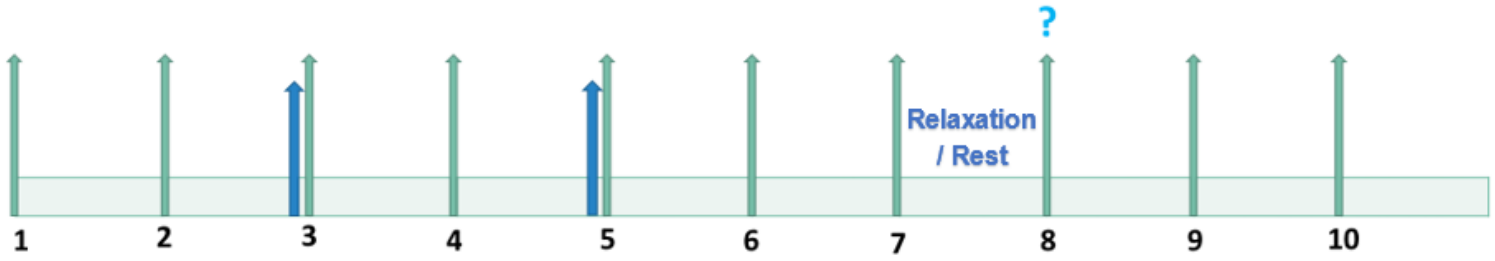
"Break" defined as - a great relief in the volume and intensity of training until almost complete rest.

During the break, it is possible to engage a different sport.



2 Every 7-10 intensive weeks > a light week

Relaxation period - reduced intensity and load - the relaxation period will apply after every 7-10 weeks in which intense activity is carried out and will include avoiding competitions or matches. The relaxation period will last about 5-7 days including light loads training.



3 Weekly rest day

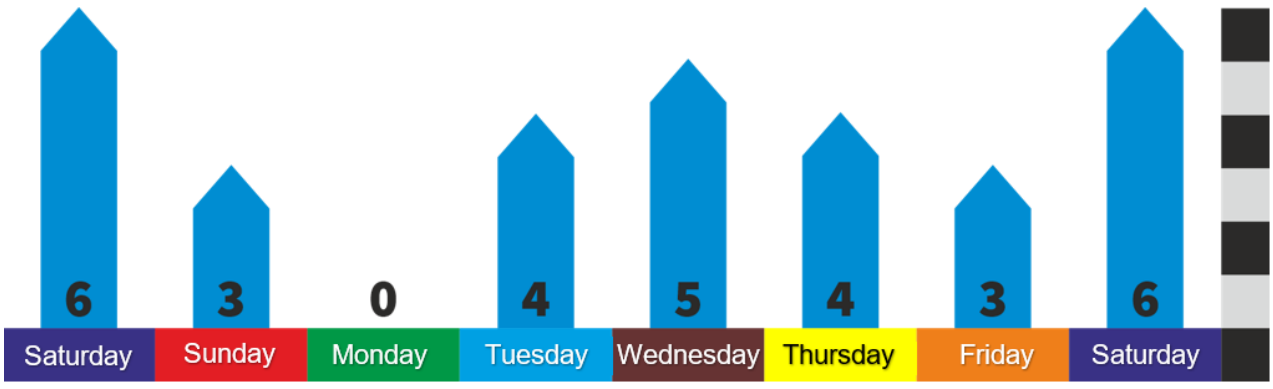
A weekly rest day while making sure to have a rest day in every "small cycle".

Since in ball sports and sometimes in other sports as well, the "small cycle" is not necessarily a week long, it must be combined with a complete rest of one day.

"Small cycle" is defined as 4-10 days

2 days post-match

2-3 days pre-match



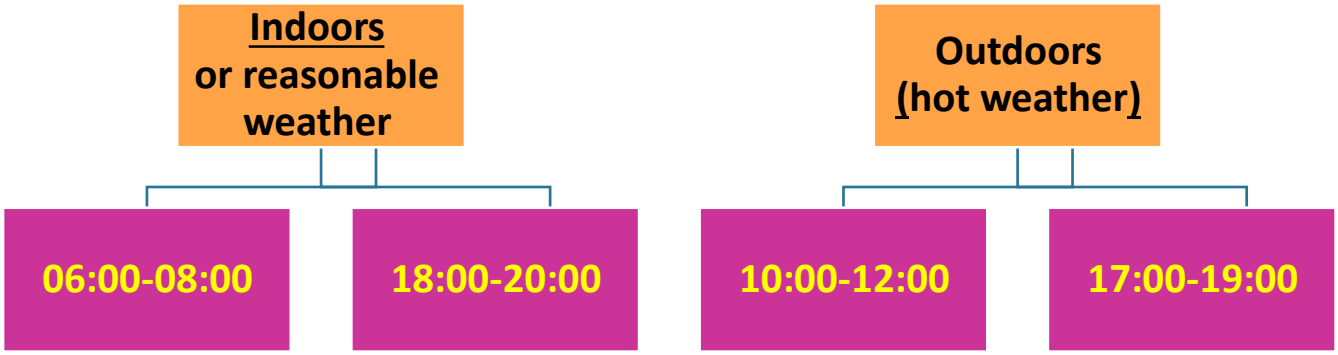
4

High intensity exercise hours

Recommended hours for high intensity training, matches or competitions:

10:00–12:00 and 17:00–19:00 are the recommended hours for outdoors & indoors activities.

For humid or warm weather, 06:00–08:00 and 18:00–20:00 are the recommended hours for outdoor activities.



5

24 hours post training, competition or a high intensity match, It is recommended to carry out a training session that has moderate to light volume and intensity to speed up recovery.

6

A day before the competition or match, it is advisable to have a training session at a moderate to light loading level rather than a complete rest.

7

In a "small cycle" it is recommended to take a rest day 48-72 hours before a competition or match.

8

During personal rest it is recommended to avoid any involvement in matches or competitions such as sitting on the bench or partial participation, since complete mental rest is required.

Background - Main changes in the world's competitive sports

A. Improvement of achievements and performance in several sports, especially in professional sports and developed sports in African, Asian and South American countries.
B. Delay or even a decrease of achievements and results, especially in professions and sports dominated by athletes in Europe and Eastern Europe in particular.
C. A decrease in the average investments of the country and local authorities in high-competitive sports and redirection of investments to popular sports.
D. An increase in commercial investments of competitive sports, an increase in its number of sponsors and the publicity it receives from the media.
E. An increase in the number of sports professions participating in major sports events.
F. An increase in the number of athletes, teams and national teams participating in sports events.
G. An increase in the number of female athletes participating in sports events, as well as an increase in the types of sports that young and adult females participate.
H. Conduction sports events on unusual dates and hours, in contrast to professional principles.
I. Changing rules regulations of competitions and sports events according to commercial and media considerations
J. Expanding the use of technological means, of science and medicine.
K. A noticeable increase in the number of sports events: the competitions, games and tournaments which elite athletes are required to participate in.

Introduction

In recent years, substantial changes have been made in the field of competitive sports, which were mainly due to the economic interests of commercial companies and media organizations. These changes are manifested in the increasing number of games and competitions in the top establishments, and the feeling among players and professionals is that those with economic interests are the ones who determine the schedules.

The lack of coordination between the various frameworks in which the sports events take place is the main cause of the incompatibility between the schedules of the events. These frameworks are managed by different institutes, driven by different interests, having different goals as well as completely different political views and ways of conducting themselves. There is no factor working to link these frameworks and coordinate the schedules between them, and the ones who eventually suffer are the athletes. **(Fanan, R.).**

Various professional team sports currently have millions of fans, broadcasting rights in the media channels, marketing and advertising. These industries generate important economic activity, for example, professional basketball competitions are held in more than a hundred countries in the world, including more than 70,000 professional players worldwide. The competitions in this industry are a profitable business that allows players to develop international career paths and provides entertainment to billions of people.

The total revenue for the NBA team in the 2018-2019 season was $8.76 billion. The total revenues of football clubs in Europe have also increased greatly in the last decade, for example, in 2009 the total revenues were 11.7 billion euros, while in 2018 they increased to 21 billion euros. The conclusion from this is that the games and competitions of the professional sports have become very profitable, expensive and ostentatious events.

Value of global sports industry rises every year: in 2019 it was estimated to be worth 458 billion dollars, and the forecast for 2025 is 600 billion. It is true that male and female athletes earn more than ever, but they are also required to participate in greater amounts of competitions and training with a heavy price to pay **(Stojanovic, M. and Ben-Melech, Y.).**

The desire for achievements and better results has changed the perception regarding athletes' preparation, which today is more intense than it has ever been. Even the annual calendar of games and competitions, planned by vested interests, has effects on the body and mind of the athletes. Nowadays, a person can watch three games of his favorite team in one week, for several weeks in a row **(Torrijo, J.).** To enable this, athletes in elite football teams are required to compete every two days or every five days for several weeks in a row. If we also consider training between games, we will see that the necessary time required for recovery of athletes from the competitions is actually shortened. In studies that followed players using monitoring devices, it was found that in the last 15 years the intensity of games has increased significantly (e.g. Premier League). The high intensity during the games increases the physical and mental effort required of the players. All of these - the increased intensity in the game, the compressed schedule, high weekly load, reduced rest time and the need to meet high standards in every game - significantly increase the physical and mental stress of elite athletes **(Georgios, G. Z.).** Therefore, the preparation of the athletes and the intelligent planning of the schedule are important tools that must be used in order to reduce the risks of injury in a season that has many competitions and games. All staff members: sports coaches, training experts, physical fitness trainers, physiologists, psychologists, doctors, physiotherapists, nutritionists and analysts - who are directly or indirectly responsible for managing the load and the performance level of the players, had to adapt professionally to the new training plan; The preparation for achievement in sports is designed to enable athletes and teams to achieve the best sporting performance in their competition. These achievements are achieved through long-term, methodical and difficult work by a large number of people **(Christou, M., Ben-Melech, Y., Stojanovic, M., and Trunic, N.).**

Chapter one - Summary of the articles

Increased amount and frequency of games and its consequences

These days there are substantial changes taking place in professional and competitive sports, both from the physiological and psychological aspects, and this is due to the way in which this sport is conducted as a result of the entry of commercial, business, economic and media factors into the field. Team and professional sports today have millions of fans, broadcast rights in media channels, marketing and advertising. These sports generate extensive economic activity, and values such as striving for maximum income and perfecting logistics became the leading values.

World sports is an industry whose value soars every year, for example, in 2019 its value was estimated at 458 billion dollars and the expectation for 2025 is 600 billion. It is true that male and female athletes earn more than ever, but they are also required to participate in greater amounts of competitions and training with a heavy price to pay. (**Stojanovic, M. and Ben-Melech, Y.).**

In recent years, the number of games held annually in the top establishments has steadily increased. Due to this, it is impossible to implement a program that is based on the classical training and competition theory, and the feeling among the athletes and professionals is that those with economic interests are the ones who manage the schedules, without considering the needs of the athletes. In this reality, the level of achievements that athletes can reach is harmed and, as a result, their national and international success also suffers. Lange G. expresses concern about the increased risk to health and well-being of athletes due to the deterioration in conditions of the competitions and games. He claims that today, elite athletes are required to work in inappropriate conditions, that even require international intervention actions **(Lange, G.)**.

Changes in conduct, intensity and frequency of competitions and games

Over the past 15 years, most international confederations have increased the number of matches per season. Professional team athletes (e.g. soccer, basketball, rugby) are sometimes employed in several frameworks simultaneously, so in one week they may play 2-3 games: local, national or international.

The number of games and competitions is almost twice than what it was 15 years ago, and in some professions even more. In popular team sports such as football, basketball or handball it is now accepted to compete in several games per week per team during the competition season. For example, an elite football player may participate in the local championship, local cup, international games (e.g. Champions League and the Europa League) and international team games (such as the World Cup qualifiers).

Maccabi Tel Aviv basketball team plays an official game every 2.8 days on average. The team often plays 3 games a week, sometimes for several weeks. The season of games and competitions has been extended, and the schedule of games has become very crowded compared to the past.

The players often have to fly to get to competitions or games, in some cases, flights are long and cross different time zones, and therefore create additional physiological stress, which greatly delays the recovery of the athletes. The multiple flights to competitions and games are designed to maximize the economic profits of the teams **(Stojanovic, M., Ben Melech, Y., Torrijo, J., Fanan, R., Georgios, G. Z. and Christou, M.).**

Even in running industry, the ambition to achieve the maximal profits dictates the conduct of the athletes. Certain representatives of athletes are known to try to maximize their income through athletes' participation in street running competitions, which are held around the world. Thus, athletes participate in competitions every week in several countries all over the earth in order to win financial prize, even if the prize may be relatively small. This desire to achieve the most possible profits causes athletes to drop out early due to injury, burnout or stagnation in achievements. However, those athletes' representatives are not bothered by this, because they can easily sign a new talent **(Lange, G.).**

Combining science in sports

The changes described above, which are mainly in media and commercial interests, have contributed that the programs of events and championships are often not in line with the theory of training and classical professional competition. Event plans contradict the professional principles and harm the athlete's achievements and health.

In this situation, instead of the professional staff building schedules that will allow suitable training and playing conditions for the athletes, the athletes and staff reluctantly adapt to the current schedules, developing unique actions relating to methods, means, training planning, periodization of training stages and recovery processes that will help them to deal with the situation. **(Stojanovic, M., Lange, G. and Ben-Melech, Y.).**

All sports professionals are interested in having improved performance actions developed for them, in the same way that sports science was able to contribute to improving athletic performance. After all, the main goal of professional sports preparation is to allow players and teams to achieve their best athletic performance in competitions. In the field of athletics, elite sports achievements derive from hard, systematic and long-term work of many people who serve the athletes. Trainers (fitness and strength trainers), psychologists, doctors, physical therapists, nutritionists and sport analyzers - all of them work in coordination to contribute as much as they can to optimize the system of sports teams, assist in recovery, alleviate muscle damage, find ways to deal with fatigue, reduce an increased risk of injuries and to improve the quality performance of the athletes **(Trunic, N., Ben-Melech, Y., Cassuto, Y. and Christou, M.).**

Monitoring and control of the load

In a survey conducted by the World Players' Federation (FIFPRO), 35%-40% of football players reported on games overload and insufficient amount of recovery days. In that survey, some players reported playing 78 games a year or 5,636 minutes because of the tight schedule, and 67.9% reported they play even when they are tired.

During periods with high number of training sessions and tight schedule, it is crucial to monitor the load of the players, to reduce the risk of excessive and continuous stress on the body. These periods require individual load planning and careful training as well as recovery from them to prevent overtraining or undertraining that might occur **(Stojanovic, M. and Georgios, G. Z.).**

To gain success in competitions, e.g. martial arts, athletes train every week, several vigorous training sessions that are perceived as difficult and very strenuous. For the most part, the coaches do not plan these trainings well, and there is a complete mismatch between the rate of effort as it is estimated by the coaches and the rate of effort by the athletes. This poor planning may lead to overtraining and later even to a decrease in the performance of the athletes (**Drid, P.**). When the workload is greater than the load the athlete can handle, the athlete is in a state of overfatigue, and risk of injury increases considerably. In order to avoid such situations as much as possible, new technology must be used in training planning that collects data on the athlete's performance, on his state of health, on training recovery and his lifestyle. With the help of this technology It will be possible to measure the load, and if necessary, even determine the rehabilitation time required for an athlete to return to training. Regular use of these means - GPS, stopwatch (chronometer), accelerometer, strength meter (dynamometer) for measuring external load (usually of duration and distance), heart rate monitoring device, blood lactate concentration test as well as subjective measurements, such as perceived exertion (RPE) - will help evaluate the intensity of training and competitions, will lead to better performances and reduce the risk of injuries.

Consistent monitoring of perceived exertion has been shown to help identify the need for recovery, predict declines in performance, anticipate health issues, and adjust quality training and competition programs for each athlete's unique abilities **(Trunic, N.).**

The purpose of workload monitoring is to reduce the risk of injury to athletes by identifying athlete's fatigue and its causes, as well as matching recovery and rest periods with training and competitions. These will be based on the personal data of each athlete: physical fitness and his degree of fatigue next to his ability to recover from it. This is how the Golden State Warriors managed the workload of their athletes. They allowed some of the athletes not to compete during the fourth quarter or alternatively to rest and not play in certain games in the 2015-2018 seasons. In these seasons, NBA win-loss ratio record has been made **(Trunic, N. and Stojanovic, M.),** a fact proving the effectiveness of workload management.

Nutrition

The difference between improving achievements and success in competitions or training and between gradual deterioration, injuries, failure and retirement from the sport sometimes stems from the athletes' lifestyle. Habits, such as breakfast prior to afternoon workout, eating a meal four to six hours before training or activity, eating a snack or a small meal, containing 50 grams of carbohydrates and 5-10 grams of protein an hour before a strenuous and prolonged activity will provide important carbohydrates to the body that will reduce muscle damage.

For years, the scientific literature indicates that during a strenuous period of training or competitions, male and female athletes reach a state of caloric deficit. During periods of great physical effort, the caloric intake of these athletes does not always equal the large caloric expenditure.

To avoid the negative effects of the caloric deficit, caloric balance and glycogen stores in the muscles and liver must be maintained. The athletes must consume 5-8 grams of carbohydrates per kilogram of their body weight every day, which will provide them with 55%-65% of the required calories per day. Trained athletes that compete at high intensity and volume, at 3-6 hours a day and 5-6 training sessions a week, may need 8-10 grams of carbohydrates per kilogram of their body weight.

In order for the players to meet the high demand for competitions, a post-game nutrition individual strategy must be adopted, to help him recover from the game. For example, when there is a need for rapid replenishment of the glycogen reserves, the athlete must consume at least 1.2 grams of carbohydrates per kilogram of his body weight every hour after the end of the activity. It is also important to monitor the

athletes' weight fluctuations, and teach them to consume carbohydrates in sufficient quantities.

The demand for protein also increases with the increase in difficulty, duration and intensity of the activity. Physical activity and especially resistance training, which is accompanied by protein consumption that encourages muscle growth. When the protein is consumed near the beginning of the workout or right after it, a synergy is created, and the muscle is built.

To build and maintain muscle mass, players must consume an amount of 1.4-2.0 grams of protein, per kilogram of body weight, per day. However, during the period when the caloric balance is negative for loss of fat mass, it is required to increase the consumption of proteins to 2.3-3.1 grams of protein per day, per kilogram. The rule is that protein serving should provide about 0.25-0.55 grams of protein per kilogram, which means about 20-40 grams of protein per serving for most athletes. The consumption of these protein portions should be spread over the day at intervals of 3-4 hours. It is important to know that proteins that are digested quickly, especially low-fat animal proteins, have a high percentage of essential amino acids, which are very effective in building muscle mass.

In addition, it is important to make sure that the players consume fluids in sufficient quantity. Loss of fluids that is greater than 2% of the body weight harms the physical function and the mental state of the athletes. Thus, especially on hot days, losing more than 2% of body weight in its saturated state, should be avoided. Every morning, it is required to make sure that the athletes start their activity when they are saturated. Daily morning weighing after urinating and checking the urine concentration will help identify dehydration and guide the athlete to increase the amount of drinking.

About four hours before the activity, the athlete must drink 5-7 milliliters of water for every kilogram of his body weight. If two hours before the activity the player has no urine or the color of his urine is dark, he must consume another 3-5 milliliters of water per kilogram. If the physical activity caused a lot of sweating and significant weight loss, at the end of the activity the athletes should be returned to their saturated body weight to allow their bodies to recover in the optimal way. It is recommended that for every kilogram missing from athletes' weight at the end of the activity compared to their weight before, they should consume 1.25-1.50 liters.

(Torrijo, J., Cassuto, Y. and Christou, M.).

Chapter two - Main changes in global professional sports

A. Improving achievements, results and performance in several sports

The improvement in achievements is mainly noticeable in personal branches. For example, in swimming profession the records were improved from 1992 to 2020 to a considerable extent, below are some examples.

- 100m men freestyle - 48.42 seconds in 1992 / 46.91 seconds in 2020.
- 200m men medley - 1:59.36 minutes in 1992 / 1:54.0 minutes in 2020.
- 100m women freestyle - 54.48 seconds in 1992 / 51.71 seconds in 2020.
- 100m women breaststroke - 1:07.91 minutes in 1992 / 1:04.13 minutes in 2020.

Also, in the field of athletics, the achievements in medium and long runs, especially in women's runs, were significantly improved. Below are some examples.

- 10k women - 30:13.74 minutes in 1992 compared to 29:17.45 minutes in 2020.
- 100m and 200m- 9.86 and 19.72s in 1992 / 9.58 and 19.19 seconds in 2020.

Even in new disciplines, such as pole vaulting for women, the record was broken - 4.05m in 1992 / 5.06m in 2020.

B. Stagnation and even declining achievements in several branches and technical professions in professional sports, especially in branches and professions that were common in Europe and Eastern Europe

Below are some facts indicating a stagnation and even declining achievements in the technical branches and professions in professional sports.

- In track and field there is a stagnation in achievements in the technical professions that are not developed in African, Asian and South American countries. Thus, for example, records in the shot put (23.12 meters in 1990), long jump (8.95 meters in 1991), triple jump (18.29 in 1995), 400-meter hurdles (46.78 seconds in 1992) and high jump for women remain intact. (2.09 m in 1987).
- Controversial women's records set by Eastern European athletes have remained unchanged since the 1980s, including that of Florence Griffith of the United States.

- Stagnation and declining results of professions dominated by athletes (and teams) from Eastern European countries, mainly referring to technical-feminine professions that African, Asian and South American countries do not have the conditions, ways, methodical and organizational scientific training methods and means to develop these professions as Eastern Europe countries had.
- The number of Olympic medals won by European countries dropped from 75% in the 1980s to 45% or even less in recent years. In contrast, the number of Olympic medals won by Asian and African countries in recent years is twice the number of medals they won in the 1980s.
- A general decrease in achievements in the technical and artistic professions, which is particularly noticeable in female athletes.

C. A noticeable increase in the number of sports professions in competitions at International events

Over the past three decades, there has been a considerable increase in sports branches and professions represented in competitions at international events. For example, in the "Tokyo 2020" Olympics there were 33 sport disciplines and 339 sport events sports in competitions, while in the "Seoul 1988" Olympics there were 23 sport branches and 237 sport events in competitions.

These were also included: 3x3 in basketball; gymnastics professions; mixed team swimming; athletics, judo; mixed team judo and beach sports.

D. An increase in the number of athletes, teams and national teams participating in sports events and programs

Below are facts to indicate growth:

- 206 countries and 11,565 athletes participated in the "Tokyo 2020" Olympics, while 159 countries and 8,390 athletes participated in the "Seoul 1988" Olympics.
- In some branches such as athletics, football and basketball, the number of participating countries was higher than 210.

E. Sports events and competitions are scheduled at times that do not suit the activity, without taking into account professional considerations

Below are facts to indicate this:

- Marathon runs are held at noon/afternoon.
- Final competitions swimming and athletics are held in the morning hours.
- World Cup event takes place in November

F. Determining the regulations and rules of the competitions and games according to commercial considerations designed to attract an audience

Below are examples of such rules and laws:

- Score in volleyball
- Rules for sailing competitions, shooting and fencing finals
- Timeouts in basketball

G. An increase in women's professions and the percentage of women participating in competitions compared to the past

Below are examples of this phenomenon:

- 5494 female athletes participated in the "Tokyo 2020" Olympics (47% of all athletes), while 2159 female athletes participated in the "Seoul 1988" Olympics (26.1% of all athletes).
- In the last two decades, women's professions were included in the Olympic Games, such as the 3000-meter steeplechase (2008), pole vault and hammer throw (2000), triple jump (1996), water polo (2000) and 1500-meter freestyle (Tokyo 2020).
- Women integrate into all branches and all sport professions, even in those that were previously male-only professions.
- Due to the increase of female athletes, categories were added in some professions:
  In 2000 there were seven weight categories in the weightlifting profession,
  In 2004 there were four weight classes in wrestling
  And in 2020 five weight categories in boxing.

H. Extensive use of science, medicine and advanced technological means

Below are some examples:

- Use of measurement and evaluation equipment such as GPS
- Footwear and clothing such as marathon running shoes and swimming clothes
- Use of imaging devices (simulation) for training in most professions.

I. A considerable increase in the number of international competitions and their frequency

Below are some data supporting the increase of competitions in several sports.

Swimming

The table below shows a comparison between the number of games, competitions and tournaments in the 1980s, the 1990s and the 2000s until today in the swimming industry. From the data it is possible to learn about the large increase in the number of swimming competitions in the last three decades.

Years	Number of competitions
the 80s	2 world championships and 8 official international competitions
the 90s	3 world championships and 10 official international competitions
The 2000s to the present day	5 world championships (WC every two years) and 12 official international competitions each year. In addition, many swimming events and professional competitions, generating large financial profits.

Basketball

The number of games played by senior teams, who played local leagues and European leagues, increased from 43 games a year (22 in the league, 15 in Europe and 6 in the national team) in the 1980s, to 55 games a year (25 in the league, 20 in Europe and 10 in the national team) in the years -90, and to 76 games per year in recent years (36 in the league, 30 in Europe and 10 in the national team).
This is in addition to cup games and games in international and national tournaments, open and official (preparation and commercial parties).

Below is a comparison between the number of games that basketball teams participated in during last season compared to the number of games the teams participated in previous seasons.

	1980	1990	2000	2021-2022
Spain	30-54	38-64	50-88	90-104
NBA	80-112	80-114	82-117	90-119
Israel	25-49	23-50	33-66	61-90

Athletics

Anatoly Shafran, a high jump coach in Israel, says that in the 1970s and 1980s, elite high jump athletes (men and women) participated in 4-5 competitions a year, in a period of two to three months. Nowadays the athletes in this field participate in 25-35 official competitions a year.
Mike Koskai, Kenya's national running coach, says that today senior runners participate in 30-35 races a year, including 3, and sometimes even 4-5 marathons (the length of a marathon is 42.195 km). In contrast, in the 80s, runners participated in 8-10 races a year, and in the 90s the runners participated in about 12 races a year, including only two marathons.

Football

	1980	1990	2000	2021-2022
Spain	36-56	36-62	40-64	51-78
England	38-52	38-64	42-72	52-84
Germany	38-52	42-60	42-72	47-72
France	36-64	38-64	42-68	50-77
Italy	39-62	42-58	44-68	51-76

Chapter three - Summary of conclusions

Consequences of Changes on Physical, Orthopedic and Mental Aspects of the Athletes

Description of the changes

Nowadays, top players in European League teams are often forced to play many minutes in three or four games a week. At least two of these games are held within the Euro League, where the intensity and the level of athleticism required are among the highest in world basketball. In a regular season of the NBA there are 82 games held in a period of five and a half months, that is a game in every two days on average. Then, at the end of the season (in the months of April and May), In the playoffs and NBA finals, 28 games are played.

The teams face a rigid schedule in which the frequency of games is high throughout the season. According to this schedule, the players are sometimes required to play five games in seven nights. Considering the flights that sometimes take place between the games, the stay at the airports, short hours of sleep and insufficient diet during these periods, the inevitable conclusion that the health of the players is in danger and their level of performance is compromised **(Fanan, R., Stojanovic, M., and Christou, M.).**

According to Lange, the maintenance of adequate working conditions, which guarantee good health for athletes, is not a top priority of the decision makers. For example, in the 2013 World Championship held in Moscow, it was decided that the women's marathon would be held at 13:58, at a temperature of 27 degrees Celsius with 66% humidity. This decision led to withdrawal from the competition of 24 female world-class athletes (out of 70).
At the upcoming World Championships in Athletics, which will be held in 2022, it was determined that the 10,000 runs for women and men, will be performed during the hours when the temperatures are even higher - 28 degrees Celsius in women's competitions and 32 degrees Celsius in the men's competitions **(Lange, G.).**

The physical load in artistic gymnastics also does not meet the requirements of classical training theory. Children start participating in this sport at the age of 7 and start specializing in it at the age of 9. The gymnasts in this sport train longer than the athletes in individual or team sports, Often, they even train 12 months a year. Required training time in artistic gymnastics has also increased in recent years. in the 70s and 80s required training time was 15 hours a week for women, and 20 hours for men. Today, gymnasts in this industry are required to train 25-30 hours a week, and sometimes even 40, in order to reach the maximum level of performance, given the high physical and technical demands **(Obradovic, J.).**
The physical, orthopedic and mental consequences of the changes in the field of competitive sports on the athletes will be detailed below.

Physical consequences

In recent years, the number of athletes' injuries has increased, which is related, among other things, to the impressive physical performance level of most players. Undoubtedly, the increase in team sports matches, as well as the level of performance and intensity of the game, raised the level of the game or competition, but it also increased the players' risk of injuries caused by the high workload. It can be argued that during busy periods of competitions, games and travel, the risk of injury to bones, joints and soft tissues increases, as the athletes tend to compete without sufficient rest periods. It can be seen and assumed that in some cases, the level of exhaustion of players who are overloaded with work is extremely high, their

level of performance may be low, the risk of injury is rises, the mental pressure is great and there are also physical symptoms of weight loss, sleep disorders and in extreme cases also eating disorders **(Fanan, R. and Stojanovic, M.).**

Athletes who train and compete at high intensity burn around 600-1200 calories of calories per hour. Therefore, two to three hours of training or competition and five to six training sessions a week can add up to a loss of 6000 calories per day and even more. Is such a large caloric expenditure balanced by a greater caloric intake? According to Cassuto, the scientific literature has been documenting for years the common caloric deficit among male and female athletes who are in a period of hard training or competitions. The caloric intake of these athletes does not always manage to balance the large caloric expenditure.

This negative caloric balance is called "exercise anorexia". There are many reasons for this negative balance, and some of them are related to reduced appetite during periods of stress and to the competition or training conditions. Over time, the negative caloric balance will impair the athletes' performance, increase their mental stress, prevent them from recovering well and increase their risk of injury **(Cassuto, Y.).**

Martial arts athletes must maintain a body weight within a fixed range, since in combat sports the athletes are classified by weight. Therefore, these athletes rely on chronic and rapid weight loss (RWL) to reach the desired weight category. The methods to induce such a decrease in them are usually causing active and passive dehydration, actions to empty the intestinal contents and depletion of glycogen stores. The number of cycles in which these methods are used is determined by the number of competitions per year. There is reasonable ground to assume that a large number of competitions per year will lead to poorer performance of martial arts athletes throughout the year **(Drid, P.).**

Studies conducted in the football industry found that more than 72 hours are required for an elite player to reach the level of physical performance he had before the game, and for his body to be able to repair damage and inflammation in the muscles. Sometimes even after a recovery period of 72 hours between two games (mandated by the regulations), many players fail to regain their physiological abilities. Physiological markers such as muscle damage, fatigue and reduced strength are present even after 72 hours or more.

According to Torrijo, in the teams he worked for, which participated in four competitive events at most in a season, the players played more than 60 official games. The multiple competitions in high frequency caused an increased acute and chronic fatigue among the players. When elite group athletes are required to compete every two to five days for several weeks in a row, they are asked to greatly reduce their recovery times. The limited amount of time left for recovery between games impairs the athletes' performance and increases their risk for injuries. On top of that, due to competition's high frequency there is not enough time to accumulate a gradual workload. However, it is necessary to compensate players who did not play on matchday. Therefore, for these players, compensatory training should be planned that has enough load to maintain the performance levels needed for the next games **(Stojanovic, M., Torrijo, J., Christou, M. and Georgios, G. Z.).**

Orthopedic consequences

Sports injuries today have become an epidemic. In the United States alone, approximately 1.5 million high school and college athletes are injured each year. Injuries in elite sports are one of the most important factors that affect the work of the training team and the medical team, because they affect the availability of the players, the performance of the team and cause high financial costs for the club. The main cause of player injuries is a heavy workload resulting in overfatigue. This fatigue affects the player's decision making, coordination and neuromuscular control. It increases the risk of injury because the external load imposed on the athlete is greater than the physical load the athlete can bear. **(Trunic, N. and Christou, M.).** It can be argued that during periods when there are frequent competitions, games and trips, there is a high risk of injuries to the bones, joints and soft tissues, since the athletes tend to participate in competitions without adequate rest in between **(Stojanovic, M.).** For example, in football industry, due to high frequency of games and conduct towards obtaining maximum performance from the teams in order to increase financial profits, high physical and psychological demands are required of the players. Physical demands increase every year, which increases the risk of injuries among the athletes **(Torrijo, J.).**

According to Christou M, the expected number of injuries per week in elite football teams that compete once a week is three injuries every second week (approximately six injuries per month), and in teams that compete twice a week it is approximately

one injury per week (approximately four injuries and more per month). Christou also states in his article that in a sample based of 13,000 observations, it was found that the rate of muscle injuries in games that are less than three days apart is 21% greater than the rate of injuries in games that are more than six days apart **(Christou, M.).** Injuries of athletes competing in gymnastics in clubs has also increased considerably due to the physical demands of aerial tasks and due to the tendency to start specializing at a young age. The estimated average for injuries per 1000 hours of competition is 1.3 acute injuries, and 1.8 overuse injuries **(Obradovic, J.).**

Mental consequences

Health is one of the most important things in human life. Elite athletes are facing an increased level of intensity in games or competitions, a dense schedule, high weekly load, frequent flights, reduced recovery time, as well as the need to meet high standards of performance in every game. As a result, the physical and the mental pressure increases.

In addition to considering the physical factor from its various aspects, the mental health of the athletes must be taken into account. In elite sports, health is mainly assessed through the criterion of players' availability for training and competition. High levels of competitive stress, depression, persistent fatigue from travel and extreme exhaustion are not measured, and damage the player's immune system might cause various diseases **(Trunic, N. and Georgios, G. Z.).**

Excessive matches and competitions can lead to a lack of motivation in players and mental burnout, the players can reach a situation where they are no longer able to prepare for games and training. It is possible that the main stress that the athletes experience is not caused by 90 minutes of the match, but by the mental preparation for the match and the long trips, where adaptation to time zone and climate is required. All these may cause low level of concentration in athletes which will affect the coordination, quality of the performance and increase the risk of injury **(Stojanovic, M.).**

There are no studies that teach about mental recovery, however, Fanan says that from his personal experience, in local teams' games, that occur after games with highly competitive tension (such as international competitions) - the level of arousal of players is very low. Thus, the framework and timing of the match, have an effect on players' degree of arousal in the match.

During the season, the medical-physical team works on several strategies to rehabilitate the players and bring them to a high level of performance on the basketball court. One of the strategies is maintaining their mental health, and this is carried out under the responsibility of the club psychologist. **(Fanan, R.).**

Chapter four - Recommendations

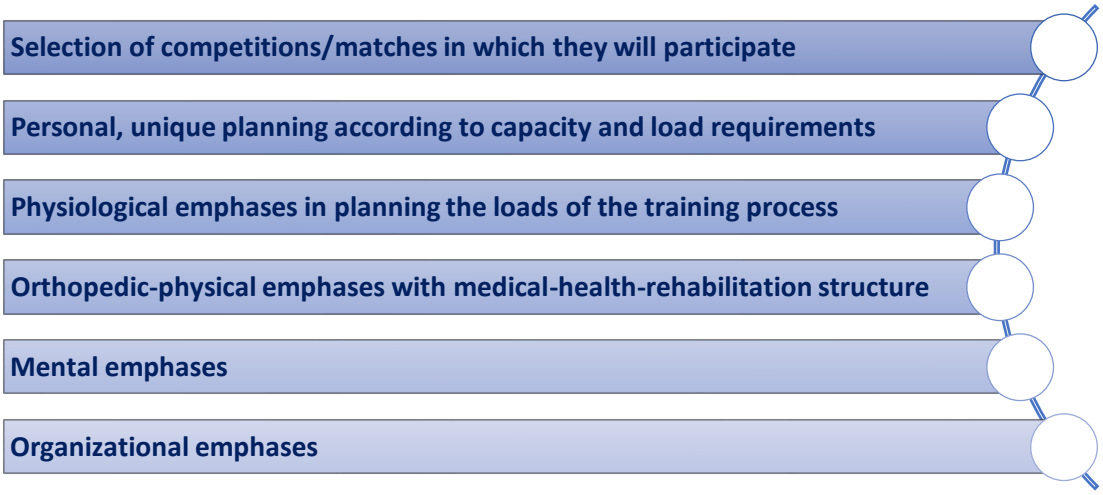
The recommendations refer to the following aspects:

1. Recommended maximal number of competitions/games by sport branches.
2. Desired frequency of competitions or games and their distribution.
3. Recommended actions to monitor and control the amount of games or competitions, their intensity, required level of load and their physiological effect.
4. Recommended actions for a quick and high-quality recovery.
5. Determining rest days and holiday during training period and competitions or games.
6. Recommended maximal number of intense training units per period.
7. Concentrated days and training camps - recommended duration, scope, intensity, timing and frequency.

General recommendations

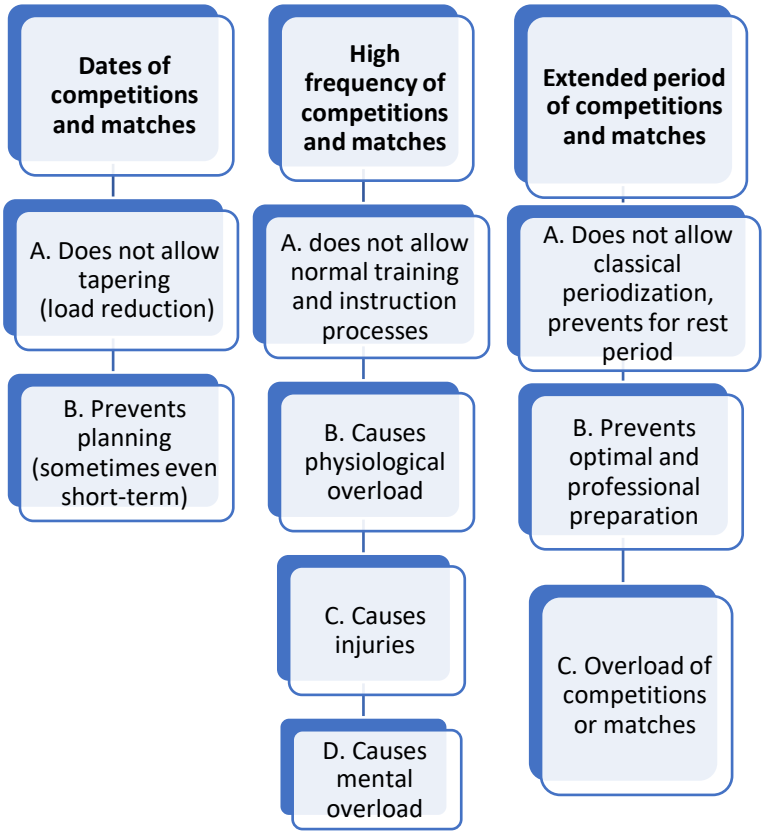
The changes in high-achieving sports described above had a great impact on the way athletes and teams were trained. As a result, many principles on which training theory was based in the past were violated or cancelled. Therefore, the system, the coaches and the professional staff must find creative ways and means to respond to the new situation. Below is a breakdown of some steps that must be taken in the athlete's training process.

A. Medical and scientific personnel with experience and knowledge in training competitive professional athletes should be added to the professional team.
B. A medical-health team must be appointed to accompany the athletes. This team will take care of the prevention of injuries, the treatment and rehabilitation of the athletes, and will work to provide quick solutions, even if unconventional, for orthopedic, internal and physiological injuries. This team will also take care of dental problems, inflammations, warts, ingrown toenails and more. Also, this team will have to take care of accompanying the athlete from the mental and social point of view.
C. Individual training should also be added to the training program. 50% of the workout in the training process of professional competitive athletes must be personal and adapted to the athlete in terms of load planning, recovery, prevention and rehabilitation.



High demands in competitive sports affects greatly on athletes training. In fact, these requirements eliminate many basic principles of training theory in the past.

The diagram below shows the new requirements and their effects.



As a result, the system, coaches and the professional staff must find ways, methods and creative means to respond to the new situation

Recommended principles for loading and recovery

Below is a breakdown of the basic requirements for optimal loading and recovery.

1. A break period of two and a half to three and a half weeks during the year. The breaks can be held in two or three times. for example:
   A. Two to two and a half weeks between one active season to another.
   B. A week to a week and a half between cycle 1 and cycle 2 (in winter). Definition of "break" - a great relief in volume and intensity of training until almost complete rest. During a break, it is possible to engage different sport.
2. A period of relaxation - reducing the intensity and load - the relaxation period will apply every 7-10 weeks in which vigorous activity is performed, and will include avoiding competitions or games. The relaxation period will last about 5-7 days and will include light weight training.
3. A weekly rest day and making sure to have a rest day in every "small cycle". Since in ball sports and sometimes in other sports as well, the "small cycle" is not necessarily a week long, it must be combined with a complete one-day rest. Definition of the "small cycle" - 4-10 days
4. Recommended hours for activity and high-intensity loading in training, competitions or games:
   A. 10:00–12:00 and 17:00–19:00 are the recommended hours for both outdoor and indoor activities.
   B. 06:00–08:00 and 18:00–20:00 are the recommended hours for outside activities, when the weather is hot or humid.
5. 24 hours after training, competition or a match at high intensity, it is recommended to hold a training session that has light to moderate volume and intensity. This type of training will accelerate recovery.
6. A day before competition or match, a training session at a light to moderate intensity is recommended. This type of training is preferable than rest.
7. In a "small cycle", a rest day is recommended to be held 48-72 hours before a competition or match.
8. During personal rest it is recommended to avoid any involvement in matches or competitions, such as sitting on the bench or partially participating in them, as complete mental rest is required.

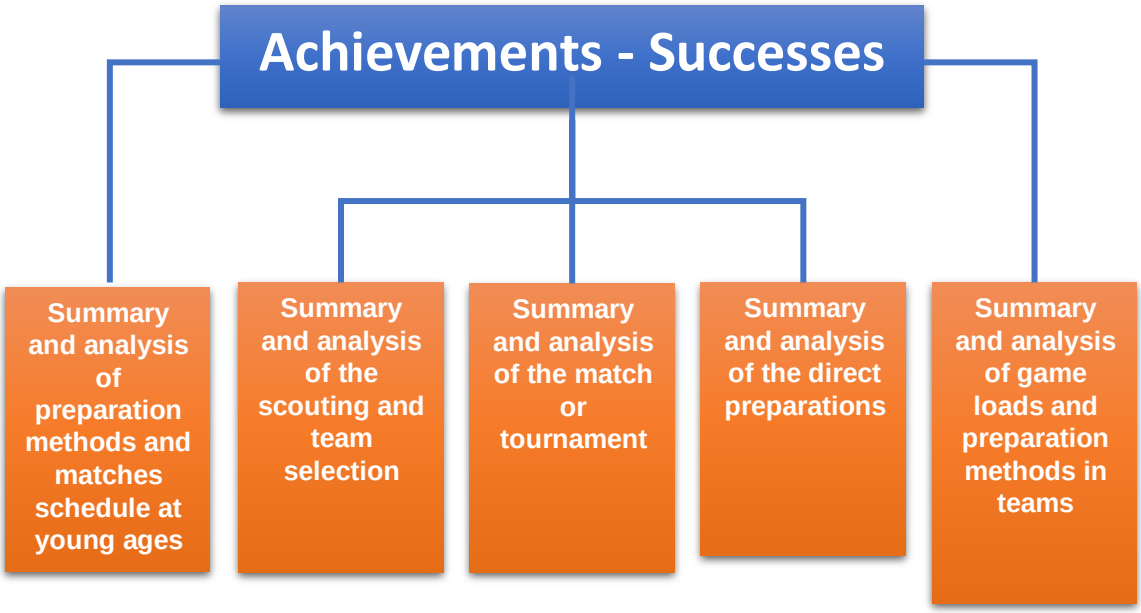
Recommended actions for loading and recovery before an international event:

- ❑ **Conduct a major competition - 4-6 weeks before an international event.**
- ❑ **Conduct a simulation competition - 1-3 weeks before an international event.**
- ❑ **Training camp of 3-5 days at a high intensity (with a training opponent) - 20 days before an international event.**
- ❑ **Preparation period of 3-5 weeks focusing on physical fitness and general work - about 10-12 weeks before an international event.**
- ❑ **Active or passive break, lasting 1-3 days - 15-18 weeks before an international event and after a previous major event.**

There must be changes in methods of scouting and training at young age

At every sporting event, and especially after a competition, match or a tournament, we must summarize and analyze:

1. The event itself
2. Th Direct preparations of the event
3. The program of competitions and preparations during the active season
4. The selection methods of athletes or competitions
5. **Athletes' sports background and especially the training of the young athletes**



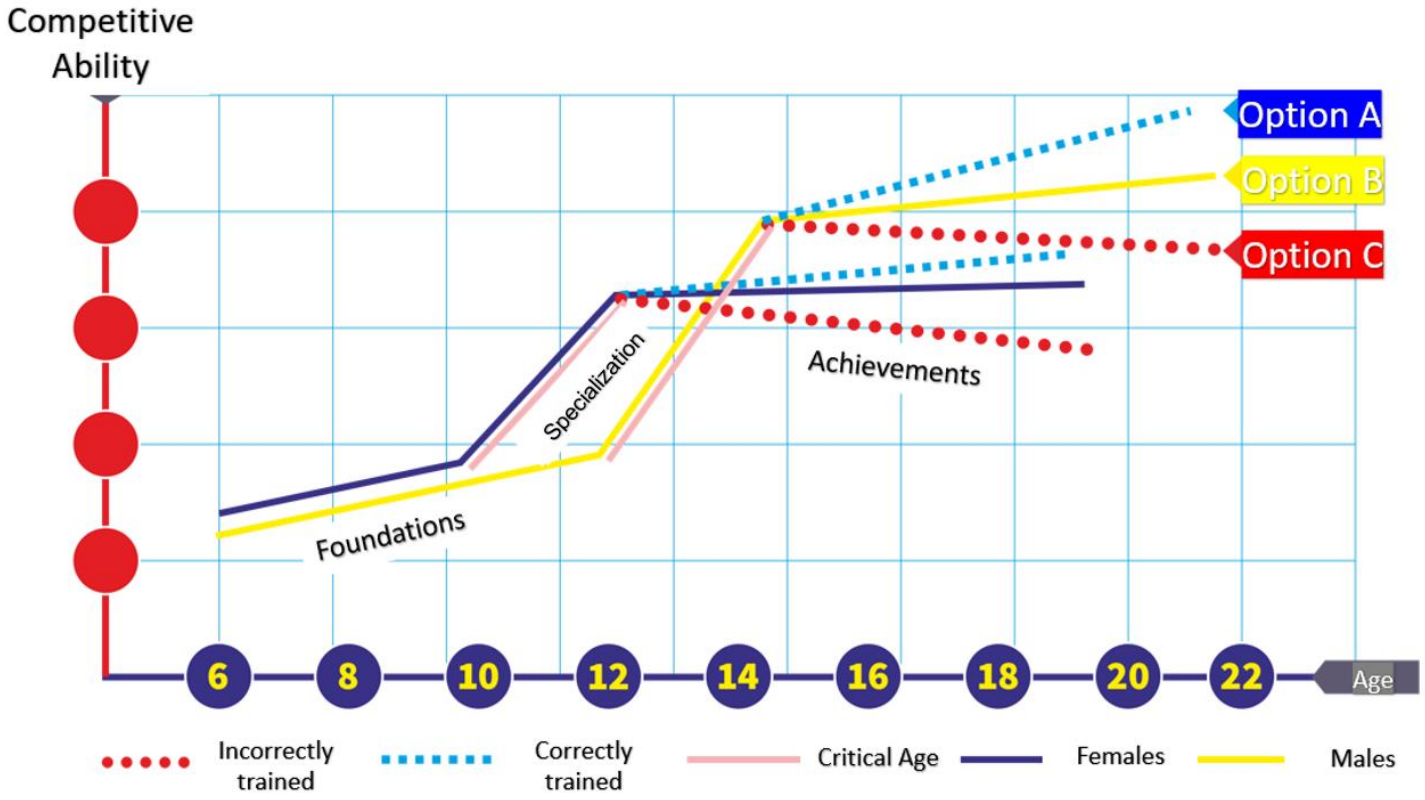
When summarizing and analyzing the young athlete's sports background, potential, methods of preparation and the competition plan in which he participated, the important questions to ask are whether the training process the young athlete went through was correct from a methodical and professional point of view, and if the athlete was trained in terms of physical, coordination, technical, tactical, mental and intellectual, so that when he reaches adulthood he can handle a high-intensity load and fulfill his sports talent.

The biological development of the young player

The graph below shows the future success possibilities of the young athlete. These possibilities are closely related to the type of training he underwent when he was a young athlete.

- **Option A**: Continued development and maximized competitive ability in adulthood.
- **Option B**: "Glass ceiling" stagnation and inability to fulfill competitive ability in adulthood.
- **Option C**: Deterioration or retirement at adulthood.

Enters the framework at age 6 ⟹ moderate development up to age 12
at age 12/13 up to 16 ⟹ accelerated development
after age 18 a transition to high competitive level with ability's exhaustion or stagnation to withdrawal.



From an article by Prof. Jelle Jolles (2021)

Sports training among children

- Every child is **curious, initiative and likes challenges**.
- A young brain is **hungry for stimulation, and needs sensory, social, emotional, cognitive and physical stimulation**.
- Child's self-regulation continues to develop throughout childhood and into adulthood, at a **different individual pace** from child to child.
- The young athlete must be given **time to discover his talents** (even a tree that grows slowly can grow to be the tallest of trees).
- The child's **inner motivation** must be strengthened.
- **At a young age the emphases should be on enjoying the sport and love for the sport**, not on achievements. **Until the age of 12, it is recommended not to choose a main sport**.
- **Children will always choose short-term goals**. They have no long-term vision
- At a young age it is important to offer the child a **wide variety of sports activities.**
- The duration of each developmental phase varies from child to child
- Even a child whose development is slow and whose achievements are mediocre, **can become a super athlete**! And the opposite is also true - a child who reaches impressive achievements at a young age will not necessarily become an elite athlete.
- It is better to **divide into groups according to ability and not age.**
- **It is not possible to determine the child's developmental phase through tests.**
- **There is no need to accurately analyze every movement and motor skill in the child**. This may create a negative effect because it is perceived by the child as non-constructive criticism
- While training children, **the child is the one in the center**, not the coach. The coach should see himself as a tool, designed to support the optimal development of the child
- The coach should see the **child/adolescent as a whole**, and consider all aspects of his personality and not just his athletic aspects.
- **Self-assessment and self-feedback** are keys to personal development.
- **Sports and competitions are good for the adolescent's social mind**, they prepare him in a healthy way for an adult social life. By participating in competitions, the teenager learns to appreciate his value.

Recommendations for optimal development of the young footballer:

1. To look at young children differently - **childhood is a period of chances and opportunities.**
2. During childhood, 4 developmental dimensions must be taken care of properly: **physical, cognitive, social and emotional.**
3. The young child should be encouraged to **build his performance ability.**
4. Work with the child on **self-regulation and self-knowledge.**
5. Work with him on **expression, thinking and drawing conclusions.**
6. Three **phases of puberty must be acknowledged: early, middle and late** phase. Each phase requires a different approach.
7. Take care of wide development of **skills and abilities.**
8. The coach should take on diverse roles in the child's life: **coach, supporter, manager, inspirer, mentor and advisor.**
9. **Schools must create conditions** for the development of **curiosity** in cooperation with parents.
10. The **role of the government is to enable the transfer of knowledge, a change of attitude and the creation of suitable conditions.**

An extensive chapter on the principles of youth scouting and training (children, male and female teenagers) will be presented in the following

Recommendations for loading and recovery by sport professions

Football - Lukasz Bortnik's recommendations

Max. no. of games per year		48-60
Frequency and distribution of competitions during the year		1-2 games a week; 4-8 games per month; Usually a busy playing period will occur in August and December
Optimal monitoring and control measures		Internal load (heart rate and RPE) and external load (tracking using GPS technology)
Required recovery actions for accelerated rehabilitation to regeneration and injuries prevention		Cold water immersion (CWI); contrast water treatment (CWT); cryotherapy; compression and cooling (trousers)
Required rest days (active and passive)	During the week	1-2
	during a period (6-8 weeks)	4-6
	during a large training cycle	6-8 rest days in a long training cycle (8 weeks) that usually occurs during the pre-season
	During the year	70 -75
Required duration of preparation period (without main competitions)	Deadlines and duration (days/weeks)	Usually 4-6 weeks
	Required emphases	General: moderate intensity aerobics - 1-3 weeks; Specific: high-intensity aerobics and speed endurance 2-3 weeks; Specific for a position on the field: speed, lactic/non-lactic strength and specific endurance - 2-3 weeks

Football - Dr. Georgios G. Ziogas recommendations

Max. no. of games per year		55-60
Distribution of competitions during the year		1-2 games a week during the season or a maximum of 6 games a month
Optimal monitoring and control measures		Checking internal and external load by the ACWR index on a weekly basis
Required recovery actions for accelerated rehabilitation, regeneration and injuries prevention		Massage, swimming pool, cold bath, eating after each practice/game, urine osmotic concentration test, nutritional supplements (if necessary), monitoring subjective fatigue, qualitative results of recovery, monitoring health status (sleep, pain, fatigue, etc.)
Required rest days or low-intensity training (active and passive)	During the week	2-3
	during a period of 6-8 weeks	12-18
	during a large training cycle	Two days a week for the entire training cycle
	During the year	In addition to written above, 24-30 rest days at the end of the season***
Required duration of preparation period (without official games)	Deadlines and duration (days/weeks)	5-6 weeks
	Deadlines and duration	Additional emphases on sport-specific strength/power/fitness weaknesses based on ergometric testing results
Other recommendations		1) Monitoring internal and external player loads daily and also at each periodic phase (weekly, monthly, etc). 2) Health report within 48 hours after a match and/or intensive training 3) ACWR 4) Testosterone/free cortisol ratio every month 5) Biochemical markers when necessary (e.g. RBC count, CPK, SGOT, etc.). 6) Psychological tests (stress, anxiety, etc.) monthly and individually

Basketball - Dr. Georgios G. Ziogas recommendations

Max. no. per year		75-80
Distribution of competitions during the year		1-2 games per week (Sunday-Saturday) during the season or a maximum of 6 games per month
Optimal monitoring and control measures		Checking internal and external load by the ACWR index on a weekly basis
Required recovery actions for accelerated rehabilitation, regeneration and injuries prevention		Massage, swimming pool, cold bath, eating after each practice/match, urine osmotic concentration test, taking nutritional supplements (if necessary), monitoring subjective fatigue, qualitative results of recovery, monitoring health status (sleep, pain, fatigue, etc.)
Required rest days (active and passive)	During the week	*2-3
	during a period (6-8 weeks)	12-18
	during a large training cycle	Two days a week for the entire training cycle
	During the year	In addition to what was said above, 28-36 days off at the end of the season***
Required duration of preparation period (without main competitions)	Deadlines and duration (days/weeks)	5-6 weeks
	Required emphases	Additional emphases on sport-specific strength/power/fitness weaknesses based on ergometric testing results
Other recommendations		1) Monitoring internal and external player loads daily and also at each periodic phase (weekly, monthly, etc). 2) Health report within 48 hours after a match and/or intensive training 3) ACWR 4) Testosterone/free cortisol ratio every month 5) Biochemical markers when necessary (e.g. RBC count, CPK, SGOT, etc.). 6) Psychological tests (stress, anxiety, etc.) monthly and individually

Volleyball - Grzegorz Rys recommendations

Max. no. games per year		10-25 international matches. 25-35 club matches.
Density and distribution of competitions during the year		IT games: tournaments, or away matches Club games: 2 rounds of home and away matches once a week + playoff round
Optimal monitoring and control measures		Game statistics, volleyball tests: height, jump, height range and others
Required recovery actions for accelerated rehabilitation, regeneration and prevent injuries		Depends on the mentality of the club or IT
Required rest days (active and passive)	During the week	IT matches: after the tournament. Club matches: day after the match
	during a period (6-8 weeks)	
	during a large training cycle	
	During the year	
Required duration of preparation period (without main competitions)	Deadlines and duration (days/weeks)	IT: 3-5 weeks before the qualification matches of the European Championship or the World Championship. Club season 6-8 weeks
	Required emphases	Fitness period: weights and endurance 3-5 weeks, technical and tactical preparations - full preparation period

Gymnastics - Prof. Yelena Oberdovich recommendations

	Artistic gymnastics	Rhythmic gymnastics
Max. no. of competitions during the year	6-8 (2 big competitions)	5-6
Frequency and distribution of competitions	6 months in two macrocycles per year, (competitions grouped in one month if only one macrocycle)	In two macrocycles per year, 6 months (competitions grouped in one month if only one macrocycle)
Monitoring & regulation for planning loads	Motoric and physiological testing before every mesocycle (every 2 month)	Motoric and physiological testing before every mesocycle (every 2 month)
Recovery and rebuilding actions	Hyperbaric therapy, sauna, swimming, jogging	Hyperbaric therapy, sauna, swimming, jogging
Rest	22 hours between training sessions (passive), 48-72 hours between same apparatus, 2 weeks between macrocycles (active)	22 hours between training sessions (passive), 48-72 hours between same apparatus, 2 weeks between macrocycles (passive)
Preparation	In first mesocycle: difficulty elements, strength and flexibility. In second mesocycle: routine, flexibility In third mesocycle: competitions and routine	In first mesocycle: difficulty elements, ballet and flexibility. In second mesocycle: routine, flexibility In third mesocycle: competitions and routine
High intensity training units	No high intensity training during the third mesocycle (competition)	No high intensity training during the third mesocycle (competition)
Intensive days & training camps	Training camp at the first mesocycle. 6 high intensity training sessions per week in second mesocycle.	Training camp at the first mesocycle. 6 high intensity training sessions per week in second mesocycle.

Marathon - Renaud Longuevre recommendations

Frequency and distribution of competitions	**From winter to spring or summer to autumn**
Monitoring & regulation for planning physical load	**Saliva test HRV**
Recovery and rebuilding actions	**Ice bath**
Rest	**2 days before competition + 1 day after**
Preparation	**4 months**
High intensity training units	**8 preparation weeks before each marathon**
Intensive days & training camps	**Training camp of 6 weeks / year**

Planning a marathon - Dr. Yitsik Ben-Melech

Recommendations on conduct in two years before the marathon competition - threshold requirements

- ❑ At least 3-4 half-marathon runs (similar distances)
- ❑ At least 12-15 competitive 5000-15000 km runs
- ❑ Total runs for distances of at least 6000-7000 km
- ❑ Performing systematic and continuous training 12 weeks before the competition
- ❑ No particular health problems in 12-16 weeks before the competition

Weekly training plan for a marathon competition and its emphases

- ❑ At least one rest day every week
- ❑ Training unit at least every 48 hours
- ❑ At least 70-80 km of running per week
- ❑ 30% of training must be at very slow pace
- ❑ 30% of training must be at high intensity
- ❑ Performing muscle endurance exercises (abdomen, arms, legs, torso) at least 2-3 times a week

100 meter run - Renaud Longuevre recommendations

Max. no. of competitions during the year	25
Frequency and distribution of competitions	Winter – 8 competitions of 60m Summer – 17 competitions of 100m
Monitoring & regulation for planning loads	Saliva test HRV
Recovery and rebuilding actions	Ice bath
Rest	2 days before competition and 1 day after
Preparation	4 months
High intensity training units	30 units or specific training
Intensive days & training camps	Training camp of 12 weeks/year

400 and 800 meters - Renaud Longuevre recommendations

Max. no. of competitions during the year	20
Frequency and distribution of competitions	4 in the winter 16 in the summer
Monitoring & regulation for planning loads	Saliva test HRV
Recovery and rebuilding actions	Ice bath
Rest	2 days before competition and 1 day after
Preparation	4 months
High intensity training units	20 units or specific training
Intensive days & training camps	Training camp 12 weeks/year

1500 and 5000 meters - Renaud Longuevre recommendations

Max. no. of competitions during the year	14
Frequency and distribution of competitions	4 in the winter 10 in the summer
Monitoring & regulation for planning loads	Saliva test HRV
Recovery and rebuilding actions	Ice bath
Rest	2 days before competition and 1 day after
Preparation	4 months
High intensity training units	20 units or specific training
Intensive days & training camps	Training camp 16 weeks/year

Long jump - Renaud Longuevre recommendations

Max. no. of competitions during the year	25
Frequency and distribution of competitions	10 in the winter 15 in the summer
Monitoring & regulation for planning loads	Saliva test Heart rate Variability
Recovery and rebuilding actions	Ice bath
Rest	2 days before competition and 1 day after
Preparation	4 months
High intensity training units	30 units or specific training
Intensive days & training camps	Training camp 12 weeks/year

High jump - Renaud Longuevre recommendations

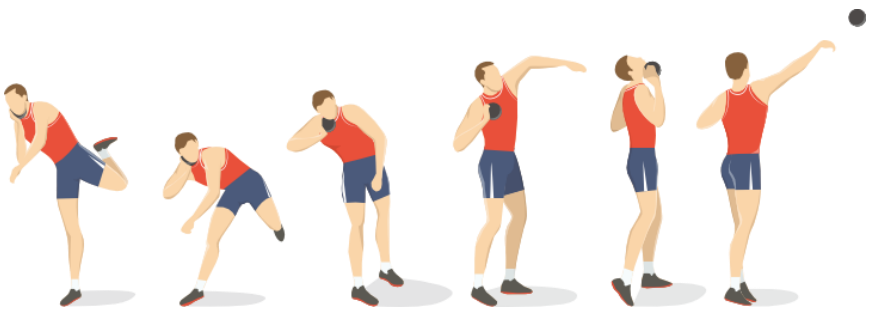
Max. no. of competitions during the year	18
Frequency and distribution of competitions	6 in the winter 12 in the summer
Monitoring & regulation for planning loads	Saliva test HRV
Recovery and rebuilding actions	Ice bath
Rest	2 days before competition and 1 day after
Preparation	4 months
High intensity training units	30 units or specific training
Intensive days & training camps	Training camp 12 weeks/year

Pole vault - Renaud Longuevre recommendations

Max. no. of competitions during the year	30
Frequency and distribution of competitions	12 in the winter 18 in the summer
Monitoring & regulation for planning loads	Saliva test HRV
Recovery and rebuilding actions	Ice bath
Rest	2 days before competition and 1 day after
Preparation	4 months
High intensity training units	50 units or specific training
Intensive days & training camps	Training camp 12 weeks/year

Shotput - Renaud Longuevre recommendations

Max. no. of competitions during the year	25
Frequency and distribution of competitions	10 in the winter 15 in the summer
Monitoring & regulation for planning loads	Saliva test HRV
Recovery and rebuilding actions	Ice bath
Rest	2 days before competition + 1 day after
Preparation	4 months
High intensity training units	50 units or specific training
Intensive days & training camps	Training camp 12 weeks/year



Non-Olympic branches and professions - recommendations of Dr. Yitsik Ben-Melech and several coaching staff

The Sport profession	Dancing Sport	Kickboxing	Thai Boxing	Jiu-Jitsu	Water Skiing	La Crosse	Football
Optimal age of athletes reaching their peak	29-32 (Women 28-30)	26–27 (women 28)	27–29 (women 28)	27-30	26-28	30-32	30-32
Recommended number of competitions per year	30-40	10–12 (35–45 fights)	10–18 (35–45 battles)	10–18 (35–45 battles)	8-10	2–3 tournaments 25–30 games	2–3 tournaments 25–30 games
Recommended international competitions (out of competitions)	20	5-6	5-6	5-6	4-5	2–3 tournaments 10–12 games	2–3 tournaments 10–12 games
World Championship or European Championship competitions (out of international competitions)	1-2	1-2	1-2	1-2	1-2	Tournament 1 3–5 games	Tournament 1 3–5 games
Date of the last international competition before World Games	21 days	6 weeks	6 weeks	6 weeks	6–8 weeks	3–4 weeks	5–6 weeks
Date of last fights or last competition before World Games	7–10 days	14–20 days	14–20 days	3 weeks	3 weeks	2–3 weeks	2–3 weeks
Number of training camp days per year	45	30	30	30	20		

Sport profession	Dancing sport	Kickboxing	Thai boxing	Jiu-Jitsu	Water Skiing
Date of last training camp before World Championship games	Up to 10 days before the event	18–20 days	21 days	10 days	10 days
Number of training sessions per week	12 (28–30 hours)	10 (15–18 hours)	10 (15–18 hours)	10 (15–18 hours)	8-10
Required emphases	Technique	Power, technique and tactics	Technique and strength	Combined battle force	Technique, physical fitness
Date of last or decisive competition before the World Championship games	7–8 months	5–6 months	5–6 months	10 months	10 months

Martial arts: judo, sambo, jiu-jitsu - Dr. Yitsik Ben-Melech's recommendations

An optimal training program for an athlete in the competitive sport in these branches is a condition for his success throughout the year. However, another condition is that in the year prior to applying the training program, the athlete performed at least 80% of the recommendations below.

Recommendations before a major international event of martial arts

- Conduct a **significant competition** 4-6 weeks before the event.
- Conduct a **simulation competition** 1-3 weeks before the event.
- Conduct a high-intensity **training camp** (with the participation of a training opponent), which will last 3-6 days, and will be held up to 20 days before the event.
- Hold a **preparation period** (work on physical fitness and general work) that will last 3-5 weeks, and will be held up to 10-12 weeks before the event.
- A **break period** (active or passive) that will last 1-3 weeks and will be held after a previous main event and 15-18 weeks before the international event.

Number of fights in the competition	World/European Championships	Major international tournaments	International preparatory competitions	National competitions	Concentrated training - battles	High intensity training camp days
35-45	1-2	4-5	3-4	6-8	60-100	30

Endurance professions - Gunter Lange's recommendations

	Endurance	Endurance for long distances	Endurance Marathon
Max. no. of games per year	3–4 cycles of competition; In each cycle 4-6 competitions: 2 preparatory or warm-up competitions, semi-final and final competitions.	3-4	2
Frequency & distribution of competitions over the year	Determining the frequency of competitions and their distribution depends on these factors: a) General endurance level at the end of the competition cycle, which is usually low b) Duration of individual adaptation / Mesocycle for strengthening general endurance (e.g. altitude training - to increase blood volume, increase hemoglobin and repair mitochondria). This is to meet the requirements of the unique event that tests general endurance before the competition or before the next cycle. It is possible to hold a competition or meso cycle every 3-4 months (except for the 42195-meter marathon). Note: The meso cycle to strengthen general endurance (aerobic) should be performed at a high altitude (2300 meters), and without lactic anaerobic load. One should train not at the pace of a competition and without fast runs, in order to minimize the damage caused to the mitochondrial membranes as a result of unnecessary metabolic acidosis that may occur at low, medium or high levels.		
Optimal means of monitoring & regulation	Monitoring endurance training (Prof. U. Hartmann, Ulrich 2020) a) Daily ○ Training documentation ✓ Training means, V/I/R; Amount / intensity ○ Hearth rate recording ✓ Nightly hearth rate (60s) ✓ Morning heart rate (beat to beat) ○ Profile of mood status ✓ Scale of NITSCH/UDRIS 1976 b) Twice a week ○ Capillary Blood ✓ Creatine kinase ✓ Urea ✓ Hematocrit c) Every 4-6 weeks ○ Performance Test ✓ Submaximal graded exercise test (treadmill, bicycle, rowing ergometry) ○ Venous Blood ✓ Hormones 1. Testosterone 2. Cortisol		

<table>
<tr><td colspan="2"></td><td></td></tr>
<tr><td colspan="2"></td><td>Regulation of endurance training

• Adaptation / Load duration in micro cycle (MC)
○ General phase MC lasting 9 days
○ Specific phase MC lasting 6 days
Reducing the length of the MC from 9 to 6 days while increasing the load (from general to specific phase) allows increased recovery (by 50%)
• Increase the Ratio of active recovery to passive recovery
• Maximize the body own natural (no doping) production of testosterone by improved quantity and quality of sleep
• Reduce Injuries by reducing the structural load (main cause for injuries among runners (e.g. shin splint)
• Ways to reduce structural load:
○ Semi specific training (ski/long distance roller skating; Deep Water Running
○ Providing specific surface for training (e.g. 3 KM jogging on synthetic surface in NHATC 2555m Teryet Uganda)
○ Regular control and replacement of worn out training shoes</td></tr>
<tr><td colspan="2">Recovery actions needed for rapid regeneration, muscle buildup and preventing injuries</td><td>See above</td></tr>
<tr><td rowspan="4">Required preparation period (without main competitions)</td><td>During micro cycle consisting 9+6 days</td><td>One day per micro cycle
<u>Note:</u>
Recently, world-class marathon runners have improved their performance because they converted their day off, which is intended for passive rest, into a two-hour Long Slow Distance run (LSD).</td></tr>
<tr><td>During meso cycle (3/6)

(6/9 days each one)</td><td>Dynamic amplification of load reduction when load is increased

For example: volume during a meso cycle

Loading 4 micro cycles: MC regeneration / load reduction
to 3:1; to 2:1; to 1:1.</td></tr>
<tr><td>During training phase</td><td>The transition from general phase in training to phase causes a peak in the amount of injuries.
To reduce the amount of injuries, these steps should be taken:
a) <u>Planning changes in biomechanics to reduce the structural load.</u>
for example, in general phase, it is also recommended to use competition shoes, and not only running shoes.
For road running, it is recommended to use carbon shoes.
For running on synthetic track, use spikes shoes.
b) <u>Maintaining a high level of these skills:</u>
1. General conditioning. For example, stabilizing the pelvis efficiently to achieve a back stride and reduced structural load (lumbar 3/4).
2. Technique.
For example, neuromuscular training for maximal strength (NMS) using:
- Jumping.
- Brief ground contact.
- Δ Strength.</td></tr>
<tr><td></td><td>In elite long-distance competitions there is no longer a classical periodization, but rather a sequence of endurance training in a meso cycle performed at high</td></tr>
</table>

	During the year	altitude, with a competition block (see level). The transition phase between training and competition is short - 2-3 weeks, and active.
Required preparation period (no main competitions)	Duration (days/weeks)	Duration of the preparation period (6) - 9 weeks to 6 months (marathon) The duration of the period depends on these factors: a) Difference (m/s) between the overall level of aerobics at the end of the competition block and between the level of the level before the competition. And also, in the specific requirement of: - a specific standard of the event/individual (speed or endurance athlete) to be achieved at the end of the endurance's meso cycle. b) The personal training ability and adaptability of the athlete, in other words the talent of the athlete. c) Training conditions For example: Altitude (living and training at high altitude)
	Emphases	General: The period consists of two parts: - Endurance - Preparation The technical model helps to develop speed, by optimizing the running steps in these ways: a) Transitioning from an easy jog to a flat sprint b) Neurological variability, for example the ability to suddenly change the pace of running, for example: finishing the marathon race. c) Semi-specific training or technical model d) Strength training / specificity / TRX Mental preparation Introduction to a new technique to optimize the level of stimulation for the athletes and the coach, for example, the Jacobson technique.
Other recommendations	**Less Can Be More** General endurance development takes a long time. For example, it is possible to measure a mitochondrial improvement that is reflected in a considerable adaptation, only after 21-28 days of general endurance training at a moderate pace. On the other hand, the contribution of the anaerobic lactic system in endurance events (marathon 800 meters) is already evident in a load of 2-3 training sessions or competitions at the pace of a race. Maintaining a higher aerobic capacity during the competition block period by taking the following steps: a) Running at a pace that will not cause a buildup of "acidic load" b) Lactic "tolerance" is wishful thinking / myth of the coaches c) d) 2-3 training sessions only at "race pace" or buildup competition. It must be remembered that competition is the best training. e) Reducing the amount of competitions will contribute in three important aspects: 1. Length of the competition block (3 weeks) 2. Improving competition performance in endurance events. 3. Recovery between competitions, especially between the MD Heat, semi-finals and finals.	

Table of recommendations according to sports profession (for professional and well-trained athletes)
Summary of the recommendations presented by the experts

Sports	Number of games/competitions per year	Required rest				Required preparation period	Comments
		Weekly	Every 6–8 weeks	in large cycle	Yearly		
Football	60–55	One Day	4-6 days of relaxation	7–10 days of rest	2.5-3.5 weeks	4–6 weeks	close monitoring and control; Up to 5 games in 4 weeks
Basketball	80–75	One Day	4-6 days of relaxation	8–10 days of rest	2.5–3.5 weeks	4–6 weeks	up to 2 games per week; Up to 6 games in 4 weeks
Volleyball	50	One Day	4-6 days of relaxation	7–8 days of rest	2.5–3.5 weeks	3–5 weeks	30-35 games within the club; 15-20 games as part of the national team
Gymnastics	8–6 international + 6–10 domestic	One Day	4-6 days of relaxation	5-7 days of rest	2–3 weeks	12–15 weeks	

Sport Profession	Number of games/competitions per year	Required rest				Required preparation period	Comments
		Weekly	Every 6–8 weeks	in large cycle	Yearly		
Medium runs	10-15	One Day	5-6 days of relaxation	7–10 days of rest	2–3 weeks	12–18 weeks	
Long runs	3-4	One Day	5-6 days of relaxation	7–10 days of rest	2–3 weeks	18–22 weeks	
Marathon	2	One Day	5-6 days of relaxation	7–10 days of rest	2.5–3.5 weeks	20–24 weeks	
Technical subjects in athletics	20-25	One Day	5-6 days of relaxation	8–12 days of rest	3–3.5 weeks	12–16 weeks	
Combat professions	8–12 (of which 6–7 are international competitions)	One Day	6-8 days of relaxation	10–15 days of rest	3–4 weeks	12–18 weeks	

Chapter five - Articles

Work load management and performance system in top basketball

Associate professor Ph. D. Nenad Trunic (Faculty of Physical Education and Management in Sport, University Singidunum, Belgrade, assistant caoch of Serbian Basketball Senior Men's National Team)

Professor Vladimir Banković (S&C coach of Serbian Wolleyball Senior Women's National team)

Introduction

There are significant differences between worst scenarios in game and average demand. This leads injuries (muscle injuries mostly in case of professionals). We need to individualize the training programs with new technology, because we can measure all the loads, even rehab processes, so we know when a player is ready to come back.

Travel, management, family issues, financial and social issues influence the preparation. As often players spend more time with the coach than with their parents, therefore coaches should not focus only on technical and tactical knowledge. It is a great responsibility to give rules to the players. Being a coach is a mission.

In top-level basketball, probably the biggest challenge is to find balance between individual and team needs. First move is to define players' profiles: health status, gender and age, body size and constitution, physical ability of basketball players, training and learning ability, capability for recovery, lifestyle and welfare, mindset, skill profile and etc.

Because of high density of practice and games as well as travel time (distance) in top-level basketball become almost impossible to work on individual skills improvement. During team practice there is no time to work individually, we need to do it before or after practice for discuss, share, understand individual needs.

High-performance system in top basketball has to be structured. How we organize the structure is the key to success. This is the reason why "*personal jacket*" has to be established. It starts with testing and measurement. Sport science approaches the average, which doesn't help most of the time. Regression to the mean is a problem with scientific data collection.

Using and making questions we can understand individual needs better. Always need to ask our players about their feeling, about the session, the load. We need to gather feed-backs. Decentralized testing means that the environment influences the validity of the extracted data. It's important to examine players in their home environment.

Personal program design for every single player requires additional time. This interdisciplinary approach gives result in 360°.

Design a personal matrix helps to have a holistic picture what happens with the player. It means collecting data from his/her performance analysis, health, strength and conditioning, mental training, nutrition, recovery and lifestyle.

Specific micro-dosing training can be introduced, sessions of 15-30 minutes early in the morning in case of poor facility condition of the gym. It is also possible to connect two trainings and work-out for 2.5 hours. Other possibility is to train out of the court. The main task is to maintain homeostasis, stabile state of player. Holistic approach and holistic decision making makes the difference.

Intellectual load and emotional load are a huge part of the monitoring process. We tend to think only the physical efforts and forget about the personal/emotional component.
In the process of basketball coaching, three relevant aspects are:

1. Prepare and protect the body,
2. Provoke and stabilize the mind and,
3. Learn and improve the movement.

As a team is made of individuals, remember first to be a player development coach. Secondly, without discipline, we can't teach anything to our players. The "one size fits all" model never works in none of the sports.

1. Work load management

Better workload management – a key to better performances and less injuries

Sport injuries are becoming a problem of epidemic proportions. In the U.S. alone, 1.5 million high school and college athletes are injured every year. The cause of overtraining and injuries is multifactorial, but recent research has identified poor workload management as a major contributor to injuries and illnesses in sport. In this paper we will present evidence-based workload management guidelines and strategies to reduce the risk of illness and injury in basketball players, while also optimizing performance.

The key concepts should be based on fundamental knowledge about:

Load; load is the combination of sport and non-sport stressors. Load is more than workload or training, load alone and also includes competition, work, recreational activities, family, homework, etc. Load can be divided in two sub-categories: external load and internal load.

External load; external load is the external stimulus applied to the athlete. It is the objectively measurable sport and non-sport physical work (number of sprints, weight lifted, total distance, etc.) performed during competition, training and daily life. External load is usually measured using global position system (GPS) devices, chronometers, accelerometers, dynamometers, etc.

Internal load; internal load is the individual physiological and psychological response to external loads, combined with daily life stressors and other environmental and biological factors. It includes objective measures such as heart rate and blood lactate concentration, as well as subjective measurements, such as perceived effort (i.e., ratings of perceived exertion).

Internal Load vs External Load; while external load provides information about the work completed and the performance capacities of the athlete, internal load is the trigger of training-induced adaptations. The constant monitoring of internal load can help identify recovery needs, predict performance decrements, anticipate health issues and adjust training, and competition programs. It's a cornerstone of an effective workload management program.

Term	Definition
Load / Workload	Combination of sport and non-sport stressors
External load	External stimulus applied to the athlete
Internal load	Physiological and psychological response to external loads, combined with non-sport stressors

Figure 1. Load definition

1.2. The measurement of Internal Load

A simple, effective and validated method of measuring internal load is to use the session-rating of perceived exertion (RPE) scale developed by U.S. sport scientist Dr. Carl Foster. This technique requires the athlete to rate each session's overall difficulty (sRPE) on a 10-point scale. The multiplication of the session difficulty by the session duration (in minutes) provides the "Load" for that session in arbitrary units (Load=RPE x Duration in minutes). This method doesn't require equipment and has been validated for monitoring internal loads in most sports, training and competition activities.

Rating	Descriptor
0	Rest
1	Very, very easy
2	Easy
3	Moderate
4	Somewhat Hard
5	Hard
6	*
7	Very Hard
8	*
9	*
10	Maximal

Figure 2. Foster's modified RPE Scale used to rate the difficulty of sessions

The original calculations used by the sRPE method:

1. Session load = session RPE x duration (minutes)
2. Daily load =Sum of all Session Training load for the entire day
3. Weekly Training load =Sum of all Daily Training load for the entire week
4. Monotony= standard deviation of Weekly Training load
5. Strain= Daily or Weekly Training load x Monotony

sRPE vs Heart Rate Monitoring

Heart rate (HR) monitoring is frequently used to estimate internal load. This method is based on the linear relationship between HR and the rate of oxygen consumption during steady-state exercise, and requires the use of a heart rate monitor.

While being scientific sound, HR monitoring has two important limitations:

1. HR monitoring underestimates internal load during short-duration high-intensity/anaerobic activities (sprints, strength training, etc.), thereby limiting its effectiveness to aerobic activities.
2. Rest, submaximal and maximal exercise HR fluctuate daily (by up to 6.5 % for submaximal HR). Without a regular calibration of individual HR training zones, HR-derived internal load calculations will likely be inaccurate.

While heart rate monitoring can provide an additional physiological insight for sessions or events of aerobic nature, it cannot be effectively used to quantify internal load during all the activities performed by athletes during training and competition. The sRPE method is simpler and provides an accurate quantification of internal load that can be applied to a much broader range of sports, as well as training and competition activities.

Inadequate workload is a leading cause of injuries

Excessive fatigue plays a key role in injuries as it impairs decision-making ability, coordination and neuromuscular control. The risk of injury increases when the external load exceeds the capacity of the athlete. For example, in professional ice-hockey, player's average playing time per game is a significant predictor of concussion and in soccer, central fatigue contributes directly to anterior cruciate ligament (ACL) injuries.

The risk of injury increases when: 1) high loads are applied to athletes who are psychologically and/or physically unfit to tolerate the prescribed workload (undertrained), or; 2) when athletes are fit and well trained, but in need of rest. In both cases, workload exceeds the athlete capacity, leading to excessive fatigue and increased risk of injury.

The role of workload management is to reduce the risk of injury and optimize performance by detecting excessive fatigue, identify its causes, and constantly adapting rest, recovery, training and competition loads, based on the athletes' individual fatigue (physical and psychological), wellness, fitness, health and recovery levels.

How to find the "optimal" workload

The "optimal" workload is a moving target. It differs for every athlete and changes constantly based on multiple factors, including phase of season, training status, fitness and fatigue levels, sleep quality, non-sport stressors, etc. Finding the optimal workload and constantly adapting training programs to the changing capacity of each athlete is both an art and a science. It is a continuous process that usually requires the daily monitoring of internal load, at least a measure of external load (often duration or distance), the tracking of wellness metrics and the use of these measures to adjust the athlete's training program, recovery and rest.

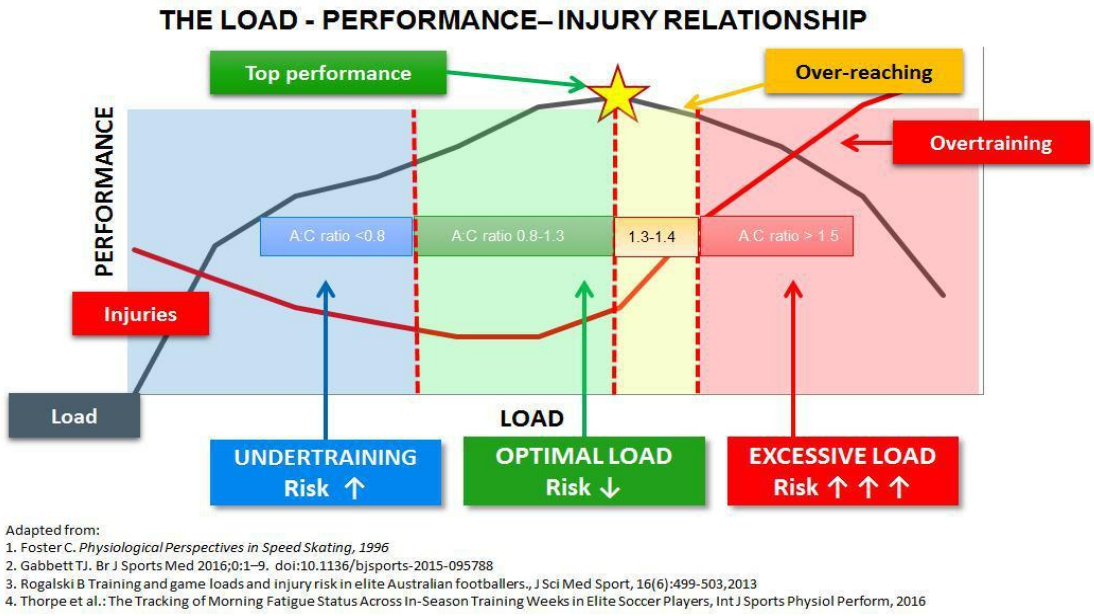


Figure 3. The Load-Performance-Injury Relationship

1.3. The tools of effective workload management

An effective workload management program can be implemented with two simple tools:

1. **A relation of trust and open communication between players, coaches and training staff**. Because self-reported information is used extensively to quantify internal load and pre training readiness, for your monitoring program to work, players need to report their data and feedback as honestly as possible.
2. **A robust workload management software.** To maximize athletes "buy-in", the software should be able to: 1) quickly collect quality and meaningful data from the athlete with minimal effort; 2) monitor wellness, internal and external load metrics;

Effective workload management's main focus is on monitoring internal load, detecting excessive fatigue and identifying external stressors.

While many professional teams have access to expensive tracking technology (GPS, video tracking, etc.), this is not a necessity for a successful athlete monitoring system. Tracking devices are useful for monitoring external load, but can't provide information on internal load. As a result, expensive equipment is not required to keep athletes performing well and injury free. Despite decades of scientific research and empirical experience, no single marker of elevated risk of injury or overtraining has been identified. Today, a multifaceted approach to workload and recovery management is considered best practice. This approach includes the collection and analysis of both subjective and objective measures, and the careful monitoring and optimization of the key metrics below.

Chronic Load (CL); This is the average weekly load (Load=duration x RPE), typically over the previous 4 weeks. Usually, the higher the *Chronic Load*, the fitter the athlete. In some situations, chronic load can also be calculated using exponentially weighted moving averages, and for periods longer than 4 weeks.

Acute Load (AL); The *Acute Load* represents the cumulative load of the current week. Usually, the higher the acute load (compared to chronic load), the more tired the athlete. In some situations, AL can also be calculated using shorter periods (eg: 3 days).

Freshness Index (FI); Similar to the *Training stress balance* proposed by Andrew Coogan, the Freshness index represents the difference between chronic and acute load (CL-AL) or between 'fitness' and 'fatigue'. A positive Freshness Index indicates an unloading phase where low fatigue and good performance levels are to be expected.

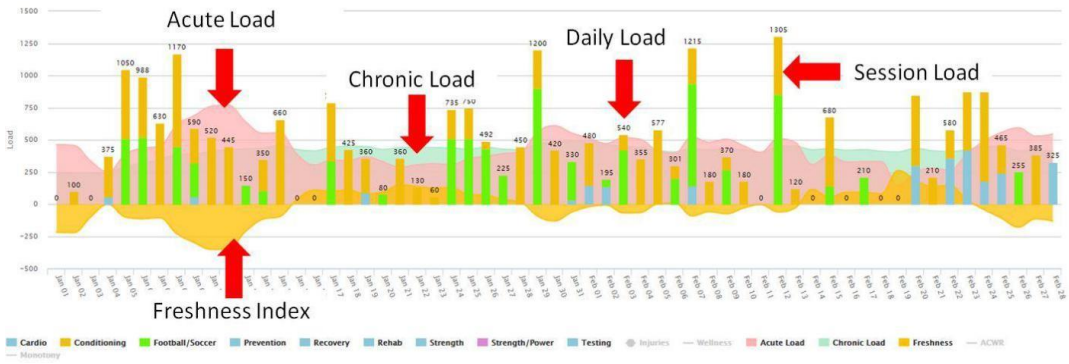


Figure 4. Graphical visualization of 3 months of acute, chronic, daily, session loads and freshness index by the AthleteMonitoring.com system

Monotony; The *Monotony* Index proposed by Carl Foster measures the fluctuation of daily loads within the week. Intensive training combined with a high Monotony Index (>2) is an important risk factor for illness and overtraining[3].

Strain; Early work by Foster demonstrated that 89% of illnesses and injuries could be explained by spikes in individual *Strain* in the 10 days preceding the incident. Thus, monitoring the *Strain* variable can be a valuable tool to control individual adaptation to training load, and prevent workload-related illness and overtraining.

Acute:Chronic Workload Ratio (ACWR)

The Acute:Chronic Workload Ratio (ACWR) measures the relationship between acute load (current week load) and chronic load (last 4-weeks average load). Monitoring ACWR helps to keep player's workload in the 'high-load, low-risk zone' (0.8-1.3). When ACWR is too low (less than 0.8) or too high (1.5 or more), risk increases and workload may be adjusted.

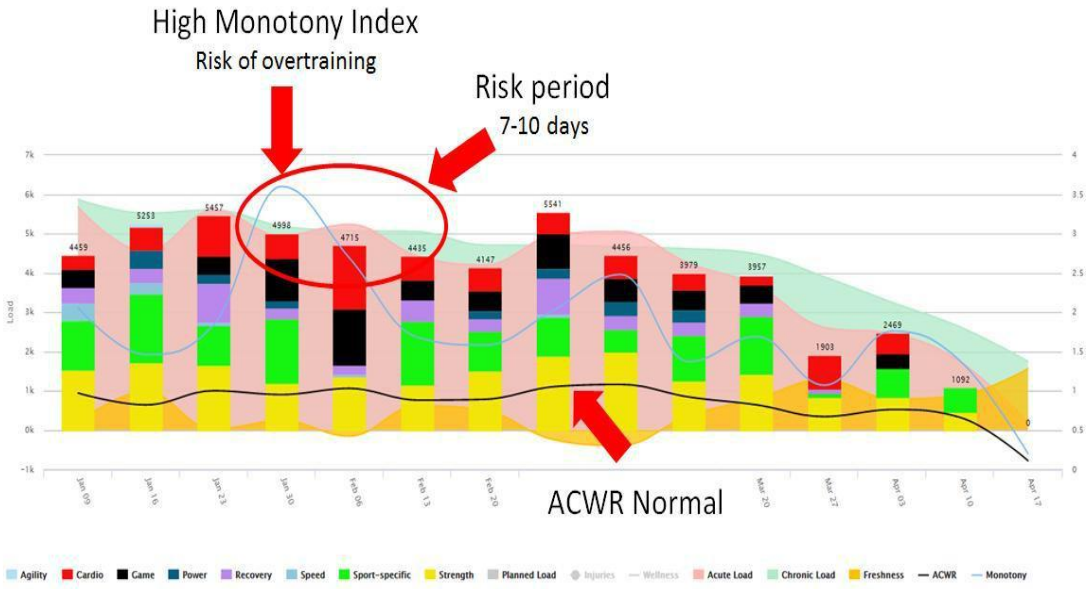


Figure 5. A peak in monotony can increase the risk of overtraining during 7-10 days, even if ACWR is in the optimal range

Week-to-Week Load Increase; This represents the percentage of load increase from one week to the next. It's a major injury risk factor as studies have shown that a large percentage of injuries are associated with rapid change or spikes in weekly loads. When load increases by ≥15 % from the preceding week, the risk of injury increases by up to almost 50 %. Monitoring week-to-week changes in load helps detect spikes in load and plays a crucial role in injury prevention

Weekly training hours; Recent research conducted by Neeru Jayanthi, an expert on youth sports injuries, indicates that when young athletes train/compete more hours per week than their age (e.g.: when 12 years old train/compete 18h/week), the risk of overuse injury can increase by up to 70 %.

Using an athlete's age to guide the weekly training and competition volume is a simple and effective approach that can help maximize performance while promoting effective and injury-free athletic development.

Self-reported Wellness; Asking athletes to complete a self-reported wellness questionnaire is a reliable and accurate method to identify athletes' readiness to train, and to measure the impact of non-sport stressors on the recovery process. Poor wellness scores indicate potential psychological or physical under-recovery and may lead to adjustments to the training or competition program. Self-reported wellness questionnaires are key injury

prevention tools, and should be used to guide the adaptation of training and competition loads.

Personal feedback; Personal oral/written feedback from athlete can help identify potential motivation/fatigue/training issues. This is crucial information often overlooked by busy coaches. When an athlete reports negative feedback, it must be taken very seriously as it could lead to motivational problems and larger underlying issues.

Enjoyment with training; Enjoyment with training and competition activities should be carefully monitored and maximized for two main reasons: 1) Enjoyment is an important determinant of intrinsic motivation, which directly predicts effort and persistence and; 2) A lack of enjoyment is associated with staleness and burnout. To maximize athlete engagement, motivation and performance, coaches are encouraged to created environments that allow athletes to have an enjoyable sport experience.

Other useful measures; When adequate equipment is available, additional daily tests of neuromuscular fatigue and recovery, such as Counter Movement Jump (CMJ), and musculoskeletal tests can provide useful information about neuromuscular recovery and/or injury. Results in these tests allow coaches to manage athletes on an individual basis, based upon their training and recovery status.

Managing workload and optimizing athlete performance while promoting injury-free participation is relatively simple. To ensure athletes optimize performance and minimize injury risk:

1. Start with the right tools,
2. Monitor the key metrics,
3. Increase weekly loads very progressively,
4. Avoid spikes in load,
5. Alternate hard, moderate and easy training days,
6. Use athlete's wellness data to guide daily load adjustments,
7. Proactively manage training and competition loads during stressful periods and,
8. Make sure athletes have an enjoyable sport experience.

2. Performance system in top basketball

Elite performance in team sports attracts attention from the general public. In particular, the best players became incredibly skilled and physically powerful that potentiates the delivery of a product that is considered attractive, exciting, and competitive. Not surprisingly, this is a very valuable product from an economic and social standpoint; thus, all sports professionals are extremely interested in developing new procedures to

improve their sports performance. In this sense, sport sciences greatly help to improve athletic performance. This is particularly noticeable in a of major changes in the regular training and competition regime, such as that which occurred during the coronavirus disease 2019 (COVID-19) pandemic.

An elite player in team sports has a large number of characteristics that are in synergy with each other. The optimal levels of development of individual characteristics, as well as their mutual harmonization, are achieved by an integrated and personalized system of sports preparation. The basic task of sports preparation is to enable players and teams to achieve the best sports performance in their competition. Elite sports achievements are reached through the long-term, systematic, and hard work of a large number of people who service athletes. Sports coaches, strength and conditioning coaches, psychologists, medical doctors, physiotherapists, nutritionists, and sports analysts form multidisciplinary teams that base their work on interdisciplinary synchronization. All these experts give give their coordinated contribution to better optimize the sports teams' system, as well as to the quality performance of each individual. The head coach, together with team manager and sports director, select the players, assigns them roles and responsibilities, determines rules of conduct and action, and coordinates the professional staff members.

Structure and inter-relationships of the main stakeholders in basketball club:

- Talent-players
- Know how-Performance staff
- Conditions - Sport management

2.1. Individual characteristics of the player

The individual characteristics of the players need to be identified multidimensionally, but in an integrated way. In this sense, sports performance arises as a result of the integrative procedures of the competition, training, and recovery of an athlete through their sports development cycle (career). In order to embark on a synergistic process of integrating all the athlete characteristics, it is important to understand which character- integrating all the athlete characteristics,

Health; The fundamental value of human life is health. In elite sports, health is mainly observed through the availability of players for training and competition. An absence of served through the availability of players due to injuries or disease seriously affects competitive results. Availability is players due to injuries or disease seriously affects competitive results. Furthermore, it is very important to take care muscles, bones, tendons, fascias, and joints of the player's immunity and respiratory and metabolic health. High levels of competitive stress, depression, demanding continuous travel fatigue, and significant exhaustion compromise a player's immune system, which can lead to a variety of diseases. In this way, mental health must be considered.

Due to all of the above, it is necessary to create a health profile of each player, which contains:

- A history of injuries and illnesses;
- Locomotor deficits;
- Immune and metabolic deficits;
- Personalized protocols/guidelines to minimize injury risk;

- Medical interventions;
- Surgical and conservative treatments;
- Rehabilitation processes.

Every team sport has its typical health threats; therefore, it is important to take into account information about the frequency, risks, and mechanisms of injury and disease in a particular sport.

Age and Gender; Age and gender are given and (mostly) unchanging characteristics of athletes. Nevertheless, respect for age characteristics and gender specificities can to a large extent make the process of sports preparation safer and more efficient. For example, common injuries in females (e.g., female triad). When registering and monitoring the age of athletes, it is important to establish the following:

- Chronological age;
- Biological age (especially in young athletes);
- Metabolic age;
- Sports age (years spent in organized sport).

It is also important to link health, training, and competition events in an athlete's previous career with the current situation. The sporting longevity of elite athletes is strongly related to current habits, behaviors, and the social environment, but also to previous experiences and events throughout a sports career. We are witnessing that sports careers are lasting longer (up to 35–40 years), probably due to the improved system of personalized preparation and the behaviors of athletes based on epigenetic pathways.

Information on the age and gender of athletes is respected and used by all members of the professional team to organize personalized training and medical, nutritional, and psychological care.

Fitness; An adequate fitness profile is a key contribution to the optimal expression of sports skills. In fact, players with solid athleticism have a much wider spectrum of possibilities to develop and fine-tune their technical and tactical skills available to them. Furthermore, well-trained athletes are less prone to injuries and recover much quicker after intense training and competitive loads, thereby likely being available to play a lot of matches throughout the season. In the fitness profiling of players, it is important to recognize the following:

- Mobility and stability of the locomotor system;
- Synergy/balance of agonist/antagonist muscles and muscle chains;
- Energy systems;
- Neuromuscular abilities;
- Sports discipline;

Based on the profile and identified deficits, preventive–corrective, energy, and neuro-muscular programs can be created to overcome the identified needs.

All capacities need to be optimized, but not necessarily maximized, as fitness qualities are a function of sporting skills. Therefore, it is important to align fitness programs with the

player's health status, age, gender, training history and culture, sports characteristics and position in the game, and the current level of training.

The fitness training of players is planned, programmed, and carried out by fitness strength and conditioning specialists, but also in part by sports coaches, kinesiotherapists, osteopaths, and physiotherapists. Different tools should be used to quantify these factors using standard tests.

Body Shape; The shape and structure of the player's body should be in line with the needs and requirements of the basketball and with the individual athlete's needs. This applies in particular to the following:

- The size of the body and its parts;
- Relative proportions between body parts;
- Body composition: muscles, subcutaneous fat, and bones; internal muscle structure (the types of muscle fibers and muscle architecture); individual somatotype.

The shape and structure of a player's body can be changed by training, diet, and external stimuli. Depending on the goal, training and nutrition programs are created that are aimed at optimizing the shape and structure of the body in accordance with the requirements of the sport and the individual characteristics of the players. Strength and conditioning coaches and nutritionists take care of the shape and structure of the body.

Trainability and Learnability; The same training program can result in different responses from different players. The ability of an athlete to learn different movement structures and to apply them in training and competitive situations is called learnability. The player's technical and tactical performance depends on this ability. On the other hand, the enhancement of a player's abilities (both energetic and neuromuscular) based on applied training programs is called trainability. Different players need a different combination of content and load for the same or targeted performance. The player's physical development and form depend on this ability. These two abilities are essential for the work of primarily sports coaches and strength and conditioning coaches, based on standard tests.

Sports History and Culture; In order to be able to draw conclusions about an athlete's current condition that are reached using diagnostic procedures, it is important to know the following:

What kind of sports environment and culture the player comes from?

What training process has the player gone through during their career so far?

What kind of training processes has the player had in the last few months?

What is the competitive history of the player?

Previous personal experiences from different environments and cultures.

The information obtained from the sports profiles of athletes serves as a prerequisite for designing individual and team sports preparation programs, which are prepared and implemented by sports and strength and conditioning coaches.

Recovery; Player tolerance to different types of fatigue during and after exercise and the ability to recover within and after exercise are the bases for creating a recovery profile. The recovery profile includes the following:

- Individual tolerance to different types of fatigue;
- Dynamics of recovery during training and competition;
- Dynamics of recovery after training and competition;
- The most appropriate means and methods of recovery during and after training
- and competition;
- Optimal doses of selected agents and methods of recovery.

Each player should have their own recovery profile that serves as the basis for creating personalized recovery protocols. The development of recovery profiles and the

implementation of the recovery process is carried out by physicians, sports scientists, strength and conditioning coaches, nutritionists, psychologists, and physiotherapists.

Mindset; The mental characteristics of a player determine their behavior in life, training, and competition. If a player's way of thinking and behaving is in line with the requirements of elite sport, the likelihood of their success increases. Since elite sports often place extreme demands on the player, the player's mindset must be adapted to such conditions.

The following characteristics are especially important in elite team sports:

- Appropriate motivation;
- Emotion control;
- Cognitive mobility;
- High focus;
- Communication skills;
- Self-discipline.

Sports psychology has effective tools and methods in its portfolio to improve all of these characteristics. In addition to psychologists, sports coaches are involved in the work on improving the player's psychological characteristics. Psychological and psychosocial interventions have a moderately positive effect on sports performance.

Lifestyle; Since the player spends most of the daytime in their own environment and organization, the control and interventions in the player's lifestyle occupy an increasingly important place. Lifestyle segments that are especially important for the integral readiness of athletes are as follows: Duration and quality of sleep; Adequate nutrition; Quality hygiene habits; Family life; Social life; Hobbies; Rest; Housework and procurement; Fun and entertainment; Intimate life; Consumption of harmful substances; Self-health. Coaches, a

psychologist, a nutritionist, and a doctor, as well as close family members or friends, can take part in controlling a player's lifestyle.

Skills; The player's competitive success depends upon their technical and tactical skills; therefore, there is no surprise that the largest proportion of training work is allocated to technical and tactical training. The player's decisions in competitive conditions are the result of a whole conglomeration of influences that take place within the system of sports preparation.

Therefore, it is important to take into account the personalization of different aspects of sports preparation, including:

- The position in the game/team;
- Retrospective and prospective analysis of competitive performance;
- The process of learning, both individually and collectively;
- Expertise in tactical training.

Therefore, it is important to dedicate a certain amount of total training time to im- proving individual sports techniques and skills and to provide individual analysis of competitive performance. Sports coaches are responsible for planning, programming, and controlling technical–tactical preparation; however, skill acquisition specialists are more frequently included among the coaching staff in order to provide new expertise on developmental pathways for players and the optimization of short-, mid-, and long-term learning in training sessions.

2.2. Creating the "Personal Jacket Performance System"

The complexity of a personalized system of sports preparation in team sports lies in the synchronization of work and synergistic actions of all experts in the sports organization, which gathers a larger number of players. Furthermore, each player has a number of characteristics to identify, analyze, and monitor. Some characteristics are in deficit; therefore, they should be brought to an acceptable and optimal state. However, other characteristics are at an acceptable or above-average level and should be further improved and their comparative value emphasized. In addition, all individuals (players and experts) need to be teamed up in order for the final result of the sports team to be successful. Therefore, it is important to implement a clear structure and hierarchized network within the expert team and to define roles, rules, and responsibilities for each member of the expert team/staff

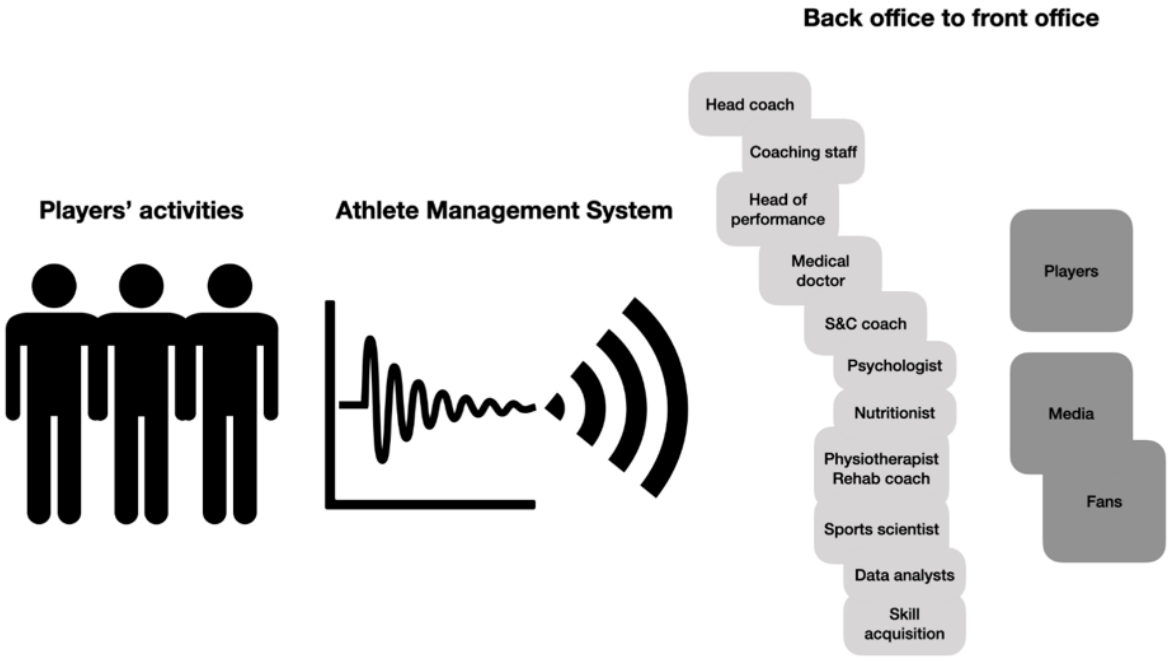


Figure 6. Structure and hierarchy of the coaching and performance staff in a sporting organization. S&C: strength and conditioning.

It is especially important to determine the method of communication within the expert team, i.e., the communication algorithms and procedures.

This is important because can be creating a 360° Personal Jacket Performance System has predefined phases, which
presented in five major steps:

1. Personalized history;
2. Personalized diagnostics;
3. Personalized goals;
4. Personalized programs;
5. Personalized monitoring.

All phases of the system are implemented in each of the system performance sectors. The general performance system (strength and conditioning, sports medicine, nutrition, psychology, recovery, lifestyle interventions, performance analytics) has the role of supporting the system of specific preparation (technical–tactical preparation). One possible approach to collecting, processing, and using player data is the matrix approach. All personalization steps in the system are carried out in each of the sectors of operation and are presented together in a matrix. The matrix for each player contains the basic characteristics of the athlete, basic areas of work, and basic operational procedures (history, assessment, goals, programs, monitoring). The matrix is available to all team members and the final appearance of the matrix and all interventions according to the individual player needs are finally approved by the head coach with the suggestion of the head of sports preparation (head of performance). Communication containing proposals and approvals takes place in the main (all sector leaders present), coordination (the head coach with the head of performance or the head of performance with the sector leaders), and/or sectoral meetings (the members of one sector present).

	Performance analysis	Health	Strength and conditioning	Mental training	Nutrition	Recovery	Life style
History	12y in sport, 4y in top level	ACL – L 6 years ago	WL - 4 RT - 8 SAQ - 6	3	5	5	4
Assessment	D - 6 O - 8 T - 7	RLM -4 RLJ -7 RLI - 3	MS – 7 EN – 6 NMS&P - 7 NMSAQ - 5	M – 9 EC - 4 F - 5 CM - 6	DNI - 5 SS – 62 Tanita BF – 15%	HRR - 7 HRV - 6	S – 6 NH - 5
Goals	D - 7 O - 8 T - 8	RLM -2 RLJ -6 RLI - 2	MS – 8 EN – 8 NMS&P - 8 NMSAQ - 7	M – 9 EC - 6 F - 7 CM - 7	DNI - 6 SS – 58 Tanita BF – 13%	HRR - 8 HRV - 7	S – 7 NH - 7
Programs	TeTa team and personal training	PRECOR	PRECOR PENT PNMS&PT PNMSAQ T	PMT	PNP	PRP	SII NHII
Monitoring	GPS TT GPS TR	IIOF	MS – FMS EN – GPS NMS&P – CMJ, TDL NMSAQ, 20mS, TT	PTO	SS Tanita BF	HRR HRV	WQ

Figure 7. The basic individual matrix

LEGEND: *Grades 1-10, D – defence, O – Offence, T – Transition, RLM – risk level (muscles), RLJ – risk level (joints), RLI – risk level immunity, MM – movement mechanics, WL – weight lifting, RT – resistance training, SAQ – speed, agility, quickness technique, MS – mobility/stability, EN – bioenergetic capacities, NMS&P – neuro-muscular strength and power abilities, NMSAQ – neuro muscular speed, agility, quickness abilities, M – motivation, EC – emotional control, F – focus, CM – cognitive mobility, GPSTT – technical-tactical GPS data, GPS TR – GPS tracking data, DNI – deep nutritional interview, SS – skinfold sum, Tanita BF – Tanita bio electric impedance scale body fat assessment, HRR – heart rate recovery test, HRV – heart rate variability test, S – sleep, NH – nutrition habits, IIOF – injuries and illnesses occurrence form, MS-FMS – Mobility/Stability – Functional Movement Screening, ENGPS – Energetics – GPS tracking dana, CMJ – counter movement jump, TDL – trap dead lift, 20mS – 20 meters sprint, TT – T-test, PTO – psychological training observation, PRECOR – preventive-corrective program, PENT – personalized energetic training, PNMS&PT - personalized neuro-muscular strength and power training, PNMSAQT – personalised neuro muscular speed, agility, quickness training, PMT – personalized mental training, PNP – personalized nutrition program, PRP – personalize recovery protocols, SII – sleep improvement intervention, NHII – nutrition habits improvement intervention*

Time	Pre-formance activity
-100	WQ, BM, BF (medical doctor, nutritionist)
-90	Breakfast (nutritionist, cheef)
-90	Medical exam/treatment (medical doctor)
-75	Mental exam/training (psychologist)
-75 to -45	Physio/Manual treatment (physiotherapist, masseur)
-60	TE-TA individual intervention (football coach)
-50	Supplements (nutritionist)
-45	Individual fitness pre-formance (fitness coach)
-25	Group fitness pre-formance (fitness coach)
-5	Arrivall to football training
0	Team training kick off

Figure 8. The pre-practice operational procedures

	Pre-formance	Tactical training	In-formance	Post-formance	Extra-formance
Player 1	Hip mobility	100%		Bicycle capillarization	Power - resistance
Player 2	Manual therapy	100%		HIIT short	Lower body strength
Player 3	Glute activation	80%	Dynamic hip stretching	Upper body strength	HIIT short
Player 4	Ankle mobility	100%		Core stability	Power-Body mass
Player 5	Dynamic core stability	100%		HIIT short	
Player 6	Glute strength	100%		Upper body strength	
Player 7	Upper-body strength	100%		Core stability	
Player 8	Trap dead -lift	100%		Bicycle capillarization	
Player 9	Bicycle capillarization	60%	Bicycle capillarization	HIIT long	Lower body strength
Player 10	Ankle mobility	20%	Ankle rehab-Manual therapy	Upper body strength	Physiotherapy
Player 11	Shoulder mobility	100%		Core stability	Lower body strength
Player 12	Electro-stimulation	0%	ACL rehab Knee-mobility	Upper body strength	Physiotherapy
Player 13	Knee stability	100%		Hip mobility	
Player 14	Lower back stability	0%	Lower back rehab – physio therapy	Bicycle capillarization	Manual therapy

Figure 9. The basic team operational procedures

Conclusions

Scientist have to know what the coach needs, on other hand, science is the safest way coaches can have to improve skills and avoid injuries. Long-term solution for player development is the key for growing new champions. Multi-sports education, multilateral physical development, movement vocabulary and physical literacy are required. Early specialization can be a limitation for players. From a human being we establish an athlete, then we build a player and then we make a winner. We need to control parents who push hard in early age for winning.

The “Personal Jacket Performance System” aims to enable the maximal use of all personal potentials of players in team sports in order to improve the performance of the team. The implementation of this system includes a multidisciplinary team of experts that is synchronized and led by a leader (director of performance) with the purpose of optimizing the processes of the team and the individual sports preparation of players. The synergistic action of all experts enables the team and each individual player to improve their sports performance. With the whole structure and organization of a personalized approach to improving player performance, the main protagonist of this system of work (Personal Jacket Performance System) is the player. The player’s understanding of the need for such a system, strong motivation, self-discipline, and commitment are the key prerequisites for the success of this system. Furthermore, every player should consistently think about this system. This way of thinking and behaving gives the player the opportunity to stay healthy, improve their competitive performance, and prolong their career.

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Congested Scheduling Effects on Injury and Preventative Strategies

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Abstract

Prolonged periods with multiple games and limited days of recovery are commonly referred as "Congested schedules". The purpose of the short review is to investigate why during congested periods there is an increased injury risk, especially for non-contact soft tissue injuries. Also, to suggest prevention strategies to reduce the possibilities of injury occurrence.

Key Points

Congested scheduling increasing the risk of injuries and especially non-contact soft tissue injuries

Main causes that may increase injury risk during congested periods

- Increased match loads
- Augmented internal load
- Fatigue accumulation
- Insufficient recovery
- Frequent travel that causes travel fatigue and jet lag
- Inadequate sleep
- Age / Previous injury
- Small squad sizes

Preventing strategies for injury reduction during congested periods

- Quality planning
- Good quality internal communication between head coach / manager, fitness coaches, medical staff and players
- Large squad sizes/depth
- Pre-season preparation: performing a greater number of preseason training sessions
- Load monitoring and management
- Sleep quality and quantity
- Well-chosen nutrition strategies
- *Travel fatigue and jet lag management*
- *Additional post-exercise recovery strategies used by professional clubs*
- *Use of artificial intelligence – machine learning*

Congested schedules

Professional team sport athletes (e.g football-soccer, basketball, rugby) are often involved in multiple concurrent competitions, including 2–3 domestic, national, and/or international games a week. These prolonged periods with multiple games (about > 55/season), and limited days of recovery (< 3-4) are commonly referred as “Congested schedules” (Bengtsson et al. 2013).

Congested scheduling effects on injury

Injuries in elite sports are one of the most important factors of interest for coaching and medical staff due to their negative impact on player availability, team performance, and significant financial costs for a club (Eliakim et al. 2020). Recently, Buchheit, M., & McHugh, D. (2022) reported that the expected number of injuries/week for elite football teams

competing once a week is ~ 3 injuries every second week (~ 6/month) and for teams competing twice a week is ~ 1 injury/week (~>4 injuries/month).

Congested scheduling seems to have a negative effect on injuries although there are limited studies that didn't report a significant effect. Most studies in football found that injuries increase during congested when compared to normal scheduling (Pinheiro et al. 2022; Howle et al. 2020; Klein et al. 2020; Bengtsson et al. 2018; Dellal et al. 2015; Bengtsson et al. 2013, Dupont et al. 2010), contrary to limited research data that didn't report significant differences (Klein et al. 2020; Carling et al. 2012). Similar findings are reported in basketball where congested game schedules (back-to-back and away games) could be one factor that impacts the risk of game injuries in the NBA (Teramoto et al. 2017). Injuries are likely to increase during congested schedules due to accumulating fatigue, and insufficient muscle reconstruction as a result of inadequate recovery time.

Dupont et al. (2010) reported an increase of 4.1–25.6 injuries/1000 h in matches during non-congested and congested periods (< 4 days) in the Scottish Premier League. In addition, Bengtsson et al. (2013) reported increased muscle injury rates in league matches with 4 days compared to 6 days recovery (29.0 vs. 26.6/1000h, respectively). A more recent study confirms the above results indicating that muscle injury rates increase by 21% when < 3 days separate matches in comparison to matches separated by > 6 days in a sample of over 13000 observations (Bengtsson et al. 2018). Moreover, Klein et al. (2020) reported higher injury incidences (> 2.7 injuries/player/season) in seasons with international tournaments suggesting an increased risk of injury with an increasing number of matches. The overall incidence rate was 12.5 (± 0.28) injuries/1000 exposure h, which was translated into match and training rates of 47.0 (± 1.62) and 8.02 (± 0.24) injuries/1000 h, respectively. Likewise, Howle et al. (2020) found increased total injury rates during congested schedules, when comparing injury incidence between single and multi-match weeks, due to increased match and training injuries (50.3, 16.9/1000h). Furthermore, they reported that between seasons total injury rates were higher when multi-match weeks increased (27.3/1000h and 22.7/1000h vs. 14.1/1000h). More recently, Pinheiro et al. (2022) mentioned a high rate of muscle injury during a long-congested fixture period, even though there are no changes in physical, physiological, and psychophysiological parameters in a professional football team.

Contrary to the above, Klein et al. (2020) reported large differences in injuries prevalence between single teams from the same division, with similar multi-match weeks, highlighting the positive impact of prevention strategies. Similar results were reported by Carling et al. (2012) which they didn't find increased injury rates for French professional players in a congested period (8 matches in 26 days) in comparison with injuries outside this period (50.3 vs. 49.8/1000h) and suggested that larger number of players and the use of rotation in teams can reduce injuries.

Why congested scheduling increases the odds of injuries rates

Increased loads (internal and external load)

External and internal load understanding during congested periods is important given the relationship that is proposed to exist between load and injury (Howle et al. 2020). Impellizzeri et al. (2019) define external load as the physical work performed during training and matches, while internal load incorporates all the psychophysiological responses occurring during the execution of the exercise. Higher total training loads (Gabbett et al. 2011) and the rate of increase in load (Rogalski et al. 2013; Gabbett et al. 2016) are suggested to be associated with higher overall injury incidence in players of various football codes. According to Eckard et al. (2018) the strongest evidence for a relationship between training load and injury in competitive athletes is for internal load, assessed using session rating of perceived exertion (sRPE), and relative training loads assessed using the acute:chronic workload ratio (ACWR). Although during congested schedules coaches will reduce training loads, and total loads may not significantly differ between congested and normal weeks, match loads increase, and players spend more time in higher speed zones (Anderson et al. 2016). These exposures may have a negative effect on injury occurrence because higher percentage of total distance running at high speeds was associated with increased injury risk (Windt et al. 2017). Perhaps an important element in preventing injuries is the optimal player load management strategy (Buckthorpe et al. 2019).

Fatigue

Fatigue can be defined as an exercise-induced decline in performance (e.g. reduction in strength, the ability to voluntarily produce muscle force). Fatigue can be considered a complex phenomenon that reveals at both the central and peripheral level and is affected by general fitness levels and individual muscle conditions (e.g. eccentric hamstrings muscle strength and endurance), muscle fiber type, metabolic capacity, and biomechanical factors (Buckthorpe et al. 2019, Giakoumis, 2020, Lievens et al. 2020).

Fatigue can interact with an athlete's optimal performance, influence movement patterns, functional test performance within the concepts of neuromuscular control (proprioception, balance, and postural control), and reduced strength and power production. Consequently, fatigue affects prospective intrinsic modifiable risk factors for lower extremity injury, indicating an altered injury risk profile for a lateral ankle sprain, patellofemoral pain syndrome, and hamstring injuries (Verschueren et al. 2020).

Following a football match, physiological markers of muscle damage, fatigue, and reduced power are evident even after ≥72 h (Doeven et al. 2018; Silva et al. 2018), although physical performance recovery takes up to ≥48 h (Doeven et al. 2018) or ≥72 h (Silva et al. 2018). Consequently, in congested periods some players might be participating in competition when not fully recovered (e.g. physiologically, mentally). Therefore, continuous matches with insufficient recovery (3 per week, <72h recovery) can increase the possibility of muscle injury. Probably the above data can explain the higher rates of hamstring muscle injuries due to their greater fatigue response and slower recovery rates, along with trunk muscles (Chen et al. 2011, Fransson et al. 2018). Understanding individual players' match-related fatigue and

recovery profiles are crucial for the development of proper prevention training strategies to reduce the possibility of muscle injuries.

Travel Fatigue and Jet Lag

Frequent domestically and internationally travel, is an integral part of professional players' lives, including high- and low-frequency short and long distances (< 3 h & > 3 h, respectively), and may involve the crossing of numerous time zones. These travel forms could cause travel fatigue and jet lag. According to a recent review by Janse van Rensburg et al. (2021) the subsequent travel fatigue and jet lag experienced, result in a myriad of shared symptoms, such as daytime fatigue, decreased concentration and alertness, desynchronization between the internal human circadian system and the time at the new destination, sleep disruption, gastrointestinal disturbances and cause psychological and behavioral disorders. These can lead to increased illness, adverse effects on athletic performance, and increased injury risk. Frequent travel for a back-to-back and away games during congested game schedules could increase game injuries risk in the NBA (Teramoto et al. 2017), though, injury incidence does not seem to increase after one long-distance air travel (≥10 h and crossing ≥6 time zones) prior to a world series tournament in rugby players (Fuller et al. 2017). Therefore, the management of travel fatigue and jet lag, after frequent travel, is a very important aspect of club medical and fitness staff.

Inadequate sleep

Most studies suggest that injury rates may increase concomitantly with lower sleep durations (≤6-8 h), in young (Fox et al. 2020), and in adult athletes (Charest and Grandner, 2020). It seems that inadequate sleep has a negative effect on recovery, fatigue, mental and physical performance, and muscle tissue reconstruction.

Small squad sizes

Teams with small squad sizes and their impossibility of players' rotation during congested fixture periods are likely to have increased injury frequency, possibly due to higher game loads, lack of appropriate recovery, and increased fatigue in players who participated in continuous matches. Furthermore, small squad sizes and greater travel demands may impede recovery during times of increased fixture congestion, increasing injury risk (Howle et al. 2020).

Age / Previous injury

Individual unmodifiable factors such as age and previous injuries should be considered, possibly even for squat formation. Although muscle injuries are multifactorial in nature, older age and injury history (HSI, ACL injury, calf strain injury) are the strongest risk factors for Hamstring Strain Injury (Green et al. 2020).

Preventing strategies

During congested scheduling the highest priority must be given to preventive strategies from coaching, fitness, and medical staff, for recovery, alleviating muscle damage, fatigue management, and reducing increased injury risk.
The following preventive strategies are proposed.

Planning

Quality planning is an essential tool for reducing the odds of injuries in a season with congested periods and thus increasing demands, since, injuries occur due to a complex and multivariate system, with multiple risk factors and risk factor interactions (Bittencourt et al. 2016). For the best possible preparation of the athletes, planning considerations must include team and individual athlete risk identification (testing and monitoring), and modifiable and unmodifiable risk factors such as eccentric strength and previous injury, respectively. Finally for the completion of the puzzle, a holistic training and multifactorial individualized prevention program must be implemented (Buckthorpe et al. 2019; Lahti et al. 2020).

Communication between coaching staff, medical team and players

As stated in the study of Ekstrand et al. (2019): 1) Elite football clubs with good quality internal communication had fewer injuries and greater player availability compared with clubs with poor communication, 2) Head coach/manager and the medical team communication was associated with team injury rates, 3) Fitness coaches and the medical team low communication quality had low player attendance at training. Good quality internal communication between the head coach/manager, fitness coaches, medical staff, and players (Fares et al. 2022) can reduce injuries and increase player availability during training and matches.

Squad sizes/depth

Player rotation can be considered as a solution for increasing recovery from accumulated fatigue and increased match loads during fixture congestion, but it depends on squad quality and availability. It is most likely that recovery throughout the period can help reduce injuries. Teams with a scheduled break during the season had a reduced incidence of severe injuries following the time of the year than other teams without a recovery time (Ekstrand et al. 2019). Since a recovery break for the whole team is not possible, player rotation can help increase the recovery process for individual players with accumulated fatigue and increase injury risk. Consequently, larger squad sizes/depth must be available, allowing increased player rotation, recovery augmentation, and decreased match exposures, all of which may decrease injury outcomes. Moreover, larger squad sizes become even more necessary if the team program includes frequent domestically and internationally travel for away games which may impede recovery times and cause travel fatigue and jet lag.

Pre-season preparation

According to Ekstrand et al. (2020), teams that performed a greater number of preseason training sessions had ''healthier'' in-season periods, lower injury burden, fewer severe injuries, and higher team match availability for the whole season, although, many other factors also affect in-season injury rates. In individual level, players who participated in a greater number of preseason sessions had a lower likelihood of injury throughout the competitive season (Windt et al. 2017). This may be attributable to the potential ''protective effect'' of chronic loads (Gabbett T.J. 2016; Hulin et al. 2016; Windt et al. 2017) or due to a ''survival of the fittest'' phenomenon, where more resilient players are likely to complete more preseason and in season training sessions. Understanding the benefit of preseason training on in-season injury patterns may inform coaching and fitness staff for proper planning and preparation before congested scheduling.

Load monitoring and management

To reduce the risk of injury, individually training and match load values of weekly loads and previous week-to-week load changes should be monitored (Howle et al. 2020). Emphasis should be given to sRPE; and ACWR monitoring. Moreover, monitoring high-speed running (HSR) and sprinting load during training sessions and matches must be of high priority, as an important risk factor for non-contact soft-tissue injury (Duhig et al. 2016; Colby et al. 2018; Gregson et al. 2020). The results of Duhig et al. (2016) stress the importance of avoiding large and rapid increases in high-speed running volumes per session (above player's individual 2-yearly session average) because they increase the odds of Hamstring Strain Injury (HIS). However, reducing the volume of high-speed running every 4 weeks may reduce the risk of HIS. Likewise, non-contact injury risk is evident not only with HSR overloading but also with under-loading. Less than 1 session/week during a 4-week period increased muscle injury risk (Colby et al. 2018), supporting the U-shaped relationship between load and injury. Additionally, match sprinting volume is a risk factor for muscle injury occurrence in elite soccer players (Gregson et al. 2020). These findings highlight the physical preparation of players to withstand high isolated and repeated sprint activities during competitive match-play, especially before congested periods. Quality planning, with progressively increased loading, during the off-season and pre-season, and players receiving high chronic load, maybe a protective 'vaccine' to prevent injuries during the high-risk congested schedule (Gabbet T.G. 2016).

Sleep

Although poor sleep quantity and quality is not a very strong isolated factor for an increased risk of injuries, sleep can be a moderator of other potentially modifiable risk factors for potential influence injury occurrence (Dobrosielski et al. 2021). In addition, sleep is an essential component of athletes' health and plays a crucial role in recovery, physical, cognitive and mental performance (Charest and Grandner 2020). Consequently, because athletes may face inadequate sleep and disturbances, clubs should incorporate individual and team promotion and interventions programs to enhance the quality and quantity of sleep as a

useful strategy for improving recovery, performance, and injury prevention (Bonnar et al. 2018; Vitale et al. 2019; Charest and Grandner 2020; Gwyther et 2022).

Nutrition

Well-chosen nutrition strategies play a fundamental role in performance, recovery, and injury prevention and recovery after injury (Close et al. 2019; Smyth et al. 2019; Mohr et al. 2022). More importantly, specific nutritional strategies must be implemented during fixture congested periods, all along with travel and training sessions, due to the importance of recovery, repeated high-level performance, and injury prevention. Ranchordas et al. (2017) proposed 4 pillars of practical nutritional recovery strategies for elite players when limited time separates repeated matches. The 4 pillars of practical nutritional recovery strategies include a) Refueling (post-match) / Pre-Loading (pre-match), b) Maintenance of Repair and Adaptation (Daily intake post-match before subsequent fixture), c) Rehydration (Immediate Recovery), d) Reduce inflammation and muscle soreness (Immediate Recovery). Although the "food first approach" must be the main nutritional strategy to ensure adequate total energy and appropriate dietary intake, there are some supplements that have the potential to help recovery and prevention (Ranchordas et al. 2017; Close et al. 2019).

Travel fatigue and jet lag management

Travel, domestically and internationally, is increasingly required for athletes, often resulting in travel fatigue and jet lag with side effects on recovery, performance, risk of illness, and injury (van Rensburg et al. 2021). To manage travel fatigue and jet lag preventive interventions must be used a) Pre-travel, b) During travel, and c) Post-travel (van Rensburg et al. 2020). As stated by van Rensburg et al. (2021), the most important interventions include:

-Travel fatigue: maximize the amount of sleep obtained during travel.

-Plan meticulously, prevent illness and formulate hydration and food strategies.

-Jet lag: maximize the rate at which the body clock adapts to the new time-zone, by following a guide that specifies 3h periods of light exposure and avoidance.

-Preserve sleep, coincide exercise training with light exposure, adjust meal timing and composition, and sensible use of melatonin at the new destination.

-Manipulating exposure to time-givers, e.g. light and exogenous melatonin may aid in successful circadian re-alignment following travel in athletes. Conversely, inappropriate exposure may be counterproductive and cause detrimental side effects.

Additional post-exercise recovery strategies used by professional clubs

Professional soccer teams used more natural strategies than physical, psychological, or complementary ones (Altarriba-Bartes et al. 2020). The most frequent used (in order of priority) after competition and after in-season training sessions:

a) Active or passing stretching, b) active field or gym based, c) cold/ice bath immersion, d) massage, e) foam rolling, f) liniment or gel application, g) contrast bath/shower immersion, i) compression garments, k) ice pack/vest application

Secondary injury prevention screening

The secondary prevention objective is to identify early injury signs and to allow for timely management before the injury deteriorates (Jacobsson & Timpka, 2015). Though, secondary prevention strategies, before, and during congestion periods where the odds of acute muscle and overuse injury increase, may use as a proactive strategy for early identification and management of players with impaired muscle function (e.g. hamstring and groin). This may assist the player preparation and risk management process in reducing muscle injury (Wollin et al. 2018).

A recent study from Lahti et al. (2022) on professional soccer players concluded that 1) although no single screening test (from 11 screening tests) was sufficient to identify players at risk of HMI, 2) lower maximal horizontal force production capacity (F0) was significantly associated with increased HMI risk when assessing injuries that occurred between the pre-season and mid-season testing sessions. It is possible that the addition of frequent F0 testing may further improve HMI risk prevention strategies, mainly before congested schedules.

During congested match fixtures, isometric hamstring strength and pain during resisted knee flexion can be used to screen individual elite youth players' post-match response on recovery and restoration of hamstring muscle function (Wollin et al 2018). Congested football match play produces a significant decrement in isometric hamstring strength and associated pain, and these are evident even 48 h after the match, as a result of insufficient muscle recovery and strength deficits.

Moreover, the 5-second adductor squeeze test can be an effective approach to include as part of a secondary injury prevention strategy during or immediately after football match congestion (Wollin et al. 2018). This can be a result of significantly isometric hip abductor strength reductions and the negative relationship between match sRPE and isometric hip abductor strength during a congested schedule.

Contrary to the above, post-match play lower limb flexibility testing is not a strong indicator for monitoring players' impaired hamstring muscle function during congested schedules (Wollin et al. 2018).

Use of artificial intelligence – machine learning

Recently, the application of machine learning - artificial intelligence (AI) opens an interesting perspective for risk assessment and helps to predict the occurrence of sports injuries (Claudino et al. 2019; Kakavas et al. 2020).

The use of AI seems to be a necessary approach since injuries occur due to a dynamic, complex, and multivariate system, with multiple risk factors (intrinsic and extrinsic, modifiable and unmodifiable) and risk factor interactions (Bittencourt et al. 2016; Kakavas et al. 2020). In addition, these complex relationships between risk factors/predictors provide further challenges for screening athletes' injury risk state due to the time limitations in real-world settings, especially during congested scheduling.

Even though research to date is limited, their results are encouraging. AI prediction model using personal or individual, psychological, and neuromuscular risk factors, showed moderate to high accuracy for identifying professional soccer players at risk of HSI during pre-season screenings (Ayala et al. 2019). Using AI, based on training load and wellness indicators, increased injury risk for individual elite volleyball players was identified (de Leeuw et al. 2022). Therefore, the development of AI modes might help coaching, fitness, and medical staff in the decision-making process or injury prevention personalized approach.

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Less Can Be More

Gűnter LANGE
DOSB DIPLOMA COACH

Reflecting today on May 1st, the **International Worker's day / Labour Day**
- Paris 1889 resolution for a "great international demonstration" in support of working-class demands for the eight-hour day; based on a general strike beginning on 1 May 1886, and culminated in the Haymarket affair, which occurred in Chicago four days later. May Day subsequently became an annual event -
about the major changes in the "working conditions" (Training / Competition) of Elite athletes which I have observed since 1987 in the International Sports Industry (here: especially Track and Field), I am deeply concerned about the increasing risk for the health and wellbeing of our "workers" / athletes due to dramatic deteriorating "working" (training and especially competition) situation.

While I am personally pleased about the observed increased shared working vision of most of our Elite **Coaches** being based on

ATHLETES CENTERED
SCIENCE BASED
COACH DRIVEN[1]

the reality of the Elite athlete's "working" (e.g. competition) conditions are alarming, calling for international actions.

<u>Elite Athletes are increasingly exposed to the following observed health / well-being threats:</u>

- ✓ **Quantification / maximal density of Elite Competitions**[2]
  - International not harmonized competition calendar with colliding interests
  - 271 authorized WA Athletes Representatives (AR)
    mostly practice the
    "ATHLETES FIRST / WINNING SECOND"
    philosophy,
    however, there are up to now only some very few AR
    – especially in the lucrative East African Market (Runners) –
    who have proven, that they are motivated and can implement a "**DUAL CAREER**" and produce Elite athletes with a Career after the (Running) Career; e.g. Haile Gebreselassie.
    It is a threat for the whole Running Industry that some AR practice maximizing "Generating income" by rampant competition participation e.g. Road Running all over the globe. This exploitation of the athletes by some AR can be observed not only on the elite level (e.g. too early/ too many Marathon / Half Marathon races) but also in the "National Level" Road Races where some of the "B Level"

[1] 3rd IAAF Coaches Conference London 7.-10. August 2017
[2] E.g., 2022 in three weeks 3 TOP Events: WC Eugene / USA; Commonwealth Games / GB; WC U20 / COL

athletes compete weekly in all corners of planet earth to win even the lowest price money.
This observed maximizing of generating income causes often early drop out due to injury / burn out; which again is no hindrance for this type of AR / exploiter, since they just contract another new talent.
Unfortunately, the comprehensive control mechanism made available by World Athletics
"Once recognized as an Authorized AR, it is possible to represent athletes ranked in World Athletics' Top-30 Track and Field or Top-50 Road Running Lists. In order to do this, it is necessary to: […]
- Notify each of the Member Federations concerned of your intention to represent their athletes by completing the "Registration of an Authorized Athletes' Representative" Form (Appendix 4) and **obtaining the Member Federation's signature of approval**"[3]
is not sufficient.
It is remarkable, that recently some NF try to protect their athletes e.g. bring controversial AR with alleged (criminal[4]) offenses (e.g. focused but not limited to Doping) to court; however other NF provide the yearly signature / approval of the AR even when the AR has repeatedly proven too generate income at all cost.

✓ **Competition venue selection ignores the health risk for (e.g. endurance) athletes[5]**

©Gunter Lange Doha 2019

While proven by medicine / sports science that the combination of high temperature and high humidity causes not only a reduction of endurance performance but provides a high risk for health (Thermoregulation) of the endurance athletes, the protection of the athlete's health / working conditions is obviously not a concern of the decisionmakers for the location of WC (e.g. Doha) and OG (e.g. Tokyo).

[3] WA: Registration with Member Federation https://worldathletics.org/athletes/athlete-representatives
[4] Unfortunately Doping is only in some few countries a criminal offense which allows to penalize / prison sentence the convicted dopers (e.g AR)
[5] Thermoregfualtion: Hot and Humid Competition venue e.g Doha WC (Doha Marathon conditions see picture)

✓ **Competition venue with substandard facilities (track with zero level)**

©Gunter Lange Nairobi 2021

For safety reasons
- after raining high water remaining on track

- Sprints start area
- D-Sections e.g. Take Off area of high Jump

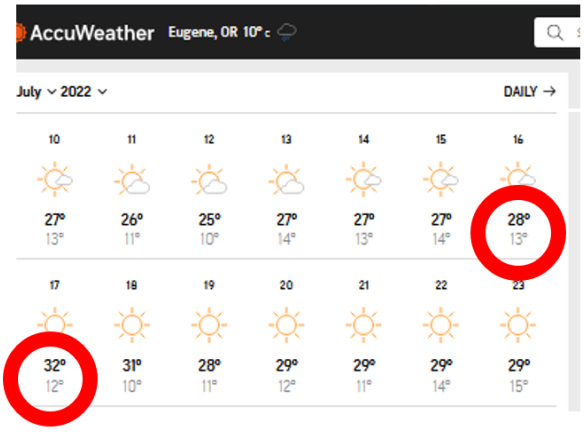
the competition in KEN / Kasarani stadium had to be stopped for hours during
a) IAAF World U18 Nairobi / Kasarani 2017
b) same venue / same threat in WA U20 2021

✓ **Competition time based on lucrative TV rights and not on athlete's performance / health**

In the 10.08.2013 WC Mosva Marathon Woman with Start at 13:58
- which again is best TV Time in Tokio 19:58 [JAP Finished 3rd and 4th) -
I observed the athletes in „working conditions" of
Temperature: 27°C Humidity 66%
This caused a **Drop Out of : 24/70 = 34% of the female world class athletes**

An actual sample of the supremacy of "generating income" over the "Athlete's (Health) FIRST" principle, are the **WA Championships Eugene 2022:**

The endurance event of 10.000m Finals are planned for the known performance reducing and health threatening temperatures / working conditions of:
Women: 16 July 2022 at **12:20** Local Time **Temperature Prediction[6]: 28°C**
Men: 17 July 2022 at **13:00** Local Time **Temperature Prediction: 32°C**



Conclusion:
"Only mad dogs and Englishman **[and athletes with no choice / lobby]** go out in the midday sun" (Rudyard Kipling)

Crosscutting element in the above observed four threats of

1. Quantification / maximal density of Elite Competitions
2. Competition venue selection ignores the health risk for (e.g. endurance) athletes
3. Competition venue with substandard facilities (track with zero level)
4. Competition time based on lucrative TV rights and not on athlete's performance / health

are:

- ✓ Athletes (Workers) are not involved in the decision-making about their own working (here: competition) conditions
- ✓ Some decisionmakers (IF; NF; AR) in the sports industry follow the prerogative of maximizing (their) income by ignoring the workers / athletes' basic human rights (Health) and income
- ✓ Coaches as the genuine potential "advocates" of the athletes (health / well-being) are successfully "sidelined"
- ✓ Most NF have successfully managed that neither coaches nor athletes are "united" / organized

<u>Way Forward:</u>

[6] https://www.accuweather.com/en/us/eugene/97401/july-weather/330145?year=2022

While most athletes / coaches are still stabilising the actual system of the athlete‘s (and coaches) exploitation by their „Silence of the lambs“[7],
athletes and coaches are ignoring the Paul Watzlawick Axiom of human communication[8]:

"One cannot not communicate, because all communication (not just with words) is behavior and just as one cannot not behave, one cannot not communicate."

While the labour movement identified on 1 May 1886 their strength **IF** being united
e.g also the traditional slogan of the German labour movement[9] stipulates already in 1863

"Man of work, wake up!
And recognize your power!
All wheels stand still
when your strong arm wills it"

there are only few sign of „awareness“ in athletes / coachesd circles 159 years later.

Interesting / sign of hope is the 2021 founded International Swimmers' Alliance (ISA) [10] :

ISA as a organised structure of athletes (swimmers)
„has called to have more athlete participation in the scheduling decisions made for the global swimming calendar.
Professional swimmers have let their displeasure with FINA and the ISL known in the wake of numerous scheduling changes that have reshaped the international swimming calendar in 2022 and beyond in recent months.
The International Swimmers’ Alliance (ISA) issued a formal letter to FINA and the International Swimming League (ISL) on Wednesday, telling the organizations that athletes aren’t happy with their lack of involvement and notice in the recent schedule changes.[11]

Staying in the element of the swimmers „water“,
the Track and Feild athletes /coaches may be well advised not only to be united but to consider that

„Never forget that only dead fish swim with the stream.“[12]

With this final remarks I wish all of us a contemplative
May 1st, the **International Worker’s day / Labour Day**

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[7] *The Silence of the Lambs* is a 1991 American psychological horror film directed by Jonathan Demme and written by Ted Tally, adapted from Thomas Harris's 1988 novel.

[8] Paul Watzlawick 1921 – 2007 Axioms of Human Communication
[9] 1863 Georg Herwegh, Bundeslied für den Allgemeinen deutschen Arbeiterverein
[10] https://swimswam.com/news/
[11] https://swimswam.com/swimmers-alliance-critical-of-fina-isl-for-lack-of-involvement-in-scheduling/
[12] Malcolm Muggeridge 1903–90

Nutrition and lifestyle aspects

Yuval Cassuto

Global sport is an industry whose value rises every year. In 2019, it was valued at 458 billion dollars (1). The forecast for 2025 is 600 billion. The athletes, on whose performance this industry is based, are now more profitable than ever, but some of them are also required to compete more than in the past (2). The training load and competitions takes a heavy toll on these people.

Developments in orthopedics and rehabilitative medicine have helped to shorten the time required to rehabilitate athletes and return them to activity. A navy of physiotherapists, sports therapists, specialists in the theory of training, a variety of equipment, tests and follow-ups are helping to prevent their injury (3). But this article will focus on the contribution of two components to athletes' lifestyle, sleep and nutrition, to their ability of successfully coping with training loads and competitions.

Improving the performance and physical ability of athletes begins at a young age. This is a very long, slow and gradual process (4). Any attempt to accelerate this process may result in increased percentage of injuries, decline in performance and a dropout rate. As described in the article, sleep, nutrition and lifestyle play an important role in building physical abilities, making the most of training and shortening the duration of recovery. **But all of these cannot replace the long and gradual physical preparation required to prepare athletes for intense competition and/or training periods**

Sleep

An extensive review article regarding this subject (5) describes the complex and symbiotic interactions between physical activity, athletic performance and sleep. Exercise helps with better quality of sleep, which in itself is important to the athletes' performance and health. Decreased time and quality of sleep severely impairs mental abilities such as reaction time, cognitive ability and behavior, motor control and more, but also physical ability and causes an increased incidence of sports injuries. Despite all of this, athletes usually do not receive appropriate conditions that allow quality and satisfactory sleep due to many reasons: jet lag following flights to international competitions, environmental changes - hotels, etc., stress and muscle pain.

The lack of sleep does not only hurts elite athletes. Its prevalence in Western society is constantly rising and harming the general population, including children and adolescents (7,6). increased frequency of car and work accidents, damage to the quality of work and learning, decrease in prosperity and well-being are all observed. That is why it is so important to emphasize the importance of sleep for the athletes' population and the general population at all ages and also to involve parents in the importance of this issues, when dealing with the consequences of sleep deprivation among young athletes.

Nutrition

Sufficient calorie intake

Athletes who train and compete at high intensity burn around 600-1200 kcal per 1 hour (ISNN 24). Two - three hours of training or competition and five to six training sessions per week can sum up to 5000 kcal per day and more. Tour de France cyclists (ISNN 29) measured a caloric expenditure of around 12k of kcal per day, or 150-200 kcal per kg in cyclists who weighed 60-80 kg. During an intensive training period, large athletes weighing 100+ kg need 6k–12k kcal per day (ISNN 31).

Is such a large caloric expenditure balanced by a larger caloric intake? For years, the scientific literature has documented the common caloric deficit among athletes who are in a period of intensive training or competitions (50, 51). The caloric intake of these athletes does not always manage to balance the large caloric expenditure. This negative caloric balance has received the phrase “anorexia as a result of exercise” (52). The reasons for this are related to an insufficient appetite and lack of awareness of the athletes but also to the conditions in which they compete or train and of course to the periods of time available for them to eat. With time, a negative caloric balance will impair athletes' performance, increase stress, prevent a good recovery and increase the risk of injury (53).

In order to prevent many negative effects, athletes should maintain a caloric balance and glycogen storage in muscles and liver, consume 55% - 65% of daily calories as carbohydrates. Around 5-8 grams per kg / day (ISNN 41 50). Athletes who train and compete in high intensity and volume, 3-6 hours daily, 5-6 workouts per week, may need 8-10 grams of carbohydrates per kg / day. In need of rapid replenishment of glycogen storage, it is recommended to consume at least 1.2 grams of carbohydrates per kilogram every hour immediately after the end of activity (ISNN 50) and in duration of four hours. It is possible to use high glycemic index products at these critical hours: sugars, white flour products and appropriate fitness bars (ISNN 53). Consuming 30-60 grams of carbohydrates per hour in appropriate drinks or snacks (NUT T 75) during an activity that lasts longer than an hour will help maintain glycogen in muscles and preserve the quality of physical abilities.

If so, it is important to monitor athletes' weight fluctuations, educate them on adequate carbohydrate intake and of course make sure they have the means to prepare/provide themselves with the appropriate food. Sometimes it is necessary to consult professionals in order to plan and build a daily routine that provides time for preparation and consumption of this food. Young athletes need their parents' cooperation, so it is important that they also be aware of their children's unique needs.

Protein

The demand for protein has increased following an increase in difficulty, duration and intensity of activity. Insufficient protein intake will result in a negative nitrogen balance followed by loss of muscle mass, slow and insufficient recovery and injuries (ISNN 76 77). The recommended amount of protein for athletes is 1.2-2.0 grams of protein per kilogram/day. In extreme situations of activity volume and intensity, the recommendation increases to 1.7-2.2 grams of protein per kilogram/day (ISNN 78 90). Good sources of low-

fat protein are chunks of skinless chicken, fish, egg whites, chunks of lean meat, milk and its low-fat products.

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RECOMMENDATIONS FOR COMBAT SPORTS

Patrik Drid

Introduction

The purpose of the "position paper" is to present the conclusions and recommendations for athletes, coaches, managers, and other personnel, sports organizations, clubs, and national and international associations in combat sports.

Combat sports are dynamic, high-intensity intermittent sports that require a whole body engagement and a wide array of modifiable technical-tactical skills to achieve excellence [Degoutte et al., 2003; Chaabene et al., 2012; Franchini et al., 2014]. In general, elite-level combat sports athletes have highly developed dynamic strength, muscular endurance, anaerobic power, and capacity, as well as aerobic power and capacity that are more prominent in the upper body than in the lower body, while muscle power appears to be better developed in the lower body [Franchini et al., 2011; Pallarés et al., 2012]. To succeed in combat, combat sports athletes undergo vigorous training on a weekly basis that is often perceived as very hard by the athletes and is usually not well designed by the coaches as there is a significant discrepancy in the rate of perceived exertion projected by the coaches and experienced by the combat sports athletes [Yoon, 2002; Viveiros et al., 2011; Drid, 2017; Ouergui et al., 2020], which can lead to overtraining and subsequent performance decrements. Beyond physical fitness, combat sports athletes must maintain a narrow bodyweight range since combat sports is a weight-categorized sport. Combat sports athletes rely on chronic and rapid weight loss (RWL) to lose weight in the desired category [Lakicevic et al., 2020; Drid et al., 2021; Figlioli et al., 2021; Ranisavljev et al., 2022]. Methods to induce RWL in combat sports athletes are commonly centered around active and passive dehydration, gut content manipulation, and glycogen depletion [Artioli et al., 2010; Lakicevic et al., 2020], and this cycle is repeated up to 10 per year [Artioli et al., 2010]. As cycles of weight manipulation are dictated by the number of competitions annually, it can be hypothesized that the greater number of competitions per year will lead to poorer performance in combat sports athletes over the year.

The number of competitions per year varies between individual combat sports. In addition to differences between sports, differences between respective national teams in the same sport are also visible. So it can be concluded that countries with intense competition at the national level (such as Japan in judo) have fewer international competitions. The same can be concluded for sambo (example of Russia, which sends the best competitors to the World Championship, which is reserved for other international competitions).

Given that for most combat sports, it is necessary to achieve good positions in the world rankings that give them the possibility of an advantage in the draw at important competitions, and as the most important Olympic norm, a greater number of participation in competitions on an annual level is necessary. However, it is necessary to find a balance between the number of competitions that lead a competitor to the OI and the number of competitions that lead him to injuries and overtraining.

Means, methods, and ways to monitor and regulate the intensity of loads and their physiological and psychological effects

Program design in combat sports is based on a detailed screening of the athletic state of preparedness. Two main ways of screening are commonly used. First, periodical screening consists of laboratory and field tests that can provide helpful information about a fighter's initial state of preparedness, and this information is necessary for appropriate program design. Second, acute, continuous screening is used to control the current state of preparedness day by day. Everyday data are used for controlling the realization of training tasks, and they should have an influence on changes in program design.

Periodical screening consists of [Jukic et al., 2017]:

- training history (martial arts training history, current combat sports record, combat sports strategy, physical training history);
- health status (injury history, actual locomotor problems, immunological status);
- laboratory testing (age, gender, body mass and height, body composition, Functional movement screen, VO2max treadmill test, Lactate threshold test, BOSCO tensiometry protocol, bench press 1RM, squat 1RM).
- Acute control of the state of preparedness consists of:
- body weight;
- RPE;
- radar medicine boll throwing;
- CMJ;
- HR record of training routines;
- HR variability;
- CK, lactates;
- orthostatic test.

Required preparation, duration, and emphasis on promoting the athletes' abilities parallel to the game/competition schedule.

Program design is a complex process that includes determining general and particular training goals and ways to achieve them. The first phase of program design includes recognizing human, infrastructural and material conditions. The second phase involves selecting contents, loads, methods, locality, and equipment necessary to finalize the sports preparation process.

Recommended action for recovery and rebuilding to prevent overload and injuries. Required rest (active and passive) during various time periods to cope with the loads in games/competitions and training sessions. Inclusion of high-intensity training units during the game/competition schedule, the number, and placement of the units. Concentrated training days – scope, emphases, and placement in the training programs.

The traditional training periodization approach includes three training macrocycles. Each macrocycle composes of three distinct periods: a preparatory period, a competitive period,

and a transition period. During the preparatory period, which lasted 6 to 8 weeks, the weekly training was composed of three training sessions emphasizing the technical-tactical development (an increase in the number of techniques performed), three sessions involving combat simulations (aiming at aerobic and anaerobic development), two conditioning training sessions (focusing on maximal strength, strength endurance, and muscle power development), and one session designed to flexibility development. During the competitive period (4 to 7 weeks), athletes performed one to three technical-tactical training sessions (tactical analysis and tactical problem solutions), two to three sparing sessions (using the competition effort-pause ratio), and two physical conditioning sessions aimed at muscle power development. The transition period between macrocycles was 2 to 4 weeks long, focusing on active rest or meetings to discuss the athletes' evolution.

Periodization of combat sports programs depends on the number of official competitions planned in the one-year training cycle. Most year cycles have 2-8 competitions. The average duration of each preparation cycle for competitions lasts between 8-15 weeks. After every single competition, combat sports fighter spends 1-4 weeks in a recovery regimen. Rehabilitation from injuries and soreness is the main goal of this short recovery period. Also, this period is used for detailed analysis of the previous preparation period and last fight. The following preparation period usually starts with a low to moderate training week, including testing procedures and equipping a new team of sparring partners.

The primary training contents of each preparation period are specific (technical/tactical) and general (physical conditioning) preparations. Specific preparation in combat sports consists of standing and floor techniques (depending on the sport) and situational sparing (close to real competition situation). General (physical conditioning) preparation consists of neuromuscular (preventive, strength, strength endurance, power, agility, and mobility programs) and bioenergetics (aerobic and anaerobic programs).

While designing a program for a particular training cycle, all previous stages of sports preparation should be considered. The next training cycle is always recumbent in prior cycles. Constructing the program depends on athletes' training history, health status, current preparedness (physical, psychological, technical, and tactical), and competition schedule.

Example [Jukic et al., 2017]

The preparation period for the competition lasts nine weeks. The week before the beginning of the preparation is dedicated to regeneration and rehabilitation after the previous competition. For every training in the cycle (Table 1), time of training in a day (T), training duration (D), internal load through RPE (IL), and training goal (G) are presented. Additionally, every week is presented with arbitrary units (AU) of load (the sum of RPE values in training in the week x the total number of training minutes in the week). An estimate of the subjective load is taken from the athlete on a scale from one to ten, 30' after training. Technical and tactical training goals were set with primary combat sports content (PCSC), a specific combined type of training through the simulation of the fight – SPEC SIM, sparring – SPA (close to competition). The physical conditioning part of the training included: preventive-corrective

protocols (PCP), maximal strength training (FMX), strength endurance circuit training (SEN), strength endurance polygon training (POL), complex strength training (KPX), and aerobic training with different heart rate zones (AER).

The beginning of the cycle (first week) has been oriented towards the gradual introduction into training, including one training a day and low to moderate loads. Basic conditioning content included extensive aerobic training (Table 2), preventive-corrective protocols (Table 3), and strength endurance training (Tables 4 and 5). Technical-tactical training was oriented toward the development of special techniques of boxing and grappling. In the second week, the load was significantly increased in both physical conditioning and specific training. The conditioning part is represented by preventive-corrective protocols and maximum strength training, and extensive aerobic training. Specific training includes more intense and longer-lasting combat sports sequences of the program. The first peak of the load in the cycle was achieved in the third week. The most significant contribution to the intensification of the physical conditioning training is given by the basic polygon training (Table 6) and intensive aerobic training. Specific training is described with longer and more demanding sessions of primary combat sports content.

Table 1a. Preparation period training program [Jukic et al., 2017]

I	1	2	3	4	5	6	7
LOW WEEK (AU≈2200)							
T	10.00	10.00	10.00	10.00	10.00	10.00	
D	60	90	60	90	60	30	
IL	5	5	6	6	6	6	
G	PCSC	AER PCP SEN	PCSC	AER PCP SEN	PCSC	AER PCP	
II	8	9	10	11	12	13	14
HIGH WEEK (AU≈5150)							
T	10.00	10.00	10.00	10.00	10.00	10.00	
D	75	90	75	90	75	60	
IL	7	8	7	8	7	8	
G	PCP FMX AER	PCSC	PCP FMX AER	PCSC	PCP FMX AER	PCSC	
T	19.00		19.00		19.00		
D	75		75		75		
IL	7		8		7		
G	PCSC		PCSC		PCSC		
III	15	16	17	18.	19	20	21
HIGH WEEK (AU≈6000)							
T	10.00	10.00	10.00	10.00	1000	10.00	10.00
D	90	90	90	90	75	75	60

IL	8	8	9	7	9	8	8
G	POL AER PCP	PCSC	POL AER PCP	PCSC	POL PCP AER	PCSC	PCSC
T	19.00		19.00		19.00		
D	90		75		90		
IL	7		8		7		
G	PCSC		PCSC		PCSC		

The fourth week followed a reduction of the overall load in order to allow the body of the athlete to be regenerated from the two previous cycles and to avoid the state of overtraining. In that week, training duration and such conditions allowed the implementation of complex training (Table 7), which is focused on explosive properties. Aerobic training again takes on an extendable shape of lower intensity. The specific part of the training is more focused on technique and special preparations for the opponents. The fifth week followed a new high raising of the overall training load. This is also the last week of the high loads in which the athlete is exhibiting the accumulation of efforts that should cause delayed transformational effects in the upcoming micro cycles preceding the competition. Besides the preventive-corrective protocols and more extensive aerobic training, training with loads combines specific polygon training (Table 8) and maximal intensity training.

Table 1b. Preparation period training program [Jukic et al., 2017]

IV	22	23	24.	25	26	27	28
MODERATE/HIGH WEEK (AU≈3300)							
T	9.00	9.00	9.00	9.00			
D	75	60	75	60			
IL	6	8	6	8			
G	KPX PCP	PCSC	KPX PCP	PCSC			
T	19.00		19.00				
D	75		75				
IL	9		9				
G	PCSC		PCSC				
V	29	30	31	32	33	34	35
HIGH WEEK (AU≈5400)							
T	9.00	9.00	9.00	9.00	9.00	9.00	
D	75	90	75	90	75	60	
IL	9	8	7	8	7	8	
G	POL AER PCP	PCSC	FMX AER PCP	PCSC	POL AER PCP	PCSC	

T	19.00		19.00		19.00		
D	75		75		75		
IL	8		9		7		
G	PCSC		PCSC		PCSC		
VI	36	37	38	39	40	41	42
MODERATE (AU≈ (2900)							
T	9.00	9.00	9.00	9.00	9.00	9.00	9.00
D	60	75	60	60	60	60	60
IL	8	7	8	8	6	9	9
G	PCSC	FMX AER PCP	PCSC	KPX BOX PCP	PCSC	SPA PCP	KPX SPA
T		18.00					
D		75					
IL		8					
G		PCSC					

The specific training simulates the energetic and neuromuscular conditions of the competition. In the sixth week, the load was decreased, dominantly at the account of more moderate specific training, which has generated the largest amount of load in the previous cycles. Maintaining high intensity in the micro cycle ensures physical conditioning training of one by one maximal intensity training and complex training, as well as maximal aerobic training.

In the seventh and eighth weeks, a trend of maintaining moderate loads was continued, which should secure the stabilization of conditional readiness. In these micro cycles, the proportions of the conditional content (preventive/corrective protocols and complex training) decreased, and specific ways of training dominated. Sparing matches and the simulation of realistic competitive conditions increase the intensity of the training, but at the same time, they cause a decrease in the general volume of training loads. With this approach (tapering), conditions for improvement upon energetic and neuromuscular characteristics of the fighter are ensured, which enables him the maximal level of competitive efficiency. In the ninth week, the training process aimed to maintain the physical conditioning state exclusively with specific content with a reduction of the total load.

Table 1c. Preparation period training program [Jukic et al., 2017]

VII	43	44	45	46	47	48	49
MODERATE WEEK (AU≈3400)							
T	9.00	11.00	11.00	9.00			
D	60	90	75	60			
IL	8	10	8	7			
G	PCSC	SPA SIM	SPA PCP	PCSC			

VIII	50	51	52	53	54	55	56
MODERATE WEEK (AU≈3100)							
T	10.00	10.00	10.00	10.00	10.00	10.00	
D	90	75	60	60	60	60	
IL	9	9	6	7	8	7	
G	KPX SPA PCP	SPA	PCSC PCP	KPX	PCSC PCP	PCSC	
IX	57	58	59	60	61	62	63
LOW WEEK (AU≈1350)							
T	10.00	10.00	10.00	TRAVEL	10.00	10.00	10.00
D	90	75	60		60	60	Competition
IL	8	8	7		8	8	
G	SPEC SIM PCP	SPEC SIM	SPEC SIM PCP		AER SPEC SIM	SPEC SIM	

T – day time; D – training duration; IL – internal load (RPE); G – training goal; AU – arbitrary units-RPE; PCP – preventive/corrective protocols; PCSC – primary combat sports content; SPA – sparing training; SPEC SIM – specific simulation training; SEN – strength endurance training; FMX – maximal strength training; POL – polygon strength endurance training; KPX – complex strength and power training; AER – aerobic training.

Table 2. Aerobic training parameters [Jukic et al., 2017]

Exercise	Modality	Intensity/Tempo	Repetition/Duration	Sets	Rest Intervals/Circles
Standard Aerobic Running	Extensive	50-75% HR Max	1 X 20-30'	1	
Fartlek Aerobic Running	Intensive	75-90% HR Max	Warm Up 5' 10km/H, 20' Alternate 12/16 km/H, Cool Down 5' 8 KM/H	1	
Interval Aerobic Running	Vo2 Max	90-95% HR Max	Warm Up 5' 8-12 km/H, 2-3' 15-18 km/H, Cool Down 10' 8 KM/H	3-5	1-2'

Table 3. Preventive/corrective training parameters [Jukic et al., 2017]

Exercise	Intensity/Weight	Intensity/Tempo	Repetition/Position	Sets	Rest Intervals/Sets
Classic Plank	Body Weight	Static	30-90''	3-5	1'
Crunches	Body Weight	Moderate	45-90	4-6	1-2'
Back Extension	Body Weight	Moderate	20-40	4-6	1-2'
Fore Arm Flex	Barbell + 10-20 Kg	Moderate	10-20	4-5	1-2'
Neck 4 Sides (Conc/Ecc)	Manual Resistance	Moderate	8-10	3-5	1-3'
Mobility Complex (5-10 Exercises)	Body Weight	Slow/Static	10-45''	1-3	20-30''

Table 4. Strength endurance (circuit training) parameters (''A'' protocol) [Jukic et al., 2017]

Exercise	Intensity/Weight	Intensity/Tempo	Repetition	Sets	Rest Intervals
Pull Up	Body Weight	Moderate	12-20	6-8	Exercise – 10-20'', Circuit – 3-4'
Dips	Body Weight	Moderate	20-30	6-8	Exercise – 10-20'', Circuit – 3-4'
Dead Lift	80-100 kg	Moderate	8-10	6-8	Exercise – 10-20'', Circuit – 3-4'
Bench Press	80-110 kg	Moderate	10-15	6-8	Exercise – 10-20'', Circuit – 3-4'
Squat	80-160 kg	Moderate	8-10	6-8	Exercise – 10-20'', Circuit – 3-4'
Curl Press	30-40 kg	Moderate	12-15	6-8	Exercise – 10-20'', Circuit – 3-4'

Table 5. Strength endurance (circuit training) parameters (''B'' protocol) [Jukic et al., 2017]

Exercise	Intensity/weight	Intensity/tempo	Repetition	Sets	Rest intervals
Dumbbell Row	24-30 kg	Moderate	12-15	6-8	Exercise – 10-20'' Circuit – 3-4'
Push Up	Body Weight	Moderate	30-40	6-8	Exercise – 10-20'' Circuit – 3-4'
Dumbbell Lunge	Db 14-20 kg	Moderate	8-10 Each leg	6-8	Exercise – 10-20'' Circuit – 3-4'
Dumbbell Arm Curl	20-36 kg	Moderate	10-12	6-8	Exercise – 10-20'' Circuit – 3-4'
Dumbbell Jerk	16-24 kg	Fast	8-10	6-8	Exercise – 10-20'' Circuit – 3-4'

Table 6. Basic polygon/strength endurance training parameters [Jukic et al., 2017]

Exercise	Intensity/Weight	Intensity/Tempo	Repetition/Position	Sets	Rest Intervals/Circles
Squat	80-120 kg	Con –Fast, Ecc-Mod	8-10	6	2'
Dips	Body Weight	Moderate	8-10	6	2'
Dead Lift	80-100 kg	Con –Fast, Ecc-Mod	8-10	6	2'
Curl Push	Barbell 20-40 kg	Con –Fast, Ecc-Mod	8-10	6	2'
Lunge	Body Weight	Moderate	8-10 Each leg	6	2'
Pull Up	Body Weight	Moderate	6-10	6	2'
Push Up	Body Weight	Con –Fast, Ecc-Mod	15	6	2'
Military Cycle (DB)	2x10 kg	Fast	8-10	6	2'

Table 7. Complex strength/power training parameters [Jukic et al., 2017]

Exercise	Intensity/Weight	Intensity/Tempo	Repetition/ Duration	Sets	Rest Intervals/ Circles
Dead Lift+ Guillotine Lifting the Opponent	80-100 kg+ Opponent Body Weight	Moderate/ Explosive	5-8	6	3'
Bench Press+ Pushing the Opponent from Laying Position	80-100 kg+ Opponent Body Weight	Moderate/ Explosive	5-8	6	3'
Squat+ Ejection of the Opponent from Laying Position with Raising	80-100 kg+ Opponent Body Weight	Moderate/ Explosive	5-8	6	3'

Table 8. Basic/specific polygon training parameters [Jukic et al., 2017]

Exercise	Intensity/Weight	Intensity/Tempo	Repetition/Duration	Sets	Rest Intervals/Circles
Dead Lift	80-100 kg	Con –Fast, Ecc-Mod	8-10	6	1-3'
Laying/Stand Up	Body Weight	Moderate	8-10	6	1-3'
Curl Push	20-40 kg Barbell	Con –Fast, Ecc-Mod	8-10	6	1-3'
Tie Catch	Opponent Body Weight	Fast	8-10	6	1-3'
Pull Up	Body Weight	Moderate	8-12	6	1-3'
Push Up	Body Weight	Moderate	10-15	6	1-3'
Double Abb Flex	Body Weight	Moderate	10	6	1-3'
Spro	Body Weight	Fast	10	6	1-3'
Box Bag Punches	Body Weight	Fast	45''	6	1-3'

Conclusion

In the off-season or at the beginning of the preparation period, a training methodology to increase muscle mass can be applied if necessary. A combat sports athlete must possess tactical excellence and be able to perform the complex skills necessary for success in combat sports, and in order to move well and efficiently, it is necessary that the required patterns of movement must not be postural disorders or incorrect activities and muscle imbalance. It is essential to train following the laws of sports training, and strength training is conducted at the end of training and in the afternoon training in order to maximize the effects of exercise.

In addition to the above, top combat sports athletes must include morning running to lift the body and increase the total amount of training.

Large physical and mental loads in combat sports demand the use of appropriate recovery methods. A significant part of combat sports training provokes intensive metabolic reactions. Lactate level during training and competition reaches values of 8-22 mmol/l. Also, explosive and fast movements and overcoming significant external loads have consequences in neuromuscular exhaustion. All previous facts are the main reasons for using both methods for energetical and neuromuscular restitution.

Some of the most common recovery methods are: sleep management, active recovery methods (capillarization running, stretching, limb shaking, foam rolling), adequate nutrition and rehydration strategies, nutritional ergogenic aids (isotonic, whole proteins, amino acids, carbohydrates, nitrates, sulfates, vitamins, and minerals), physical methods (cold bath, contrast bath, sauna, steam bath), massage and biotherapy. Each method is meant for a different type of training and a different phase of the preparation process or competition.

WELL-TRAINED PROFESSIONAL ATHLETES– RECOMMENDATIONS FOR LOAD AND RECOVERY PROGRAMS

	Judo	Wrestling	Sambo	Karate	Boxing
Max. no. of competitions during the year	6-8	4-6	4-6	6-8	3-5
Frequency and distribution of competitions	2 months	3 months	3 months	2 months	4 months
Monitoring & regulation for planning loads	Min. 3 per year	Min. 2 per year	Min. 2 per year	Min. 3 per year	Min. 2 per year

Recovery and rebuilding actions	Min. 1 week after the competition	Min. 2 weeks after the competition	Min. 2 weeks after the competition	Min. 1 week after the competition	Min. 2 weeks after the competition
Rest	Min. 1 day per week	Min. 1 day per week	Min. 1 day per week	Min. 1 day per week	Min. 1 day per week
Preparation	8 weeks	12 weeks	12 weeks	8 weeks	16 weeks
High-intensity training units	See table 1	See table 1	See table 1	See table 1	See table 1
Intensive days & training camps	See table 1	See table 1	See table 1	See table 1	See table 1

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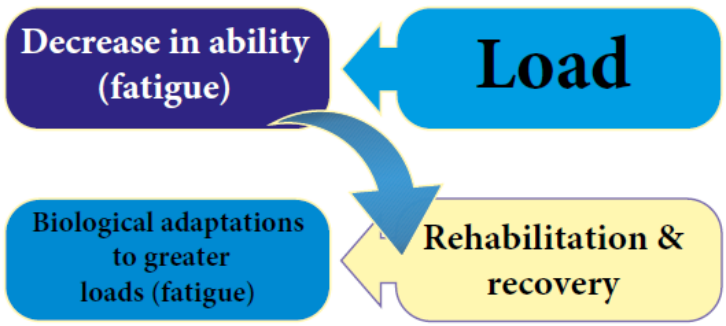
Dr. Yitsik Ben-Melech, Dr. Georgios zigos

Introduction to the process of loads and biological adaptation

1. Introduction

In order to improve abilities and performance, appropriate stimuli are required. Only when the increase in load is systematic, graded and correct, the level of performance can be improved. The ability in competitions or matches depends on the intensity of the stimuli and especially on the biological adaptation to these stimuli.

The biological process following training and playing



There are principles and rules for loading and recovery, but above all we must remember:

• It is the intensity of the loads that determines the performance

• Participation in high intensity match/competition and training allows better development.

• Incorrect planning at the higher levels may cause injuries, overload and delay in achievements

Training elite teams or players is a complex process that includes many factors, because improving performance involves a series of physiological changes in the human body as a result of training. For a beginner athlete, the improvement in performance is not so difficult because there is a lot of room for adaptations in almost all body systems. On the other hand, in elite athletes, significant physiological adaptations have already occurred as a result of a long-term training process. Therefore, the space for further physiological adaptations is narrow. In this case, training requires a very fine balance with careful short and long-term planning for volume, intensity and frequency in order to allow small physiological adaptations without overtraining the athlete.

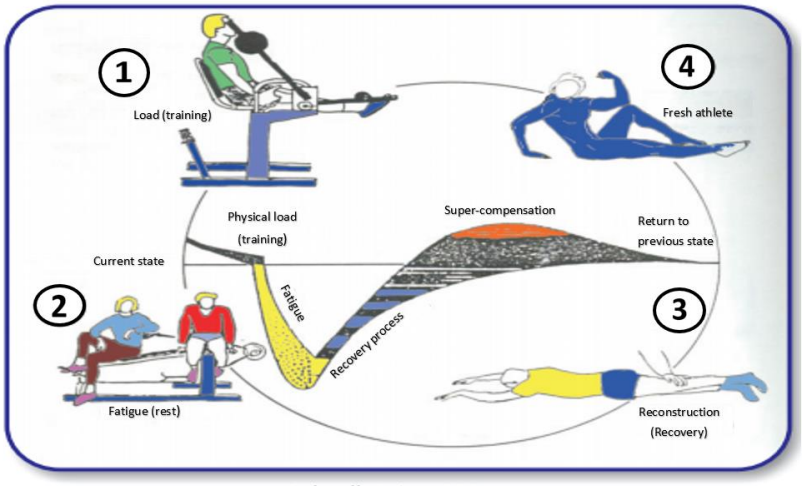
External load versus internal load

In sports literature, training load is divided into external and internal load. External load refers to the load performed by an athlete (e.g. total distance, running distance at high speed, weight lifted, etc.). This is usually measured by external EPTS.

Internal load refers to how the body or the athlete perceives the training load (e.g. heart rate, blood lactate response, HRV response - changes in heart rate, RPE, FAS, creatine kinase concentration, free testosterone to cortisone ratio, etc.) and can be measured by subjective scales, biochemical analysis or modern devices that measure internal responses (e.g. heart rate monitoring devices or changes in heart rate, etc.)

2. Biological loading and adaptation processes

The process of loading, fatigue, recovery and adaptation is shown in the figure below:



Schnell, Spitz 1986

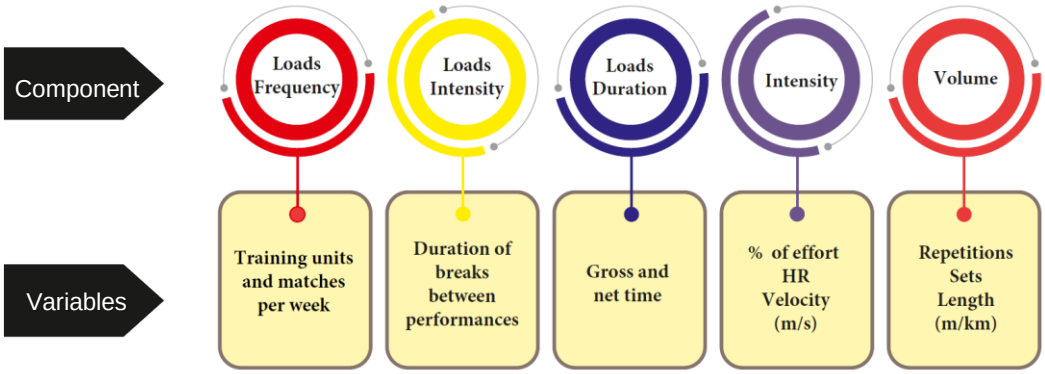
It must be considered that physical load (external load) causes physiological changes (internal load) such as:

- Increased heart rate
- Increased body temperature (up to 40-39.5 degrees Celsius)
- Increased lactic acid concentration
- Depletion of glycogen storage.

The coach may notice fatigue through the following signs:

- Sweat
- Pallor or flushing
- lack of focus
- Slow recovery rate
- Distorted technique
- Lack of motivation and bad mood
- Athlete's complaints (expansion on fatigue and overtraining - at the end of this chapter).

3. Loading Components in physical training



In the training process, all the elements shown in the figure are important, but only balanced planning in accordance with principles of training theory will improve the ability to perform, and as a result, achievements will improve. Intensity is of utmost importance in improving achievement. In fact, intensity determines the degree of improvement in ability. However, the risks inherent in high intensity of matches and training must be kept in mind:

- Training overload
- Injuries
- Mental and physical fatigue

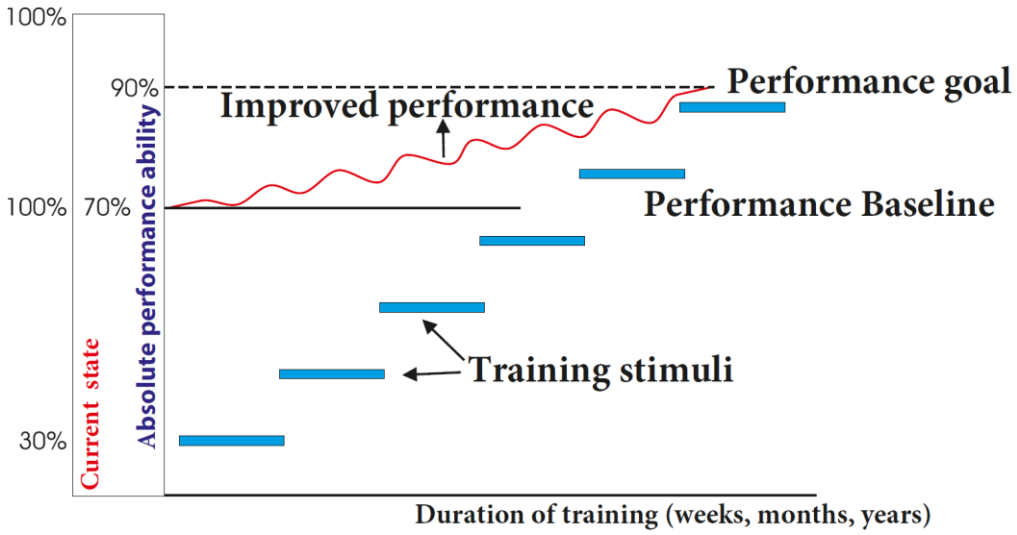
4. The principles of loads in sports training:

- Increasing the load
- Persistence loading
- Alternating load
- Correct sequence of loads
- Personal load
- Periodization of loads

4.1 The principle of increasing the load

To improve performance, we must increase the load in a methodical, graded and constant manner. In the following figure you can see the development of performance: for an untrained athlete, the current potential is only 70% of the potential that exists in him, a low level of about 30% is enough to improve his ability. After series of trainings, competitions and matches, he must increase the loads, and when he reaches a high achievement level, he must increase the loads to least 70% in order to improve or at least maintain his achievements.

Optimal development of the training process



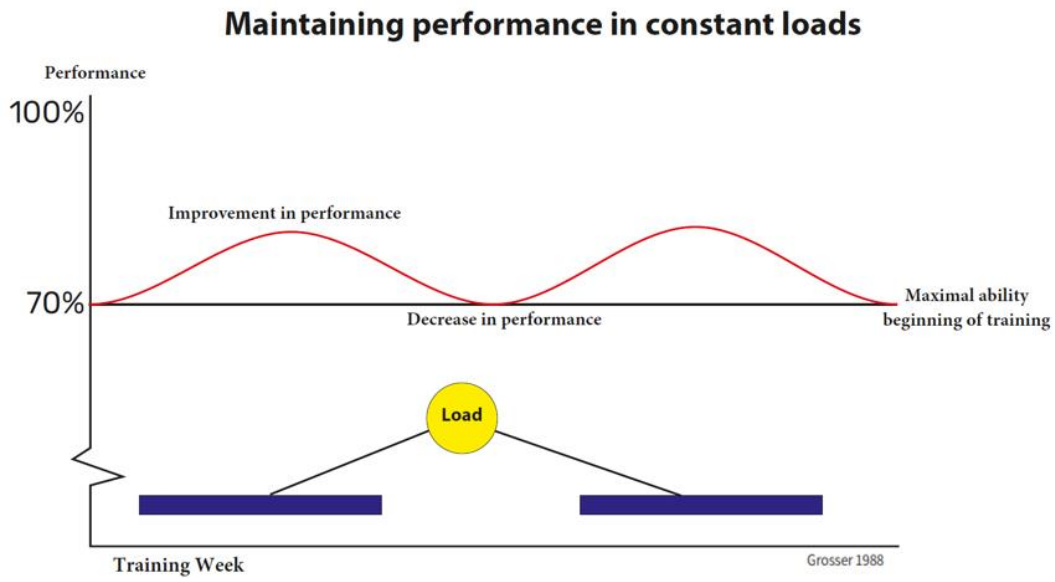
In the process of training and competitions/matches, it is necessary to observe a gradual increase in the volume of the loads, intensity of the loads, frequency (number of units per week) and duration of the loads. Without such an increase, there will be no improvement in performance in the results, however, rapidly increasing the loads will not allow the athlete to contain the loads and will cause injury.

To deal with a gradual increase in loads, light loads must be combined with recovery periods next to heavy loads.
The increase in loads is gradual and measured over time.

4.2 Principle of load persistence

In many cases, athletes train in components of ability, volume or intensity that they have no chance of persisting with. In this way, they may damage the basic ability, since stopping training after adaptation is causing a decrease in ability and reaching below the initial state. It is important to remember: it is better not to train at all than to train with physical loads that cannot be sustained!

Maintaining the ability to achieve under constant loads



In many cases we witness that during training process, coaches include new and unusual loads, such as maximum strength training during the preparation period in ball games and breaks during the league period.

Although training gradually and regularly in such loads is important for the athlete's development, inclusion of such loads and their complete cessation can damage the strength capacity.

This is the case in non-competitive fields, where you try to start physical activity for the purpose of weight reduction or for the sake of aesthetics: starting physical activity with high intensity and frequency and stopping afterwards will cause more harm than good (similar to a short-term diet).

4.3 Principle of alternating load

Loads in different components of strength, speed, flexibility, endurance and coordination require different volume, intensity and duration of recovery. To optimize the training process, different combinations of load components and their types are necessary.

Example of combinations between ability components in a training week at load

Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat (Match)
Load's Volume	5	1	3+3 (2 units)	4	3	2	5
Load's Intensity	1	1	4	4	-4	3	5
Physical fitness components	Aerobic endurance, Flexibility	Muscle Endurance	Speed, Strength, CV Endurance	Explosive strength, Muscle endurance	Speed	Flexibility Speed	Combined loads

levels of 1-5

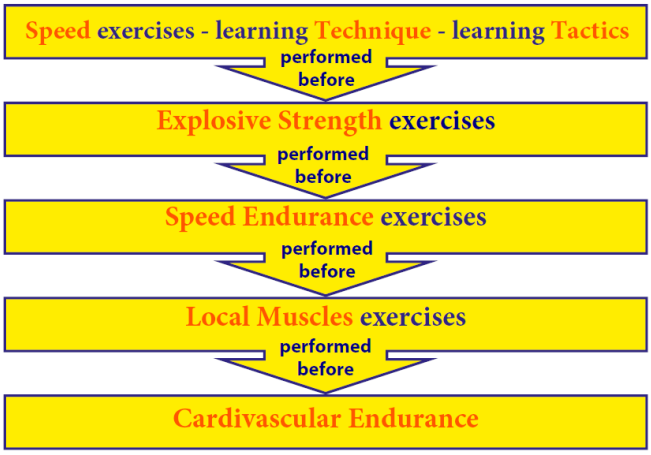
Diversity is important both mentally and physically:

- An athlete needs diversity to mentally cope with a dense and strenuous load process
- An athlete needs a diverse and broad base to fulfill his ability in the sports profession.

4.4 Principle of correct sequence of loads

Sequence of loads principle is especially important in training units and cycles where the goal is to practice different elements of performance. In training theory, there are very clear principles and rules for the load of the various components of ability:

A. Before technique learning, speed development, explosive force and coordination, the player is required for a full recovery.
B. It is possible to practice and train muscle endurance and cardiopulmonary endurance also in the condition of fatigue.
C. The correct load sequence is as follows:



4.5 Principle of personal training

Because of the differences between the abilities of athletes, the training process should also include personal training, which takes into account the athlete's ability to withstand loads, recovery rate, development rate and of course, his sports' history. In team sports, it is important to have personal training and team training according to the current physical condition of the players and according to their roles in the team.

The volume and duration of training within the team does not allow the inclusion of all required elements for athlete's training. Since most of the trainees have no other "street activity" apart from the sports framework, we must fill in the gaps with personal training or guided "homework".

In addition, we must remember that in a group of athletes there are always different levels of ability and background, therefore a significant part of the athletes do not receive appropriate loads during training.

Therefore, personal additions and enrichment of the team's training program (in ball games and individual disciplines) is required.

The options are:

- "Homework" dictated by the coach
- Personal enrichment and completion before or after training
- Enrichment and completion in morning training or on a free day
- Enrichment and completion during vacations in "concentrated days"

Enrichment and completion can be included in all training aspects:

Technical, mental, physical, social, educational and cultural aspects.

The key principles of progressive individual loading are fundamental to performance improvement, as different athletes may respond differently to similar training programs. Also, a training load that is too low will not provide an adequate stimulus for adaptation. On the other hand, an excessive training load may lead to overtraining, a decrease in performance and delay the increased compensation process (super compensation). Therefore, managing the training load is critical in order to avoid insufficient or excessive training load and to improve performance.

4.6 Principle of periodicity in load (periodization)

From a physical and mental point of view, the athlete is unable to keep up with the limit of his competitive ability all year round. Every period of time requires relaxation and recovery.

- During the training week - 1-3 intense training units or match/competition should be implemented.
- Every 7-8 weeks, the player should receive few days of recovery and lightening of the loads so that he can improve his competitive ability.
- Every 15-20 weeks the athlete needs a short recovery period and renewed preparation.
- In each year of training and competition matches, the athlete needs a rest period of 3-4 weeks followed by a preparation period of 3-7 weeks.
- During of training and matches, the combination of load and recovery must match the changes and the periodic characteristics. Only in this way is it possible to reach the desired capacity at the right times.

Division by periods

The periodic division includes:

- Preparation period
- Period of matches/competitions
- Transition period - break.

The preparation period:
during this period, basic preparation of the athletes is carried out for the matches/competitions period. In the modern era, the preparation period is relatively short, and usually takes place twice a year. The main preparation period in ball games lasts 3-6 weeks, and the secondary preparation period lasts 10 days to 4 weeks. This period creates basic techno-motor and other required conditions for achievements and training loads during the competitions/matches period.

The period of the competitions/matches:
the period of time in which the optimal formation and stabilization of the competitive ability. During this period the main goal is to develop the performance capacity and stabilize it. The training includes unique and game exercises. The intensity of the loads reaches its peak.

The transition period - break:
this period of time is used for mental and physical recovery both mentally and physically, as well as breaking the sequence of loads, treating health, environmental and personal problems. The goal during this period is the player's rehabilitation, while emphasizing the relief of fatigue. The transition period lasts up to four weeks.

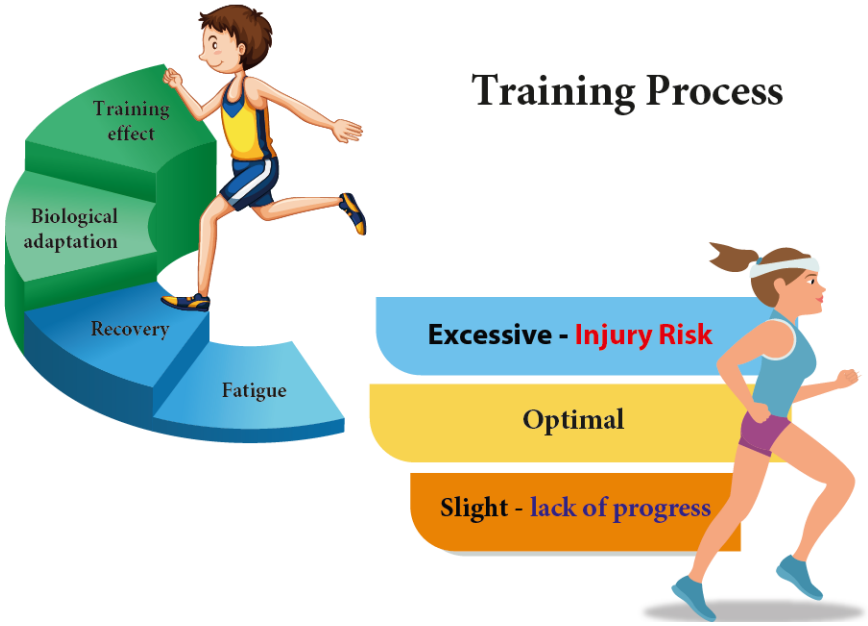
Planning of the loads during training and competitions/matches must be very precise and careful.

In the vast majority of sports, the training load is not routed at all, or it is routed discontinuously (specific days only) using a crude index (training time) or using an index from modern monitoring devices (distance/weight/power). For example, in swimming or cross-country running sports, total distance is typically used to route load. Also, in resistance sports such as weightlifting, daily total weight is commonly used as a tool to measure load.

Some fitness trainers use measures related to heart rate (time spent above a certain heart rate or average training heart rate), blood lactate concentration, etc., while others use specific load or metabolic measures derived from algorithms found in wearable cameras or electronic performance tracking systems (EPTS). Examples of these measurements are fatigue index, dynamic stress load, total load, total impacts, etc.

The thin path - the art of the coach!

The coach must balance between a process with loads of intensity, density, volume, frequency or duration that are too high and will lead to delay or regression in development and sometimes injuries, and a process with loads of intensity, density, scope, frequency or duration that are too small, preventing the possibility of development.



Decisions regarding loads are determined on the basis of extensive and accumulated experience in high-competitive sports, training processes, competitions/matches, methodical and scientific principles and mainly according to the coach's sensations about the athlete, his ability, sporting history and his ambitions. In the training process it is important to avoid increasing and intensifying the loads in a way that would harm the optimal development.

Increasing the number of training units or the intensity, volume, frequency of the loads by more than 5-10% in each cycle (6-8 weeks) or by more than 25-30% per year is “jumping” too high, which can cause damage and stop the development at a later stage. Also, significantly increasing the number of competitions/matches or their level and quality will cause damage in the short term, the medium term and in the long term.

Moreover, in training and competitions/matches, the following rules are required:

- A small cycle (7-10 days) required for a rest day (a day free from training)
- In a medium cycle (6-8 weeks) one week with lighter loads is required in a secondary preparation period of 1-2 weeks.

- **In a large cycle within an annual program (20-24 weeks) a break of 7-10 days and a secondary preparation period of 1-2 weeks are required.**
- In a large annual cycle, a break period of 3-4 weeks is required (from an active-passive phase) as well as an initial preparation period (4-7 weeks in ball games, and 12-20 weeks in individual sports).
- After a day of rest - preference for training with light to moderate loads.

5. Load planning for a competitive task:

5.1 Before an important competition in long runs (marathon, 10,000 m):

- 4-5 half-distance running competitions during the last two years;
- Last important competition around 6 weeks before the main event;
- 10-12 long-distance preparatory competitions during the last year;
- 10,000-5,000 km per year, in the last two years;

Load planning

Volume: 100-200 km per week

Intensity: 30% at a slow pace

30% at high intensity

40% at medium intensity

Frequency: 8-12 training units for 6 days a week

Enrichment and additions

About 100 minutes a week strengthening, flexibility and coordination

Loading for the event

• Very intense loads up to 6-8 days according to the main competition;

• Maintaining the volume of the loads, reducing the intensity in the week before the main competition.

5.2 Before the start of the soccer league (adults):

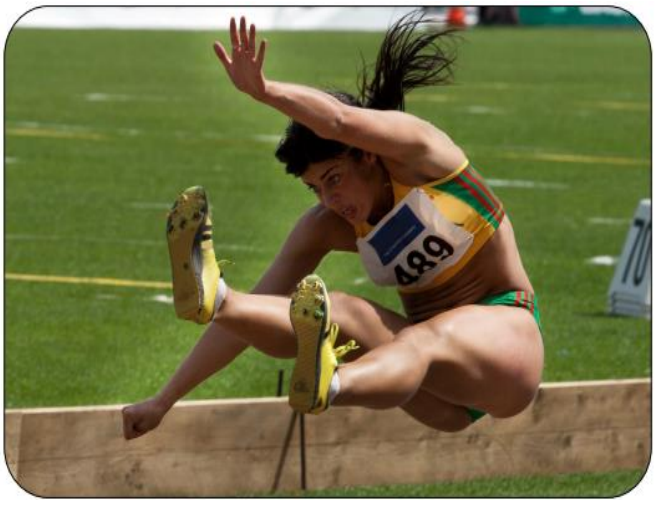
- 12-15 days of break from previous game season (active and passive)
- 30-50 days of general and unique preparation towards the start of the league games;
- 8-6 preparation games;
- Incorporating a training camp or intense general physical loads for 5-7 days, 3-4 weeks before the first league game;
- Incorporating a training camp or intense loads of technique-tactics field, in a time frame of up to 10 days before the first league game.

5.3 Before a main competition in a combat profession: judo/jiu-jitsu/wrestling:

- 10-15 fights in 6-8 competitions during the activity season before the main competition
- Last battle simulation about 7-10 days before the main competition;
- Last competition around 3 weeks before the main event;
- A training camp or concentrated training with high intensity and volume loads, up to 4-6 days before the main competition.

5.4 Towards a main competition in a technical profession such as long jump and shot put:

- 6-4 competitions during the last active season;
- Last important competition 4-6 weeks before the main competition;
- In technical professions, more competitions can be held during the year.



To succeed you must be critical and always strive for better performance

6. **Recovery, reconstruction and overload processes of an athlete.**
   Recovery processes are just as important as loads. As the level of training increases, the athlete is required for more recovery actions.

Some actions require complete recovery before performing them:

- Learning technique and coordinative training;
- Training that requires high concentration;
- Training to improve speed and explosive power;
- Matches.

In contrast, there are actions that do not require recovery, and can be performed in a state of fatigue

- Cardiopulmonary endurance exercise;
- Exercise for muscle endurance;
- Exercise for speed endurance;
- Practice of willpower and fighting spirit.

Subjective effort or fatigue measurements such as Rating of Perceived Exertion (RPE) or Fatigue Severity Scale (FSS) or Fatigue Assessment Scale (FAS) are also used as a single measure or in combination with training time (e.g. RPE * training time) in an attempt to assess training load.

Table 1: Common methods for assessing training load

training time	Weekly, monthly, quarterly, yearly
Total distance covered	Weekly, monthly, quarterly, yearly
Distance covered at high intensity	Weekly, monthly, quarterly, yearly
Distance covered with high metabolic load	Weekly, monthly, quarterly, yearly
Other markers of load or fatigue such as dynamic stress load, fatigue index, total load, etc.	Weekly, monthly, quarterly, yearly
Time above heart rate threshold	Weekly, monthly, quarterly, yearly
load lifted (weight)	Weekly, monthly, quarterly, yearly
Metabolic load or equivalent metabolic distance	Weekly, monthly, quarterly, yearly
RPE	Weekly, monthly, quarterly, yearly
RPE * training time	Weekly, monthly, quarterly, yearly
acute to chronic workload ratio (ACWR)	weekly
Blood/biochemical markers such as free testosterone to cortisol ratio, creatine kinase, etc.	monthly or bimonthly

The actions for recovery and reconstruction are these:

Sleep and rest

The need for sleep and rest is relaxation for the mind and body. The more tired we are (physically or mentally), the more we need a larger dose of "deep sleep" (REM sleep). This stage is the fourth stage of the sleep cycle (lasts 90 minutes).

Sleep is important for the physical and mental functioning of every person, but sleep for the training athlete is of greater importance than usual, and it is even greater and more critical for the young training athlete.

Sleep is a physiological state during which the body is in relaxation. As a result, we are able to function physically and mentally.

Recovery and rebuilding

In physical efforts, physiological changes occur in the body. In fact, after prolonged effort and fatigue there are reactions that are similar to a disease state. In training children and, you can find an increased heart rate (up to 230-220 beats per minute). The body temperature increases (up to over 39.5), and there is a noticeable increase in the concentration of lactic acid; On the other hand, there is a decrease in body fluids, depletion of collagen reserves, and more.

Following exercise, there are 3 types of fatigue:

- Muscle fatigue
- Physiological fatigue
- Mental fatigue
- In addition to fatigue caused by injuries such as warts, teeth and ingrown toenails.

Expression of fatigue:

- Pain
- Hypersensitivity
- Lack of motivation
- Depression and moodiness
- Poor sleep
- Lack of appetite.

During exercise, carbohydrate reserves are converted into glycogen, and after these reserves are depleted, the breakdown of fats begins.
The amount of oxygen to the muscles decreases, and at this stage there is slight dehydration.
When anaerobic processes begin, lactic acid accumulates, contractions appear, and the rate of activity slows down.
With the depletion of the sugar reserves in blood, a situation where the brain has no "available fuel", which is accompanied by dizziness and exhaustion (mental and physical).
As a result of a changing levels of sodium (electrolytes) there is pain in the joints, the blood becomes thick, viscosity is created in the bloodstream, higher blood pressure, and there is exhaustion.

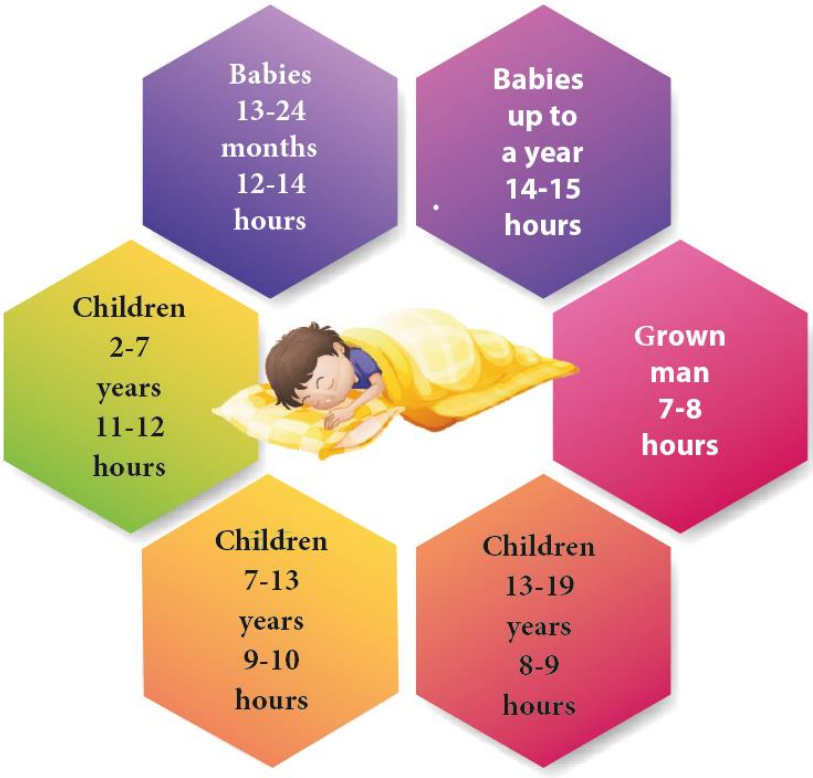
Recovery and regeneration are parts of training and matches process

In order to gain achievements and a high level of training, the athlete is required to perform recovery, rehabilitation and regeneration operations with high frequency. When the athlete risks the balance between the demand for excessive effort and the required recovery and rehabilitation, he endangers not only his health but also his ability to renew and increase efforts and performance.

Duration, quality and time of recovery determine directly the effectiveness of training!

Lack of sleep causes exhaustion. Continuous sleep, at required time (see table), helps to improve the athlete's ability to deal with physical and mental loads. The amount of sleep per day depends on age, gender and environmental conditions.

Required hours of sleep:



The quality of sleep is extremely important, and during sleep all our senses need to rest. Lack of sleep can cause irritability, lack of concentration and unexplained depression.
The most effective hours for sleep are the night hours (darkness). During these hours, when there is no solar energy, it is possible for the physical body to be in a state of sleep, relaxation and the charging of new energy.

Table shows important sleep hours

22:00	Optimal sleeping hour
24:00	-
01:00-04:00	Deep quality sleep
06:30	Optimal wakeup hour
07:00	Breakfast
10:00-11:00	Optimal performance hour
13:00	Lunch
14:00	-
17:00	High performance hour
18:00	-
20:00	Dinner

7. **How to recover from exercises?**


There are several ways to recover during training or competition/match:

- light running ("jogging") without effort and with complete relaxation of the muscles of the upper body
- Stretching, static and dynamic flexibility
- Mental exercises, concentration, positive thinking (remember that the opponent is always more tired)
- Complete or active rest (walking)
- Drinking and refreshment

Between training or after the competition/match:

- Light, long runs on flat and flexible terrain
- Massages, hot and cold baths, jacuzzi
- Flexibility exercises, mainly static
- Light activity such as dancing, concert dancing, aerobics, amusement games, recreational games, etc.
- Mental activity - reading a book, watching a movie, dealing with theoretical subjects that are not the main sport.
- Showering, changing clothes and shoes immediately after exercise.

8. **(Over) Training/Load**

Three types of over-training cause functional problems in soccer players:

- **Muscle overload (local)** resulting from great effort on a certain muscle group;
- **Physiological overload** that usually results from intensive and dense loads;
- **Mental overload** resulting from satiety, conflict or mental stress

Athletes of various levels fall into a situation of overload, but it is precisely athletes of a high level, who train at a high level of intensity and do not pay attention to recovery processes, that are affected the most.

A distinction must be made between overexertion, which is the result of a heavy load that does not match the player's fitness level, and overload, which is actually chronic fatigue.

Causes of overload

Overload usually results from a combination of the following factors:

- Highly dense and heavy loads in competitions/matches and training;
- Inappropriate lifestyle, especially not for the player's level of training;
- Training during infectious disease;
- Poor nutrition and lack of essential nutrients;
- Mental stress, social or family crisis, stress in studies or work during training and matches/competitions;
- Long breaks between training periods and matches/competitions and non-gradual return.

Signs of overload

From a physiological point of view, it is possible to check a state of overload with CPK (creatine kinase) enzyme in the urine. CPK is measured in the morning, before breakfast and before any activity.

A deviation from the normal value indicates an overload condition.

The coach may notice overload according to the following signs:

- **Lack of appetite**. Despite the great effort in training and great fatigue, athlete has no appetite.
- **Irregular Sleep** or Restless. Despite the high-intensity training or difficult training series, the player's sleep is impaired. He has difficulty falling asleep or he wakes up after a short time, and in the morning he is tired.
- **Lack of motivation**. The athlete lacks drive and motivation in training and matches. He has no desire to train intensely.
- **Depression and low mood**.
- **Sensitivity**. Any external stimulus gets an exaggerated response.
- **Complaints** about physical activity.
- **Constant fatigue.**

Functional changes can be observed:

- **Decrease in achievements**. Decrease in the athlete's achievements in the training and match/competition components.
- **Slow recovery**. Slow return to athlete's normal state after exertion.
- **Loss of body weight** mainly due to lack of appetite.
- **Pulse**. Heart beats faster at rest and during recovery.
- **Blood Pressure**. Systolic blood pressure is higher than normal.
- **Muscle aches**.

The damage due to overload is mainly focused on these body systems:

- **Nervous System**. The damage to the nervous system will manifest in an emotional imbalance.
- **The motor system**. The damage to the motor ability will cause disruption in various components of movement, including coordination, technique and speed ability.
- **Vital body organs**. Organs that supply oxygen to the muscles will be damaged, including the heart and the respiratory system.

Over-training is a general syndrome manifested in temporary or chronic fatigue of the nervous central system, body systems and metabolism, impairing muscle function, recovery process after exertion, and results in a general decline in physical condition

Treatment of overload includes:

- Rich protein diet.
- A significant decrease in the intensity of training and the cessation of matches participation.
- Practicing various sports and non-routine training.
- Changing the place, social company and participants of activity.

Advantages and disadvantages of common methods for evaluating training load

Although the purpose of the article is not to explore detailed methods that are commonly used to monitor training load, the advantages and disadvantages of the most common external, internal and subjective methods are presented below.

Modern outdoor wearable devices are commonly used in team sports such as football, basketball, soccer, etc. EPTS is used in combination with micromechanical devices such as gyroscopes, accelerometers, gravitometers which are equipped with fast processors in order

to measure several variables related to movement and loads of the player. The most common external variables used are total distance, high-speed running distance (> 19.8 km/h), sprint distance (> 25.2 km/h), average metabolic load (AMP), and number of intense accelerations and deaccelerations. In addition, they can measure intervals between the load indicators that are related to heart rate measurements. These devices are strong, light, non-invasive, accurate and can transmit a lot of information in real time during training. In addition, data can be viewed, analyzed and saved for long-term user in order to monitor loads and performance. With the help of additional equipment (antennas, ultra-smart band technology, Bluetooth and Wi-Fi receivers) they can also be used indoors.

Disadvantages include cost, relatively limited number of measurements, installation time, time for detailed data analysis, skilled personnel, which increases the overall cost of use.

Internal load devices such as pulse receivers are easy to use at a relatively low cost and do not require additional training. On the other hand, they do not provide data related to external load. Also, the late heart rate response during sudden changes in speed or body movement affects the correlation between heart rate and external load.

Subjective measures of load or effort such as RPE or the product of training time * RPE, are also used as indicators of training load. The advantages are that RPE is easy to understand and manage, very low cost, can be used daily, and can be easily recorded and graphed for further analysis, to track weekly or monthly fluctuations. The big disadvantage is that it is a subjective measure. In addition, some familiarization and skill is required. This may not be particularly suitable for children as they tend to underestimate fatigue. Also, RPE is affected by intensity during the last part of the workout, therefore, the perceived exertion at the end of the workout may not represent the load in the first part of the workout. Similarly, training at the highest intensity during the first half of training and a low-intensity program during the latter part of training may result in a lower perception of total training effort. Finally, since this is a subjective measure, some athletes may not report their true level of exertion for several reasons.

Suggestions for load routing

What is the best marker for monitoring training load? Before we try to answer these questions, it is important to examine the most common factors that may increase load and affect fatigue (Table 2)

Table 2. The most common factors that may affect fatigue

✓ Type of stimulus ✓ Type of muscle contraction (concentric, eccentric, isometric, alternating, etc.) ✓ Duration of stimulation ✓ Rest/work interval ✓ Frequency ✓ Training volume ✓ Intensity of training

- ✓ Direction of movement or load (change of direction, vertical, horizontal, etc.)
- ✓ Force of the collision or the total intensity of the impacts
- ✓ Type of muscle fibers
- ✓ Physiological ability of the athlete
- ✓ Training background
- ✓ Nutritional status
- ✓ External stressors
- ✓ Quality of sleep
- ✓ Blood profile
- ✓ Environmental factors or surface condition
- ✓ And more…

Because fatigue is influenced by several factors, acute or chronic strain cannot be represented by just one measurement or single variable. Therefore, it is recommended for fitness trainers to use a combination of external, internal and subjective factors in order to monitor the load of the players. Because elite athletes train daily with significant changes in training volume and intensity each day, daily load may be less important than cumulative (e.g. weekly) load. Therefore, it may be more important to monitor volume, load intensity, and perceived fatigue on weekly basis. This approach will allow the fitness trainer to determine whether the higher perceived fatigue is due to an increase in volume, intensity or is due to other external factors (for example in a situation where the perceived fatigue is high but the volume and intensity are low).

Quick tips for load monitoring:

1. Choose no more than 4/5 external parameters related to your sport. Make sure they represent different types of load (e.g. volume load, intensity load, metabolic load, etc.)
2. Choose 1/2 internal parameters (for example, a variable related to heart rate)
3. Select 1/2 parameters of perceived effort or perceived fatigue
4. Track the parameters you chose every day, no matter how intense the workout was (record them every time there is a workout)
5. Be consistent and accurate and record the data in a worksheet for further analysis.
6. It is important to consider an individual monitoring program since the same load in different athletes may produce a completely different effect (for example, the same load in an athlete with high fitness versus an athlete with medium fitness, load in an athlete with a high percentage of fast twitch fibers compared to an athlete with a high percentage of slow twitch fibers or two athletes with different training backgrounds).

Matches and competitions workloads

Marko stojanovic

Introduction

A. An introduction and data about the increase in competition /games and unprofessional planning of the international tournaments and national calendar (a result of commercialization and television). Examples of multiplicity of competition

Professional team sport nowadays involves millions of fans, broadcast rights, merchandizing, and advertising. These sports constitute an important economic activity, with revenue maximization and logistical optimization frequently considered as key factors (Kendall et al., 2010). For example, professional basketball competitions have emerged in over 100 countries with more than 70,000 professional players worldwide [3], creating a lucrative business that provides legitimate career pathways for players and entertainment for billions of people. Furthermore, total revenue in National Basketball association (NBA) reached $8.76 billion in the 2018-19 season. Each one of the teams is worth at least $1 billion, and a team is worth on average $2.12 billion—about 14% higher than the 2017–18 season (Forbes 2020). The NBA makes money primarily through television, merchandising, sponsorships, and tickets. For over ten years now, the English Premier League has generated revenues of up to €3 billion more than any other 'major' European leagues. The 12% increase in EPL revenue to €5.4 billion from the 2015-16 season to the 2017-18 season was mainly dictated by television broadcasting, and increased by another 10% in the next two seasons (Barnard, Boor, Winn, Wood, & Wray, 2019). Total revenues for European club football have grown during the past decade from €11.7 billion in 2009 to €21 billion in 2018. The key drivers of this growth have been centralized revenues (league broadcasting) and individual club commercial revenues, with top three clubs receiving around 85% of all centralized revenues (the financial landscape of European football,2021). The current format of the match calendar in most popular team sport is under extreme pressure from all stakeholders, as global economic and social trends are changing the team sport industry.

There is growing trend of increasing number of games and competitions in order to increase revenue and profit. **F**or example, UEFA nations league was presented in 2018 with 10 South American countries likely to join in 2024 and a clear goal to increase the number of official

games national teams play annually. Similarly, UEFA presented conference league (third-tier competition) during 2021/2022 season with general idea to provide additional opportunity for clubs from lower-ranked UEFA member countries to progress beyond their customary elimination from the Champions League and Europe League and to play more international games. Starting with 2016-2017, the Euro League is made up of 18 teams, with a total of 34 games played by each team plus playoff games and final 4 games for the teams that qualify. Along with cup and domestic league with approximately another 28-30 games and playoffs this could bring to about 75-80 games per year for top level European basketball team, much more than 10 to 15 years ago (ref). NBA has fixed format of 82 games per year plus play offs that evolved from 3 to 4 rounds and final change done in 2003 with first round modification from best of 5 to best of 7 rule.

Consequently, in popular team sports such as soccer, basketball or handball it is common to have several games per week (i.e., ≥3) per team throughout a competitive season. For example, The NBA's regular season consists of 82 games played in 5 and a half months, meaning a game being played every 2 days on average. This is followed by the postseason playoffs (April–May) and NBA finals (potentially 28 games). Therefore, teams are confronted with high-density fixture scheduling throughout the season,[23] which has required players, on occasion, to play 5 games in 7 nights. Thus, players are seldomly provided with 48 hours or more for recovery between games. Basketball situation is pretty much the same in Europe, with an ACB League team that also participates in the Euro League could play 83 games in 8 and a half months of competition. In other words, on average, a game is played every 3 days. Similar situation is in soccer, with very likely for soccer teams to compete in as many as 50–80 matches during a 40-week competitive season. Indeed, English and Spanish teams were found to play the highest number of games per year, followed by Italian and French teams. In addition to the normal league matches, successful teams often take part in national and international cups, and the players also play for their country (Ekstrand et al.2004). This means that playing two games per week is regular practice for most of the season, and at some points in the season, three matches during weekly cycle is also common [1,2]. In a survey conducted by the World Players' Union (FIFPro), 35–40% of soccer players believed to have too many matches, and have an inadequate number of days for proper recovery [3]. Moreover, in the same report there are individuals reported to play to 78 games per year or 5,636

minutes due to the congested schedule with 67.9% of them reported to be played while fatigued (less than 5 days rest; Pedri, Barcelona; FIFPRO player workload monitoring). Finally, increasing number of games and international tournaments has led to an extension of the competition period in handball, which now regularly last for 10 months, with common practice to have two matches per week (karcher&Bucheit, 2014) for top level teams during the season.

Not just that more and more games are played in team sports, but intensity has raised significantly. For example, seminal study in soccer (Burnes et al,2014) reported that average high-speed distance and sprint distance increased by 30 and 35% respectively from 2006-20013 in premier league! The growing physicality of the English Premier League is further supported by the fact that between 2006–07 and 2012–13, the absolute number of both explosive and leading sprints increased and that latterly a much higher proportion of sprints was performed explosively (Bradley et al.,2016). Furthermore, a recent publication (lago penas) has analyzed the evolution of physical performance in Spanish *LaLiga* during eight consecutive seasons, (2012-13 to 2019-20), and found that number of high-intensity efforts increased throughout the eight seasons, with a variation that ranged between 14.6% and 9.2%. Data reported for both European basketball and NBA reveals that game demands increased significantly due to rule changes (Ben abdelkrim et al.2007; Ibanez et al, 2018; Cormery et al.,2008) and team focus on particular match indicators such as turnovers, 3-point field goals attempted or fouls (Salazar et al,2020; Ibanez et al.,2018). Game pace is found to be higher in NBA than Euro League, with positive trends reported for both competitions from 2000 to 2017 (mandic et al.2019). Handball is recognized as a sport with very high dynamics of play and as a general trend the game is characterized by fast play with increased number of goals scored per match (Taborsky, 2003; Meletakos and Bayios, 2010) as a result of a significant increase in the number of attacks per game due to significantly faster attacks (Spate, 2005). It is generally recognized that due to relatively recent changes in game rules (e.g. starting the game quickly from the center) and improvements in the tactical use of rolling substitutions, the intensity of the game is increased, with Players able to perform more high-intensity actions.

The aforementioned changes have resulted not only in a lengthy season, but also in a very condensed in-season game schedule, which requires elite team sport athletes to compete every 2 to 5 days for several weeks in a row. The combined effect of increased game intensity,

increased fixture density, higher total weekly load, frequent air travel, reduced recovery time along with the need to meet high-performance standards during competition, increases physical, physiological, mental and psychological stress on elite athletes. Training is scheduled in between games, reducing drastically recovery time. At the same time, players have to travel frequently, sometimes in long flights or in different continents where they train/compete in different time zones which poses an additional stress on the body.

Physiological effects of competition/games and training loads

The biggest stress in the team sport athletes is likely experienced during games. Team sports involves many demanding activities including sprinting, changes in direction and running speed, jumps and tackles, as well as technical actions such as dribbling, shooting and passing. In performing these activities, a decline in performance known as fatigue can occur. Generally, fatigue is defined as any decline in muscle performance associated with muscle activity [Allen et al,2008]. Participation in a single match leading to acute fatigue characterized by myriad physiological alterations and a decline in physical performance over the following hours and days. The decline in performance observed at the end of a match arises from a combination of several factors involving mechanisms from the central nervous system to the muscle cell itself and energy production (Bigland- ritcie, 1984). As a result, players may experience acute and chronic fatigue potentially leading to underperformance and/or injury. Physical performance decrements during matches have traditionally been associated with physiological fatigue [Mohr M, Krustrup P, Bangsbo J. Fatigue in soccer: a brief review. J Sports Sci 2005; 23(6): 593-9.], although different situational variables or contextual factors can also influence players' physical performance. In soccer, several studies have reported that more than 72 hours are required to achieve pre-match values for physical performance, as well as normalizing muscle damage and inflammation among elite players (Ispirlidis et al.2008). Sprint performance is impaired immediately after exercise by -2% to -9% (Nedelec et all.2012). Jump performance decrement after game is generally around 12% with sometimes more than 72 hours needed for full recovery (ispirlidis et al,2008). In aditiion, the strength decrement of knee flexors and extensors immediately after exercise ranges to up to -36% and -25% respectively. Similar decrements in performance outcomes are regularly observed after a basketball game. For example, 10 m sprint speed and CMJ height were found

to significantly decreased after 24 (ES = 0.5) and 48 h (ES = 0.6) post-match, respectively (Chatzinikolaou et al., 2014), indicating that basketball athletes may need ~24–48 h of recovery post-match before the next intensive practice or match

Ways to keep track of athletes' loads and physiological-physical-mental status (load monitoring in team sport)

The results of high frequency and competitions/games are physiological/physical injuries

Concerns around congested fixtures have been highlighted recently in many team sports (Kloke, 2016; Holmes, 2018; Sport, 2020), with predominant reasons including a lack of training and recovery opportunities, with increased training load likely produces negative effect on the athletes' both health (Teramoto et al., 2017; Lewis, 2018; Rossi et al., 2018) and performance (Moskowitz and Wertheim, 2011; Mitchell et al., 2019; Esteves et al., 2020). In addition, this could also lead to a lower product quality for consumers and broadcasters (Shelburne, 2017).

There is a real risk of playing too many matches. In addition to the normal league matches, successful teams often take part in national and international cups, and the players also play for their country. There is reason to believe that too many matches can lead to lack of motivation and mental burn out—that is, players are no longer able to gear themselves up for matches and training sessions.[19] Concentration deteriorates which can affect coordination, leading to underperformance and greater risk of injury.[20] It may be that the major stress factor is not the 90 minutes of the match itself, but the mental preparation for matches, travel, and possible adaptation to changes in time and climate.[13]

Increased training load has previously been reported during weeks where 3 games were played, in both semi-professional (Fox et al., 2020b) and European professional (Salazar et al., 2020b) basketball. In this study, only 3/26 regular season weeks involved less than 3 games, meaning that "high game load" weeks in other leagues is normal practice in the NBA. While these differences are important to consider, the absolute volume of training undertaken by these players does not exceed 7 h per week on-court, even in the highest load periods. Therefore, it is likely that periodization of loading and recovery is more important than the absolute training volume. Similarly, dellal et al. (2015) presented higher injury rate during

prolonged period of fixture congestion to that reported outside this period in top level soccer players.

The combination of intense periods of matches competition and travel was suggested to contribute to a greater risk of bone, joint, and soft tissue injuries as these athletes were more likely to compete with less, and potentially disrupted, rest (Yeh et al., 2012; Podlog et al., 2015; McLean et al., 2018). Indeed, the Golden State Warriors managed their athletes' workloads by having some of them not compete during the fourth quarter or excluding them from some matches during the 2015–2018 seasons, where they exhibited the best win-loss record within the NBA (Zhang et al., 2019a). in addition, Bradley and Noakes (12) reported that senior players adopt a self-pacing strategy in order to sustain high intensity running performance during periods of fixture congestion.

Although the question of whether schedule density impacts injuries is multifaceted , as it requires a complex analysis, adjusting for many related factors such as prior injury, travel time, time zone difference, home vs. away, or acute vs. overuse injuries (Mack et al., 2018); sleep, training, and recovery opportunity are impaired due to the traveling schedule of team sports athletes (Sortino, 2015; Fullagar et al., 2016; Nutting and Price, 2017; Lastella et al., 2019). Additionally, in teams or leagues with lower budgets, or amateur sports, substantial differences in travel quality, particularly the presence of bus trips, non-charter flights, and the inevitable differences in hotel and restaurant accommodations should also be considered (Mitchell et al., 2019). Against this background, leagues have tried to modify schedules in the spirit of creating more nongame days and better traveling combinations (Holmes, 2018). Nevertheless, for especially congested periods of the season, some teams may still opt to rest players in order to provide them with extra recovery time, entailing a negative effect on the team’s competitiveness and the game-product quality (Shelburne 2017). In such conditions of high frequency of games with ever increasing game and training load the maintenance or improvement of the player’s performance is determined by both appropriate conditioning but also by the ability of the body systems to recover and regenerate after multiple stress stimuli.2–5.

Appropriate training periodization and scheduling of trips and training sessions can likely be considered critical in order to optimize training and recovery and consequently maximize health and performance.

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Psychological Effects

Dr. Georgios G. Ziogas

During the last 15 years, several national federations have increased the number of games and/or difficulty of competition during the season (e.g. by introducing play-off and play-out games), in an attempt to increase the level of competition and product revenue. At the same time, international federations have increased the number of games and/or level of competition among national teams, especially in qualification rounds. If we take into consideration the local competition as well, some athlete may compete in more than three competitions during the same season. For example, an elite soccer player may need to participate in local championship games, local cup games, international competition games (e.g. Champions League, Europa League etc) and National Team games (e.g World Cup Qualifications). In addition, some of the most important international competitions are taking place during off-season or early preseason (e.g. Euro finals, World Cup, Olympic Games etc) extending the length of competition to 10-11 months and as a result some athletes may train and compete for more than 320 days each calendar year.

The aforementioned changes have resulted not only in a lengthy season, but also in a very condensed in-season game schedule, which requires elite team sport athletes to compete every 2 to 5 days for several weeks in a row. Training is scheduled in between games, reducing drastically recovery time. At the same time, players have to air travel frequently, sometimes in long flights or in different continents where they train/compete in different time zones which poses an additional stress on the body.

Moreover, studies using player monitoring devices have demonstrated that game intensity also increased over the last 15 years (e.g.in Premier League), which results in additional physical and mental demand on players. The combined effect of increased game intensity, increased fixture density, higher total weekly load, frequent air travel, reduced recovery time along with the need to meet high-performance standards during competition, increases physical, physiological, mental and psychological stress on elite athletes. Although some authors have investigated the short-term effects of high fixture density on injuries, game performance and overtraining, the long-term effects remain unknown. This short review focuses on the physiology of stress response and suggests ways for improved monitoring of the physiological and physical status of the athletes.

1. Physiological background and the effects of large scale frequent and intensive game and competition loads.

Life exists through a dynamic process that aims at maintaining a constant internal environment in the human body, called homeostasis, which is challenged daily by internal or external stressors.
Exposure to intense competition or high training and game load imposes high and constant physical, physiological, mental and psychological stress in the human body and disturbs homeostasis.

Human body responds to stress by activating a series of physiological and behavioral responses in an attempt to adapt and re-establish homeostasis. These responses may result in physiological and psychological adaptations which improve performance and allow the body to cope with stress more efficiently when exposed to similar stress in the future. Intense training or games, competition, air travel etc. are some of the acute stressors that affect the athlete on a regular basis. When training load is carefully planned and recovery time is adequate, body adapts and induces beneficial adaptations that improve or maintain sport performance.

Repeated time frames with condensed fixture density along with intense competition, frequent air travel, reduced recovery time and psychological pressure represent chronic stressors that may disturb homeostasis and lay the ground for injury, reduced sport performance and/or metabolic, autoimmune, psychological/mental disorders.

How does the body respond to chronic stress? What happens when homeostasis is disturbed and the body fails to adapt?

This review does not intend to describe in detail all the endocrine and neural responses to acute and chronic stress but rather to describe the key steps of the stress response that a sport professional can easily understand. Also, ways to monitor player load during condensed fixture density are described and future directions are suggested.

Physiology of Stress Response

The two main stress responses in humans are a) the rapid "fight or flight response" where adrenaline is released and b) cortisol release by adrenal cortex which is considered better indicator of *repetitive or chronic stress*[12]. This is why for sport professionals the term "stress" is tightly linked to increased secretion of adrenaline and cortisol.

When an athlete is exposed to physical activity or to acute stressors, a certain part of the nervous system, called sympathetic nervous system (SNS), increases its activation and coordinates a series of physiological responses known as "fight or flight response" which prepare the body to react and cope with stress. For example, heart rate and force of contraction increases, blood flow is reduced from the gastrointestinal organs and redirected to skeletal and cardiac muscles and energy stores are mobilized. This response is rapid since it is directed primarily through the central nervous system. It must be noted that adrenaline is also released by adrenal medulla in addition to the release of adrenaline by SNS.

At the same time, body initiates a hormonal stress response which is not as fast as the "fight or flight response" but it lasts longer. The hypothalamic-pituitary-adrenal (HPA) axis is central to cortisol release response and homeostasis. Release of cortisol from adrenal cortex is stimulated by adrenocorticotropic hormone (ACTH) from the anterior pituitary which is turn is stimulated by corticotropin releasing hormone (CRH) from hypothalamus[7]. The release of ACTH and therefore cortisol, is also stimulated by vasopressin and adrenaline both of which increase during stress. Cortisol is secreted in spurts and exhibits a circadian rhythm. It must be noted that even the anticipation to participate in sport competition

influences cortisol secretion and the anticipatory cortisol response increases closer to the start of competition[10].

Activation of the stress system leads to physical and behavioral changes that are adaptive and time-limited (Table 1) and improve the chances of the athlete to cope successfully with stress.

Table 1. Acute effects of increased cortisol and adrenaline secretion during stress

Physical Effects	Behavioral Effects
Protein catabolism	Increased arousal and alertness
Increase liver uptake of amino acids in order to be converted to glucose (gluconeogenesis)	Increased cognition, vigilance and focused attention
Increased triglyceride catabolism in adipose tissue	Euphoria (or dysphoria)
Increased glucose availability by increased hepatic and muscle glycogenolysis	Increased body temperature
Inhibition of inflammatory and immune response	Suppression of appetite and feeding behavior
Inhibition of some functions such as reproduction and growth	Suppression of reproductive axisC
Inhibition of gastric mobility and digenstion	Containment of the stress response
Redirection of blood flow from viscera to skeletal muslces	Heightened analgesia
Increased response of blood vessels to noradrenaline and other stimuli	Decrease sense of fatigue in skeletal muscles
Increased cardiac function (e.g. increased heart rate and force of contraction, increased blood pressure etc)	
Increased ventilatory response	
Increased oxygen consumption	

Adopted from Chrouos and Gold and from Weidmeier

When the body is not experiencing stress, SNS activation is reduced and there is also a direct feedback of cortisol to hypothalamus and anterior pituitary gland to stabilize or reduce CRH, ACTH and cortisol concentration in plasma to resting levels.

During prolonged periods of condensed fixture density, increased competition, training without days-off, frequent air travel and reduced recovery time, there is increased physical, mental emotional and psychological stress in athlete's body. Under these circumstances, stress magnitude, nature or duration may overcome the adaptive resources of an individual and adverse physical and behavioral consequences may occur[2] which are summarized in Table 2.

Table 2. Effects of increased HPA axis activity along with dysregulation of adaptive processes in adults

Chronic stress
Depression
Anorexia nervosa / Malnutrition
Obsessive-compulsive disorder
Excessive exercise (obligate athletisism)
Chronic active alcoholism
Alcohol and narcotic withdrawal
Diabetes mellitus
Panic disorder
Functional gastrointestinal disease

Adopted from Chrousos and Gold

Can prolonged periods of condensed fixture density overcome the athlete's ability to properly respond and adapt to stressors leading to performance decrements, injuries or metabolic, immunological, mental or psychological disorders?

Some authors have examined the effect of condensed game schedule on team performance and injury rate. Game spacing and density in relation to risk of injuries in National Hockey League (NHL) was examined by Blond et al[1]. They found that a condensed schedule and <1 day of rest between games were associated with increased injury rate. These results are in partial agreement with Teramoto et al[13] who demonstrated an increased risk of injuries in NBA games played back to back on the road but not at home, while others have shown a decrease in injury risk for each day of rest[9]. In contrast, a 15yr analysis of UEFA elite clubs demonstrated that team that performed more preseason training sessions had less injuries during the in-season period[4]. However, it must be noted that a difference between the UEFA study and the previous studies that demonstrated a higher injury risk with condensed game density, is that in European soccer, there are at least 2 days interval in between games, in contrast to NBA or NHL where in some cases there is 1 day of rest between consecutive games and in other cases, games are back-to-back. In agreement with the UEFA study, Teramoto et al.[14] did not found increased risk of concussions during unconventional game schedule in the NFL. In regard to team performance, Esteves et al.[5] examined the effect of schedule congestion cycles and game outcome in NBA. They concluded that the likelihood of winning a game increased significantly when playing with one day rest in between games compared to playing back-to-back games.

Although the results on the effect of condensed game schedule on injures in team sports are mixed and inconclusive, the increased activation of HPA axis along with inability to adequately recover and adapt, may result to psychological and behavioral disorders. Accumulated evidence suggests that there is a high rate of psychological problems such as anxiety and depression in athletes, during or after retirement from sports[8,11,16]. However, although injury and team performance data are easier to track and analyze with modern performance tracking devices, behavioral changes and psychological disorders such as anxiety, depression, alcoholism etc may either go unnoticed or they might be found too late since they cannot be detected and recorded automatically by performance tracking devices. Therefore, there are very few studies on the effect of chronic stress on the psychological/mental wellbeing of the athletes. In addition, although there are reported cases of alcoholism, severe depression and suicide attempts of elite players during their professional career, it is not clear whether excessive or chronic stress existed and was a contributing factor in these cases. Since competition and game density increases in professional sports, it is suggested that professional teams, assess the psychological and behavioral profile of each player on a regular basis along with training load assessment in order to better whether athletes can adequately adapt to repeated exposure to stressors in periods of condensed fixture density.

2. Ways of regulating and monitoring the physiological and physical status of athletes during frequent and intensive loads.

During periods of high volume/intensity training or condensed fixture density in professional sports, player load monitoring is crucial in order to reduce the likelihood of excessive or chronic stress on the human body. Moreover, condensed game schedule followed by recovery days exposes game starters and benched players to vastly different daily and weekly loads which require individualized load monitoring and careful training and recovery planning in order to prevent overtraining or detraining.

Lightweight wearable monitoring devices allow accurate analysis of game and training volume and intensity and they are widely used in professional sports. Most of the provided metrics measure the external load that player has performed (e.g. Total Distance, Intense Acceleration and Deceleration Efforts and Distance, High Speed Running Distance, Sprint Distance, Dynamic Stress Load, Total Load, Metabolic Power etc.). Other metrics are used to evaluate players' internal load e.g. Heart Rate Exertion Index, Heart Rate Variability etc. and in some cases blood analysis after training is also used for determining creatine kinase levels as a marker of muscle damage or muscle fatigue. Teams also monitor subjective measures of fatigue and recovery such as Rating of Perceived Exertion (RPE), Total Quality Recovery Score (TQR), Wellness Questionnaires etc.

However, most of the time player load monitoring methods mentioned above, focus on acute (daily) external, internal or subjective indexes since single training/game analysis is easily created and exported automatically by the advanced software that is provided along

with the monitoring devices. Although this approach is reasonable since teams are mostly concerned about the result of the upcoming game and want to monitor daily load and player "freshness", it provides no information about the impact of accumulated or chronic load on player performance and well-being. Chronic load calculation and analysis is more complex since it requires further analysis and big data processing capabilities.

Acute to Chronic Workload Ratio (ACWR) proposed by Gabbett et al.[6] has received more attention during the last 6 years as a useful index for evaluation of performance improvement and injury prevention. It uses rolling averages of external load during last 7 days (Acute Load) compared to average external load during the last 3-6 weeks (Chronic Load). Although ACWR extends to the previous 3-6 weeks only and it is questionable if this period is long enough to be considered "chronic", ACWR is a useful index for training load and injury prevention in condensed fixture density. However, it provides information based on external metrics only.

It was mentioned earlier, that excessive and uncontrolled chronic stress increases the activity of HPA axis and may create psychological and behavioral disorders as well. Based on our observations and experience, excessive load on a period of 3 to 6 weeks may lead to overtraining syndrome (OTS), but this period is not enough to induce significant psychological, behavioral changes which related to chronic stress and most likely longer periods (>3 months) of monitoring might be needed.

To conclude, monitoring external and internal load as well as subjective indexes of fatigue, recovery and performance is essential not only during condensed game periods, but during all season.

External load metrics

- ✓ Must be analyzed *daily* and compared to the individualized values rather than to team average.
- ✓ Total *weekly, monthly, tri-monthly and annual* load using specific metrics of volume and intensity must be calculated for each player. Calculation must include game and training load (including individual and recovery training). Totals should be compared to the previous values of the same player
- ✓ ACWR can be used as an additional tool for performance and injury prevention

Internal load metrics

- ✓ Must be analyzed *daily* if possible (especially those related to heart rate) and compared to the individualized values rather than to team average.
- ✓ Any changes observed in internal load must be compared to external load.
- ✓ Low internal and low external load? May need to increase workload
- ✓ Low internal and high external load? Adaptations is taking place!
- ✓ High internal and high external load? May need to decrease workload
- ✓ High internal and low external load? Indicate maladaptation
- ✓ Complete Blood Analysis: On a regular interval during season (e.g. every 2 months). Better after day off and without strength training for 72h prior to blood collection

Subjective metrics

- ✓ RPE and Wellness Questionnaires on a daily basis
- ✓ RECOVERY questionnaires – for starters after games and for those with higher weekly load
- ✓ Psychological Profile analysis on a regular basis (e.g. once per month) or more often based on specific observations/events)

During Condensed Game Periods

- ✓ Monitor more closely subjective and behavioral changes as well as wellness scores (including sleep quality) on game starters and on those players with higher weekly load.
- ✓ At least cortisol, free testosterone, adrenaline analysis before and after the condensed game period

At the end of each 3 months and at the end of season

- ✓ Monitor total volume and intensity load
- ✓ Monitor psychological profile changes
- ✓ Use these data as a personalized guide for next season (along with subjective performance evaluation)

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Gymnastics Sports – Training Volume and Early Specialization

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Introduction

When we speak obout gymnastics sports we have to mantioned the international federation which included four olimpics sports and fuor nonolimpic disciplines. The International Gymnastics Federation (FIG) is the governing body for Gymnastics worldwide. It is the oldest established international federation of an Olympic sport and has participated in the Olympic Games since their revival in 1896. The FIG governs eight sports: Gymnastics for All, Men's and Women's Artistic Gymnastics, Rhythmic Gymnastics, Trampoline - including Double Mini-trampoline and Tumbling - , Aerobics, Acrobatics, and Parkour. It counts 156 national member federations and has its headquarters in the Olympic Capital of Lausanne (SUI).

Gymnastics For All (GA)

Gymnastics for All is the center of two signature FIG events: The World Gymnaestrada and The World Gym for Life Challenge. Both of which are held at four-year intervals, with an alternating timetable assuring there is an international event every two years. Both are in essence a celebration of the infinite possibilities of Gymnastics performance, open to participants of all stripes. Although known to many because of its World Championships and prominence at the Olympic Games, Gymnastics is far more than a high-level competitive sport. It is the foundation of all sports, and an activity that can be practiced by everyone, young and old, big and small, regardless of color, creed and capability.

Men Artistic Gymnastics (MAG)

With roots in Ancient Greece, Artistic Gymnastics is as ancient as it is spectacular, combining speed, strength, power and flexibility with tumbling and acrobatic skills, all performed with an emphasis on style. Gymnasts display superhuman strength as they challenge gravity and push the limits of physics in six separate events: Floor Exercise, Pommel Horse, Still Rings, Vault, Parallel Bars and Horizontal Bar.

Floor Exercise features tumbling and other acrobatic elements on a specially created Floor Exercise mat. Pommel Horse requires gymnasts to show circles, flairs and other swinging elements above the horse. The Still Rings is a test of endurance and strength, withe gymnasts supporting themselves and performing complex holds with their arms. Vault, one of two power events along with Floor Exercise, is the fastest event and features a gymnast propelling themselves over a vaulting table at full sprint. Parallel Bars and Horizontal Bar are both swinging events with frequent releases and a big dismount.

On all events, gymnasts are judged on difficulty of the exercise, execution, along with dynamics, including height and distance from apparatus, and must show strength, flexibility and balance.

Women Artistic Gymnastics (WAG)

Artistic Gymnastics is one of the most popular, celebrated and thoroughly modern sports for women, having undergone more transformation than perhaps any other Olympic sport. With a thrilling combination of daring and grace, gymnasts perform challenging elements on four apparatus - Vault, Uneven Bars, Balance Beam and Floor Exercise - with emphasis on agility, artistry, flexibility, power and style.

Though it has much in common with Men's Gymnastics, Women's Artistic Gymnastics is distinctly unique and is a showcase for excellence in women's sport. The apparatus have evolved and the sport transformed by successive generations of gymnasts pushing the limits of physics further and competing with each other to create new and exciting moves.

Vault is the fastest event and features a gymnast propelling themselves over a vaulting table at full sprint, flipping or twisting back onto the mat. Uneven bars involve gymnasts performing swinging elements around two asymmetric bars, frequently releasing the bar and re-catching it, while Balance Beam involves tumbling, acrobatics, choreography and dance elements on a narrow beam only 10 cm wide. Floor Exercises is the only event set to music and features tumbling, leaps, turns and choreography on a spring-loaded mat.

On all events, gymnasts are judged on difficulty of the exercise, execution, along with dynamics, including height and distance from apparatus, and must show strength, flexibility, balance and rhythmic.

Rhythmic Gymanstics (RG)

Heavily influenced by ballet and modern dance, Rhythmic Gymnastics is the juncture of sport and art. Performing routines with music, either as individuals or in groups, rhythmic gymnasts amaze audiences with their astonishing skill as they execute enormously difficult maneuvers with hand-held apparatus: Hoop, Ball, Clubs, Ribbon and Rope.

Flexibility and musical interpretation are important elements in a Rhythmic exercise. However, it is the amount of risk a gymnast takes, often throwing the apparatus several meters into the air and losing sight of it while performing stunning leaps, turns or acrobatic maneuvers before regrasping it - often in impossible-seeming catches - that sets the routines apart.

Trampoline Gymnastics (TG)

Of all the Gymnastics disciplines, Trampoline gymnasts get the biggest air, thrilling audiences with their high-flying exploits. That's especially true for the "Higher" part: Athletes use the trampoline to catapult themselves to heights that can surpass 10 meters, the height of a three-story building. Without technological devices strapped to the body, Trampolining is as close as human beings get to flying solo.

Trampoline gymnasts compete in one of four categories: Individual Trampoline, Synchronized Trampoline, Double Mini-trampoline and Tumbling. The best gymnasts often specialize in two of the four disciplines: Individual trampolinists often compete in Synchro as well, while some top Double Mini gymnasts take part in Tumbling at the World level. While it's not unheard of, very few will do Individual Trampoline as well as Double Mini or another combination of the two.

The relationship between gymnast and the trampoline is paramount, as one badly judged takeoff or landing can send a gymnast flying off the equipment and onto the mats below. Unlike in other forms of Gymnastics, a fall from the trampoline ends a routine, giving each exercise an additional element of suspense.

Acrobatic Gymnastics (AG)

Acrobatic Gymnastics is equal parts performance and partnership, as groups of gymnasts work together to complete spectacular and extraordinary feats.

Acrobatic gymnasts perform in pairs, trios or groups, in which each of the individual gymnast's size and skill are used to complement each other. Set to music and interspersed with choreography, the routines combine art and skill as the gymnasts perform static elements such balances and holds; and dynamic elements such as lifts, throws with complex somersaults and twists; and tumbling skills.

Pairs and group exercises must include human pyramids that are created by the gymnasts and must be held for three seconds to be scored; the pairs exercise must contain at least six partner-balance elements held for two seconds. Competitive Acrobatic Gymnastics consists of five group formations: Women's Pair and Men's Pair, Mixed Pair (male and female), Women's Group (three females) and Men's Group (four males). Each pair or group performs three routines - balance, dynamic, and combined - in competition.

Aerobic Gymnastics (AEG)

Born in the fitness explosion of the 1970s and 1980s, Aerobic Gymnastics fuses mainstream Aerobic exercise sequences - including its seven basic steps combined with arm movements - with Gymnastics difficulty elements, original/creative transitions, collaborations and interactions between members, and lifts. The routines are inspired by the music, performed in sync with a driving beat and phrases, and using its melody and theme as a whole.

Competitive Aerobic Gymnastics offers several platforms for showcasing the discipline's variety and creativity. Gymnasts may compete singly, or in Mixed Pairs, Trios, Groups of five or in the case of Aerobic Dance and Aerobic Step, teams of eight. In all categories, continuous movement covers all the competition space, including floor and aerial movements to the music.

Parkour

Originating on the streets, Parkour can be summed up as the art of getting from one point to another by respecting one key principle: efficiency and fluidity. Parkour was developed as a training method but over time it has inspired diverse sporting events, action movies, gaining many followers.

In FIG events, the Parkour area is strewn with a variety of blocks, walls and bars designed to mirror the different obstacles found in urban areas. To overcome them, athletes must make use of a range of techniques, such as the cat leap, arm jump, drop jump and wall run.

There are two categories: Speed and Freestyle. In the Speed event, athletes must overcome obstacles as quickly as possible to reach the finish line in the quickest time. In the Freestyle event, athletes make use of the obstacles to show off their style and creativity as their technical performance is judged.

There are a lot of investigations of every of these sports and disciplines. But in this paper we will concetrate on olimpic sports which couses a lot of helth problems and which are the oldest diciplins not only in FIG, but in the Olimpich games: Men and Women Artistic Gymnastic and Rhythmic Gymnastics.

Rhythmic Gymnastics

There are two competitions in the RG program: individual and group competitions. The program for senior individual gymnasts usually consist of 4 routines, and for senior groups consists of 2 routines, with one type of apparatus and two types of apparatus. The duration of the routines ranges from 1'15" to 1'30" for individual, and from 2'15" to 2'30" for groups (FIG, 2016).

The training volume in RG has increased over the recent years (Berlutti et al., 2010). During the 70's and 80's the requirement was 15h and 20h per week, respectively (Georgopoulos et al., 2012). Elite gymnasts train 25-30h per week and, in some cases, 40h per week to achieve the essential preparation for a good performance, due to the high physical and technical requirements in RG (Ávila-Carvalho et al., 2013; Zetaruk et al., 2006). Thus, most studies use the weekly training volume (hours of training per week) but this tells us very little about training intensity (Malina et al., 2013).

According to Bobo-Arce & Méndez-Rial (2013), the training process in RG has high demands in volume and intensity, and technical elements with a high difficulty level. However, according to Malina et al. (2013), hours per week provide limited information about demands placed in the training in gymnastics. Training hours include a considerable "down time" or reduced activity (explanations, corrections, waiting between repetitions, recovery, nutrition breaks, etc.). For the authors, the training in gymnastics is more complex than hours per week. Thus, the constant effort for perfection in the execution of group technical elements constitutes an objective and fundamental direction in the preparation of gymnasts (Avilés et al., 2014)

Batista, Gomes, Garganta and Avila-Carvalho (2018) investigated the training intensiti of Brasilian rhyithmic gymnastic group. Nine gymnast, from Brazilian National Group Team (20.8±1.9 years old), were studied. Accelerometers (ActiGraph, model GT3X+) were used to estimate the gymnasts energy expenditure during training session, in two periods – morning and afternoon. Training activities (types of exercises performed) in the evaluated session were recorded. The assessment of intensity in a training session (7 hours) of BNT gymnasts, showed that only 35% of the training (2h27min) consisted of training activities of moderate to very vigorous intensities, corresponding especially to the routines parts training. The most part of the training session evaluated presented light intensity training activities (65%). The higher intensity level in the training (moderate to very vigorous intensity exercises) corresponding especially to the training of routines parts. Several exercises characterized by a hard work of strength and endurance (ballet and warm-up) were classified as light intensity probably due to lack of changes in the body axis and/or displacement. On the other hand, the RG training is composed also by light intensity exercises (specific exercises such as flexibility training, apparatus handling

techniques, etc.) and moments (stops for explanations and corrections) that are essential for the improvement of technique, tactics, physical, intellectual and psychological development in gymnasts' performance.

Artistic Gymnastics

Artistic gymnasts of both sexes are characterized by short stature, later maturation and a slower tempo of growth (Malina, 1994, 1999). A question that is consistently raised is whether the growth and maturity characteristics observed in gymnasts are a consequence of training, normal physical developement or interactions between the two, e.g. accretion and hypertrophy of muscle mass during adolescence and young adulthood in males (Malina, Bouchard, Bar-Or, 2004). The issue has received considerable attention since the 1970s and 1980s when Olga Korbut and Nadia Comaneci achieved success at World Championships (WC) and Olympic Games (OG) with what were perceived as physiques of pre-pubertal 'girls' in contrast to Olympians of the 1950s (Larissa Latynina) and 1960s (Vera C˘ a´slavska´). Mean ages, heights and weights of world class female artistic gymnasts declined from the mid-1960s through the 1980s (Malina, 1994, 1999). Minimum age for participants was 13.0 years at the 1987 WC (Rotterdam, The Netherlands) and raised to 16.0 years at the 1997 WC (Lausanne, Switzerland). Mean ages have since increased: 16.5 (1987 WC), 17.4 (1997 WC), 18.0 (2000 OG), and 18.8 (2008 OG) years; however, heights and weights have changed little from 1987 (154 cm, 45 kg) to 2000 (152 cm, 43 kg)(Claessens, 2007) and 2008 (153 cm, 45 kg) OG (Feeley, Agel, LaPrade, 2016).

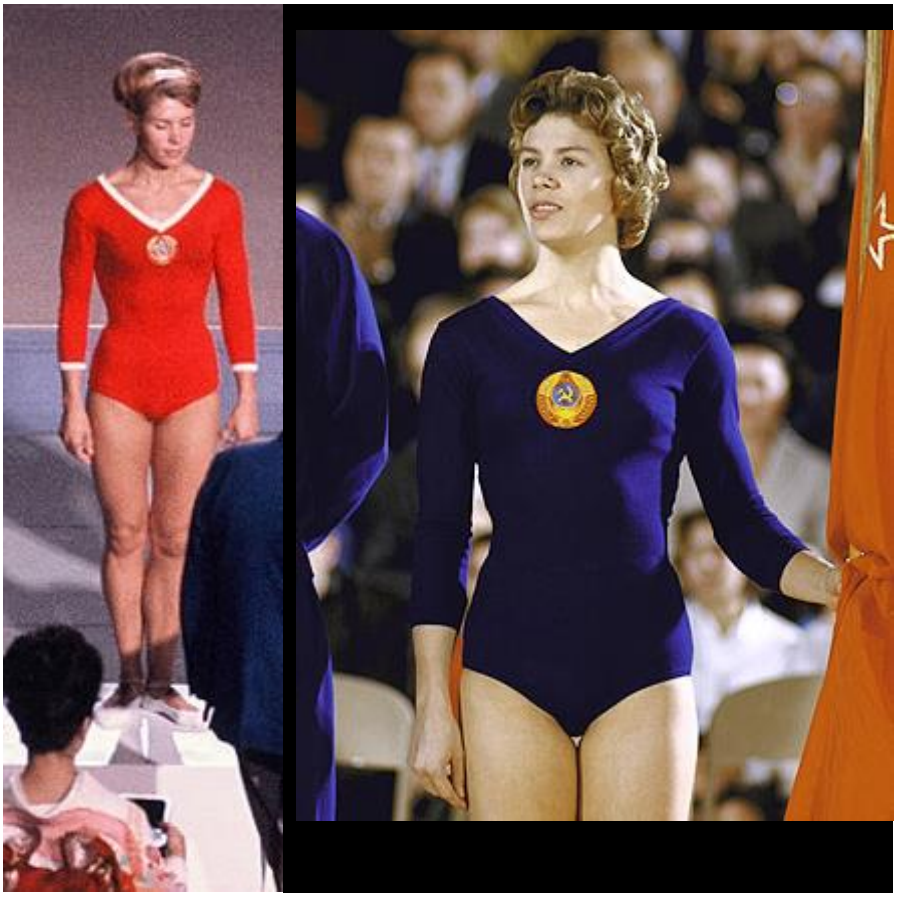

Figure 1 . Larissa Latynina – 14 Olimpic medals (1956-1964)

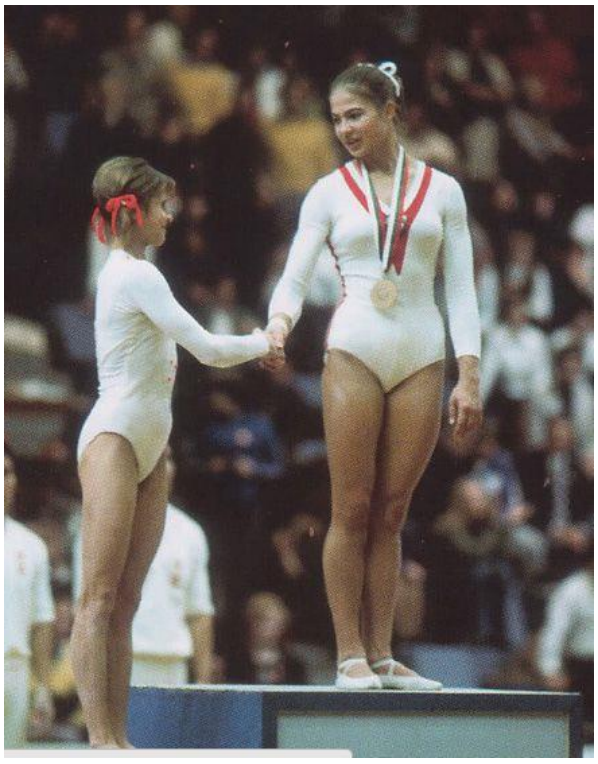

Figure 2. Olga Korbut and Judmila Turicheva WC 1974.

Figure 3. Nadia Comaneci - 8 Olompic medals (1976-1980)

Figure 4. Angelina Melnikova OG 2021 – Olimpic all around medalist

The short stature and later maturation observed in female artistic gymnasts have often been attributed to the effects of intensive gymnastics training from a young age (Georgopolous, Markou, Theodoropoulou et al., 2004; Georgopolous, Theodoropoulou, Leglise, et al., 2004). This perhaps reflects the earlier attainment of advanced levels of training and competition among females, specifically during the interval of the adolescent growth spurt, whereas the more rigorous training for male gymnasts occurs later in the growth spurt when significant gains in muscle mass and muscular strength occur (Malina, Bouchard, Bar-Or, 2004).

In response to this ongoing debate, the Scientific Commission of the International Gymnastics Federation (FIG) convened the authors (Robert M. Malina, Adam D. G. Baxter-Jones, Neil Armstrong, Gaston P. Beunen, Dennis Caine, Robin M. Daly, Richard D. Lewis, Alan D. Rogol and Keith Russell) of paper (Role of Intensive Training in the Growth and Maturation of Artistic Gymnasts) in 2011 to review the current literature and address four questions on the growth and maturation of artistic gymnasts: (1) Is there a negative effect of training on attained adult stature? (2) Is there a negative effect of training on growth of body segments? (3) Does training function to attenuate pubertal growth and maturation, specifically rate of growth and timing and tempo of maturation? (4) Does training negatively influence the endocrine system? The committee was also asked to address terminology for characterizing the growth and maturation of gymnasts and issues for further study. The authors (Malina, Baxter-Jones, Armstrong, Beunen, Caine, Daly, Lewis, Rogol, Russell, 2013) reported:

- Hours per week provide limited information about demands placed upon young artistic gymnasts. Hours training include considerable 'down time' or reduced activity associated with instruction, waiting between repetitions, recovery, nutrition breaks, etc. Specific emphases and intensities of training vary among individuals, with age and competitive level, during the season, and among coaches. Training loads and sequencing of training activities are highly variable among individuals, which limit comparisons. Variation among individuals in responsiveness to gymnastics training has not been systematically considered. Responsiveness to training is an individual characteristic that has a genotypic component. Differences among studies and individual athletes, seasonal variation and lack of information correlating hours per week with indicators of growth and maturation preclude establishing a threshold of training time within which to evaluate available data. If in fact a training threshold does exist, it is likely to be highly individual. Moreover, information relating training to gymnastics performance is lacking. Involvement in other physical activities also merits consideration. More than one-half of female gymnasts (levels 4–10, USA Gymnastics) reported participation in other sports with little variation by competitive level, while mixed-longitudinal samples of female gymnasts and non-gymnasts did not differ in habitual physical activity from 4 to 10 years of age.
- Evidence suggests that gymnasts as a group, though somewhat shorter than average on entering the sport (4–6 years of age), have heights within the normal range. Those who persist in the sport tend to be shorter leading to 786 R. M. Malina et al. the question of whether elite gymnasts are a self-selected group or are selected by others based on shorter stature.
- Is there a negative effect of intensive gymnastics training on attained adult stature? Available evidence does not support the suggestion that adult height or near adult height of female and male artistic gymnasts is compromised by intensive gymnastics training at young ages or during the pubertal growth spurt. To answer this question definitively, late adolescent growth of gymnasts should be monitored into the early 20s.
- Is there a negative effect of intensive gymnastics training on growth of body segments? Although attenuated growth of upper body (sitting height) and lower body

(leg length) segment lengths of gymnasts has been described, it is not possible to link the observations with training. Variation in methodology (due in part to incomplete description) and in CA and adolescent maturation among individuals confound observations in short-term longitudinal studies. Sitting height/standing height ratios in several samples of elite artistic gymnasts overlap reference values for youth suggesting no differences in relative leg length.

- Does intensive gymnastics training attenuate pubertal growth and maturation, specifically rate of growth and timing and tempo of maturation? SA, secondary sex characteristics and landmarks of the growth spurt in female and male artistic gymnasts indicate later maturation. Stature and maturation of gymnasts are similar to short latematuring youth who are not athletes. Allowing for normal variability, gymnastics training does not appear to attenuate pubertal growth and maturation. A primary role for constitutional factors underlying growth (shorter stature) and maturity status (later maturation) of young artistic gymnasts is indicated
- Does intensive gymnastics training have a negative influence on the endocrine system? Presently available data are inadequate to address endocrine changes associated with intensive training in artistic gymnasts
- Data on energy intakes/imbalances among female gymnasts are largely short term so that it is difficult to make inferences about the potential influence of high-energy expenditure and low-energy intake on growth in height and weight and maturation; although shorter and lighter, female gymnasts have, on average, appropriate weight-for-height, but maturity status is a factor that affects weight-for-height relationships. Corresponding data for male gymnasts are lacking.
- Some gymnasts show low annual height increments, but age- and maturity-associated variation, use of a single cutoff criterion, and measurement variability limit interpretations in short-term studies. Use of terminology that implies a direct causative link between gymnastics training and growth and maturity status is not warranted
- Data dealing with culture and environment of artistic gymnastics are lacking. The popular literature for female gymnasts and limited research suggest a need for critical evaluation of the environment of the sport.

Researchers (Pasulka, Jayanthi, McCann, Dugas, LaBella, 2017) reported that children started participating in gymnastics earlier than other sports (~7 years) and began specializing at the youngest age (~9 years) compared with all other individual and team sports. In conjunction with higher rates of early specialization, gymnasts tend to have a higher training volume (~15 hours/week) than athletes in other individual and team sports and often train 12 months of the year, with elite level female gymnasts training up to 36 hours per week. (Caine, Knutzen, Howe, Keeler, 2003) Peak performance in gymnastics typically occurs during adolescence, and participation in Olympic gymnastics can begin at age 16. (Feeley, Agel, LaPrade, 2016).

Due in part to the aerial task demands as well as an increased tendency toward early specialization, rates of injury in club gymnasts are significant, with estimates for acute and overuse injuries of 1.3 and 1.8 injuries per 1000 hours, respectively (O'Kane, Levy, Pietila,

Caine, Schiff, 2011). An injury estimate over a longer, 3- year study in club gymnasts demonstrated an even higher rate of 2.5 injuries per 1000 hours. Although reinjury in gymnastics occurs at a lower rate than initial injury (0.61 per 1000 hours), these rates warrant attention from an injury-prevention perspective. (Feeley, Agel, LaPrade, 2016).

The efects of performing intensive training during growth remains controversial, with claims of negative efects upon growth and maturation purportedly due at least in part to a combination of hormonal disturbances and inappropriate nutrition.

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Competition Density In Elite Football

Juan Torrijo

Nowadays, it is prevalent to see several matches of your favorite team in the same week, sometimes up to three, in addition to prolonging this type of dynamic for several weeks. This way of structuring the competitive calendar entails a series of consequences for the player, both physically and mentally.

The evolution of current football directed and guided to get the maximum economic performance from our team. With that, we are going to expose the players to a very high level of conditional and psychological demand due to the high frequency of matches. If we also add the increase in conditional requirements year after year (Dupong G and al., 2010), the risk of injury to our athletes is exceptionally high.

Let us analyze the recovery times that there are after the match in detail. Following the studies carried out (Ekstrand and al., 2004) and many more, we can know that to have adequate recovery between match and match, although not complete, the interval between one meeting and another must be about 72 hours. However, with this regeneration period, the capacities of many players would not be fully restored. The performance of the athletes would be diminished, and the risk of injury is much higher the lower the time between matches. Therefore, it is advisable to recover all conditional abilities between 96 and 120

hours fully. There are no studies that let us know about mental recovery. However, my own experience tells me that after playing games of high competitive tension, such as those played in international competitions, the players when they face teams from the domestic competition have a level of activation (Arousal) much lower since the whole environment has a very different dynamic to the one experienced in one game and another.

In my experience in particular, in teams where we have had up to four competition formats in the same season, we have played more than 60 official matches, representing a very high competitive density. In this way, the external load to which the players are subjected and its repercussion on both acute and chronic fatigue indices are very high, given the records we obtain from the well-being questionnaires administered to the players daily.

Among the strategies that we have applied for this type of competitive demand, we have decisively prioritized two, being the post-match nutritional ones in a period of up to 24 hours, which have been applied individually to the needs of each player and the rest both in quantity as well as in the quality of sleep, considering both as fundamental for the correct recovery of the player. We have also applied many other strategies for post-match recoveries, such as cryotherapy, active recovery, stretching, compression methods for the lower limbs, electrical stimulation, and massage. However, the literature does not offer us scientific evidence that demonstrates the effectiveness of these methods (Shona L. Halson, 2015).

On the other hand, when we face these scenarios of high competitive density, we cannot forget the players who do not participate in the matches or do so for a short time. When this situation occurs, we do not have time to accumulate workloads progressively, and we must measure well and compensate for the work that these players have not done on match day. For them, we must plan a compensatory training that has enough workload to maintain the performance levels that may be required in the following matches, and without overloading them too much, since the proximity of the matches does not allow us to introduce high-impact loads. To do this, we control the workloads individually to establish a balance in the distribution of playing time as long as the tactical needs of the team allow it. In particular, it is convenient to introduce a short training immediately after the match, with fundamentally neuro-muscular content. The next day I focused on more aero-anaerobic and specific tasks with the ball. In this way, we can balance and compensate for the lack of training and avoid a decline in the performance of these players.