TRAINING LOAD MONITORING IN HANDBALL

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Training load in handball, much like in any competitive sport, plays a crucial role in optimizing athlete performance. Training load is the cumulative amount of stress placed on an individual from a single or multiple training sessions over a period of time[1], and is important for training adaption, as the body adjusts through cycles of training and subsequent recovery. Therefore, achieving performance improvements depends on striking the right balance between the amount of training load and sufficient recovery.

Training load monitoring refers to a systematic observation of training load over time, and has gained interest, both in research and in practice over the last decades[2]. Training load monitoring should aim to provide information that can be used to manage the load in an appropriate manner, and in that way be positive for long-term performance. By being able to have more insights into the training load that athletes are subjected to, and how they adapt to the load, the training planning process can be more precise. Thus, monitoring of training load represents an important feedback tool for coaches/practitioners in the training planning process[3].

Although the concept of training load monitoring is not new, the gained interest could be attributed to the vast development in technology and methods applied for training load monitoring: From being primarily dependent on coach observation and notational analyses, the training load monitoring process is now packed with different technology that is meant to help coaches/practitioners gain insights into different aspects of training load for their athletes.

This article aims to give insights into methods for collecting training load data in handball, and to discuss the important aspects of a successful training load monitoring process in a practical setting.

TRAINING LOAD DATA

Training load is often grouped into the constructs external and internal training load[4,5], where external load refers to measurable aspects occurring externally to the athlete (such as distance travelled, speed, or number of accelerations) or internally to the athlete (such as heart rate, oxygen consumption or subjective ratings). In other words, external load is the physical work the athletes do, while internal load is how they physiologically respond the external load. For both internal and external training load there are numerous variables that are available for coaches, athletes, and scientists[2,6]. Yet, the scientific foundation for many of these markers remains limited, with no single variable emerging as universally definitive. Consequently, selecting which training load variables to use is subject to multiple interpretations, each with its own merits, and with the absence of a universally right or wrong choice. It is also important to note that different sports have different traits, further complicating the choice of training load variables.

External load

Time-motion analysis is the recording of time-and-distance data, movement patterns, frequency, mean duration and total time spent in a specific activity (e.g., total distance, sprint distance, accelerations). Time-motion analysis can be done using different technologies, such as video analysis, global navigation satellite systems (GPS), or local positioning system (LPS). As handball is an indoor sport, GPS is not a reliable method for collecting data – but both video analysis and LPS can be used. In fact, the use of LPS has risen in handball, and in international tournaments such as the world cup, all teams are tracked using LPS. Time-motion analysis variables are among the most used variables for training load monitoring in team sports[7], especially distance in high-speed running and sprinting categories are frequently used to quantify training load[7]. However, there are a lot of other movements that also contribute to training load, that are not sufficiently

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Illustration

covered by time-motion analysis. Especially in sports like handball, with limited space compared to other team sports, other movements, such as such as rapid changes of direction, tackles/collisions, accelerations, and jumps, are common, and should be considered a vast part of the training load. These movements cannot he measured by time-motion analysis, and thus other types of technology is needed.

Inertial sensors, such as accelerometers (acceleration sensors) and gyroscopes (angular rate sensors), are often collectively called inertial measurement units (IMUs). IMUs were initially used for gait analyses, however, the use of IMUs is now also common in team sports[8]. IMUs have also been used for match and training analysis in handball[9,10], and has shown to provide complementary information on training load compared to using time-motion analyses alone[9]. For instance, research has shown that wing players are the position with most distance covered in higher speed (such as sprinting)[11], which time-motion analysis provide information on, while for other positions, the training load might be more dependent on accelerative efforts, such as changes of direction and jumps[9], which could be monitored with IMU. IMUs are often incorporated in LPS, thus providing both time-motion analysis and IMU metrics.

Although the combination of LPS and IMU can give a comprehensive insight into different aspects of training load in handball, one should note that there are few handball-specific variables that have been developed. In addition, some load aspects, such as "wrestling" actions in defence and offence (especially relevant for pivots) will not be captured, as it does not elicit movement – however this does not mean that these actions are not physical demanding. This just shows that there are still load aspects that are not accurately measured with today's technology.

Internal load

There are several variables used for internal training load, and in team sports the most common are heart rate and session rating of perceived exertion (sRPE)[7]. Both have their advantages and limitations. Heart rate provides objective data related to the physiological demands placed on an athlete during training and competition. It offers insights into the cardiovascular and metabolic stress experienced by the player, which can be crucial for monitoring training intensity and ensuring athletes are working within the desired training zones. However, the fact that handball is a highly intermittent activity, heart rate measurements alone might underestimate the load athletes experience, due to the delays in heart rate response[12].

Session Rating of Perceived Exertion (sRPE) offers a subjective measure of an athlete's perceived effort during a session[13], encapsulating not only the physical but also the psychological and emotional exertion. This variable is particularly valuable because it accounts for the individual's perception of effort, which can be influenced by factors such as sleep quality, stress, and nutrition, aspects that heart rate measurements might not fully capture. However, as a subjective measure, sRPE is prone to error and especially in a competitive environment it is important that the athletes are properly educated in how to rate their training. A lack of education on sRPE can lead athletes to provide untruthful answers, potentially trying to influence future training plans or their selection for the team[14].

Integrating external and internal load variables

The integration of both types of variables (external and internal) allows for a

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comprehensive approach to training load monitoring. While external load variables such as distance covered, accelerations, and workload offer a quantitative measure of what the athlete has done, internal load measures like heart rate and sRPE provide context regarding how the body is responding to these demands. The combination of internal and external load variables have conceptual benefits, as for example the uncoupling of load may be used as an indicator of how athletes cope with their training program[4]. This can help coaches and practitioners to fine-tune training programs, ensuring they promote optimal performance while minimizing the risk of overtraining or injury. Additionally, understanding the relationship between external load and internal response can guide decisions on recovery strategies, individualizing them to meet each athlete's specific needs based on their physiological and psychological responses to training loads.

IMPLEMENTING TRAINING LOAD MONITORING IN HANDBALL

From other team sports, such as football and rugby, we know that training load monitoring is commonplace in elite settings. Surveys have shown that almost all elite football teams (both male and female) use some form of training load monitoring scheme[15,16]. However, there are several challenges that needs to be considered when implementing training load monitoring in a practical setting. These challenges can vary in different settings, but some common challenges are outlined below, and include economical/time constrains, lack of expertise/knowledge, and the motivation of coaches and athletes[3,17].

The financial aspect of integrating a comprehensive training load monitoring system can be formidable. High-quality equipment, technology, and software—essential for collecting and analyzing data on athletes' performance, health, and workload—are often expensive. This includes wearable technology like LPS units, heart rate monitors, and IMUS, as well as the software needed to process the vast amounts of data these tools generate. Additionally, the collection of data plays a key role in a training monitoring process, however, to be impactful, it is not enough to only collect the data, we need to use the data in an appropriate manner. To make a real impact, we can break down the training load monitoring process into three key stages: collection, analysis, and implementation. Each of these stages plays a crucial role in the process, and none can work well without the others. Thus, time that staff spends on the training load monitoring process might be extensive. For clubs with limited budgets, prioritizing these expenses can be challenging, especially when funds might be competing with other critical needs such as player acquisitions or facility improvements. Coaches and support staff are often already stretched thin with their existing duties and finding additional time for these tasks can be challenging. Thus it is important to find solutions that are within both economical and time constraints in the sporting environment.

A successful training load monitoring system is not just about having the right tools but also possessing the expertise and knowledge to use them effectively. This includes understanding the principles of sports science, the reliability of the data, data analysis, and the specific demands of the sport. However, not all teams have access to professionals with the necessary expertise, and smaller clubs might find it challenging to attract or retain such talent. Additionally, there's a learning curve associated with adopting new technologies and methodologies, which can be a barrier for staff who are unfamiliar with advanced monitoring tools and techniques.

Finally, the attitudes and motivations of the athletes and coaching staff towards training load monitoring can significantly impact its successful implementation. Some players may view the wearing of monitoring devices as intrusive or uncomfortable, potentially affecting their compliance. Similarly, coaches who are skeptical of data-driven approaches or resistant to adjusting their traditional training methods based on analytics might not fully engage with the monitoring process. The challenge, then, is to foster a culture that values and trusts the insights provided by training load monitoring, recognizing its potential to optimizing the training process and enhance performance.

PRACTICAL RECOMMENDATIONS FOR TRAINING LOAD MONITORING IN HANDBALL

To address the challenges of implementing training load monitoring in handball, certain key areas can be emphasized as initial focal points:

1. Focus on a limited number of variables
   It's advisable to limit the number of variables being reported to coaches and players. Overloading on data can complicate analysis and dilute focus from key insights. Start by identifying a core set of variables that are both relevant to handball and that are understandable within your team's context. It is recommended that both external and internal load variables are included.
2. Reliability of the data
   Ensuring the data's reliability is important; consistent and accurate data are crucial for making meaningful comparisons over time. Utilize technologies and methodologies that have are found to be reliable within the sports science community to ensure that the data you rely on for decision-making is dependable.
3. Use the data to make better training decisions
   For impact, and for coach/player motivation for the process, it is important that the data is actually put to use – if not, why should we bother with the process? Use the data to make decisions about training and recovery for the athletes, and track performance over time to ensure that the training monitoring process is working as intended.

SUMMARY/CONCLUSION

Even in the era of pen and paper notational analysis, coaches and sports scientists aimed to fine-tune training programmes through training load monitoring. With today's data and technology, this process has evolved. Even though we still deal with complex concepts and limited knowledge of cause and effect, a successful training load monitoring process can support the training planning process, and long-term impact athletes and teams' performance.

The methodology involves tracking both external and internal loads to provide a view of an athlete's exertion and response. While external load variables offer insights into the physical demands of training, internal load variables delve into the physiological and perceived exertion, crucial for tailoring recovery and training intensity. However, adopting such a system is not without its challenges. Financial, time, and knowledge constraints, along with varying levels of acceptance among coaches and players, can hinder successful implementation. However, by focusing on a manageable set of key variables, ensuring data reliability, and using insights to inform training decisions, teams can leverage these tools for significant performance insights.

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