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Internal Training Load in Collegiate Basketball Players: Effort Ratings vs. Heart Rate Measurements in NCAA DII Players

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College basketball is an extremely intense team sport that requires players to jump, sprint, pivot, and slide laterally during practices and games. Basketball utilizes both the aerobic and anaerobic systems in the body to play a 40-minute-long game and cover around 2-3 miles on average per game (Narazaki, Berg, Stergiou, & Chen, 2009). All of the quick movements made to play basketball put very high demands on the athlete's cardiovascular and musculoskeletal system over time. According to the Insurance Information Institute, in 2017 basketball caused 500,000 injuries in the United States putting it in second place for the sport that caused the most injuries. The most common type of injury for a basketball player to sustain would be a lateral ankle sprain due to the jumping and quick change of direction that players do to play the game (Garbenytė-Apolinskienė, Salatkaitė, Šiupšinskas, & Gudas, 2019).

The high workloads that players experience on a daily basis in practices or games can lead to fatigue, which is a negative aspect of training. When an athlete begins to experience fatigue, it increases their risk for a potential injury (Garbenytė-Apolinskienė, Salatkaitė, Šiupšinskas, & Gudas, 2019). Fatigue can reduce the dynamic knee stability which increases the risk of an ACL injury, an injury sustained by many basketball players (Garbenytė-Apolinskienė, Salatkaitė, Šiupšinskas, & Gudas, 2019). That is why it so common for basketball teams at any level to include a warm-up before they practice or play because it reduces fatigue in the muscles, which can lower the risk of injury(Garbenytė-Apolinskienė, Salatkaitė, Šiupšinskas, & Gudas, 2019). This is why it is so important that sports scientists study and monitor the internal and external training loads on basketball players to help enhance their athletic performance as well as prevent injuries over time.

“Training load (TL) is classically subdivided into an external component (eTL), which refers to the volume and intensity of the stimulus designed by coaches, and an internal component (iTL), which often represents the player’s psychophysical response (i.e., heart rate, blood lactate, and exertion),” (Fox, Scanlan & Stanton 2017). The most common methods to determine internal training load would be to use heart rate monitors or session rating of perceived exertion (sRPE). Both of these methods can be used to calculate the training impulse (TRIMP) of each session completed by the athlete. TRIMP is a single number that represents the overall intensity for a workout session and it can be calculated using various methods that have been developed by researchers. Therefore, TRIMP is significant because it is another way that the internal training load can be quantified and compared over time (Foster, 1998).

Many studies have analyzed the effectiveness of sRPE and heart rate monitors in regards to describing the training load athletes experience during different exercises. sRPE is known for its simplicity and validity when describing the internal load of an athlete (Sansone et al., 2018). Heart rate monitors are reliable for low to moderate types of exercise, but for high intensity workouts they’re not as accurate (Hopkins, 1991). Additionally, heart rate monitors can be very expensive and perhaps too expensive for college coaches to afford. Therefore, the purpose of this study is to investigate the effectiveness of the sRPE method compared to heart rate monitors when calculating TRIMP for an athlete's workout session. If it is possible that the sRPE method to calculate TRIMP is just as reliable as the heart rate monitors then it would be the more cost-effective route for college coaches to monitor the condition of their players during the season.

Rating of Perceived Exertion (sRPE)

sRPE is a psychological method that can indicate the level of intensity for a workout session and it's based upon the athlete's subjective perception of the workout (Foster et al., 2001). This is an individualized type of monitoring technique which means that every athlete's perception on the intensity of the workout can vary. The sRPE is self-reported and can be determined by using the Borg's 0–10 Category-Ratio scale (Foster et al., 2001). At the end of the session, the players are asked to reflect on the entirety of the session and pick a number between 0-10 (not intense to extremely intense) to rank the intensity (Fox, Scanlan & Stanton 2017). Rating of perceived exertion is advantageous because it is noninvasive, simple to calculate and cost efficient (Fox, Scanlan & Stanton 2017). This means that sRPE can be used by coaches to assess the training load of their athletes if it's multiplied by the duration of the workout session (in minutes) to determine TRIMP. Studies have also shown that sRPE can be used for a wider variety of exercises as opposed to heart rate monitors (Foster et al., 2001).

A disadvantage for measuring internal load using a sRPE scale is rooted in the subjectivity of a person's perception on how hard they believe to be working. It is possible for an athlete to not feel fatigued but the physiological changes in the body might not align with athlete's perception. However, the rating that an athlete decides to assign to each training session does provide a holistic view on their internal load based upon how fatigued an athlete feels at the end of each session. This essentially means that sRPE is a reliable method to use in addition to other methods that measure the internal load physiologically because it illustrates a more complete picture of internal load. In addition, studies have also shown that sRPE can be used for a wider variety of exercises as opposed to heart rate monitors (Foster et al., 2001). Although there are many positives of self-report effort, heart rate monitors provide an accurate intel measure of effort athletes' give and can provide useful information to both coach and athlete.

Heart Rate Monitors

Heart rate monitors are electronic devices that have the ability to measure the frequency of electrical activity in the heart (Berkelmans, et al., 2018). It is important to note that heart rate can be influenced (increase or decrease) based on factors such as: emotional state, level of hydration, natural variation, nutritional state, cardiovascular drift, temperature, humidity, altitude etc. (Berkelmans, et al., 2018). Heart rate monitors are capable of measuring internal load and it is done by measuring the physiological response of one's heart rate during exercise. These devices can be worn during practice/competition and they will not distract or restrict the athletes. They are reliable devices that are convenient and noninvasive. However, heart rate monitors are known for being more expensive and they can have a tendency to malfunction occasionally for various reasons. If they were to malfunction or if an athlete forgot to put on the heart rate monitor then the data for that practice session will be lost (Foster et al., 2001). In addition, these devices can underestimate the intensity of a session if the athlete is participating in high intensity exercise such as: basketball, soccer, hockey, plyometric exercises, HIIT training etc. (Fox, Scanlan & Stanton 2017). This is due to the fact that there is a temporal delay that occurs in the heart rate response when there are rapid changes in the intensity of exercise (Fox, Scanlan & Stanton 2017). Heart rate monitors are more effective when combined with a training load model because it will reduce the limitations experienced if they were to be used independently.

There is a linear relationship between heart rate and oxygen uptake which means that heart rate monitors can be used to measure energy expenditure and oxidative metabolic recruitment within the body during exercise (Berkelmans, et al., 2018). This is valuable because when reviewing data from a basketball practice/game it could indicate the physiological internal load that an athlete is experiencing throughout all of the biological systems (respiratory, cardiovascular, and musculoskeletal). In addition, heart rate monitors can gather data on the heart rate recovery of an athlete after a single or multiple bout of exercise. By measuring an athlete's heart rate before and after a training session it can provide insight on their state of fatigue, as well as, their cardiovascular system's ability to adapt to the accumulation of training (Berkelmans, et al., 2018). If an athlete has an increase in resting heart rate prior to practice this could indicate fatigue whereas a lower heart rate would suggest proper adaptation of the cardiovascular system to the training sessions (Berkelmans, et al., 2018). Overtime, large changes in heart rate from the baseline can also be a sign that the athlete's system is overreaching and may need to spend more time recovering (Berkelmans, et al., 2018). If these important signs are ignored that is when an athlete will begin to experience fatigue and that will increase their risk for sustaining an injury.

Training Impulse (TRIMP)

The concept of TRIMP, in its most basic form, involves taking the average heart rate for a workout session and multiplying that by the duration of the workout. This will allow one to calculate a quantifiable number to monitor training load for each training session. There are a few common models for calculating TRIMP. Foster et al., used the sRPE method mentioned prior and the summated heart rate zones (SHRZs) method. The summated heart rate zones can calculate the internal load for an athlete's workout session based upon the duration spent in each heart range (Scanlan et al., 2014). The heart rate ranges typically are depicted by specific percentages of the maximal heart rate. The duration spent in each HR zone is then multiplied by a specific multiplier for that zone and the results are added together (Scanlan et al., 2014).

Bannister's training load model was based on the exercise session duration and resting, mean and maximum heart rate responses during the session (Scanlan et al., 2014). The Bannister training load model can be used with a basketball team very well because it only requires the use of heart rate monitors and it won't distract athletes during the training. A limitation for this training model would be that coaches must take on the responsibility of determining the maximal heart rate and heart rate at rest (Banister, 1991). The Lucia and SHRZ training impulse models are also applicable basketball because they are capable of detecting changes in loads and providing information on the difference between players (Fox, Scanlan & Stanton 2017).

Methods and Materials

The purpose of this study was to compare the internal load and recovery of college basketball players during their pre-season and mid-season practices, using the sRPE method versus a heart rate monitor. The participants of this study included 26 collegiate basketball players that were on the Wayne State University Women and Men's basketball teams. The participants included 15 female and 10 male athletes. Before the study began, we received informed consent from the basketball players and coaches for both teams to conduct the study. All participants were asked to wear a Firstbeat™ (Jyvaskyla, Finland) heart rate monitor so that data about overall recovery prior to practice and internal load during practice could be collected.

All participants were pre-assigned Firstbeat™ heart rate monitors and wore them for the entire duration of each practice (about two hours in length). Before each practice athletes were instructed to perform a quick recovery test (QRT) for three minutes. This involved the athletes laying quietly in a supine position for the entirety of the test that resulted in a recovery score daily. The Firstbeat™ software was able to record heart rate, percentage heart rate max, TRIMP, duration of session etc. on all of the athletes during each practice session. In addition, all participants and coaches were asked to rate the intensity of the practice for that day, using the Borg's CR-10 RPE scale (0-10), as soon as practice had concluded.

An arbitrary number can then be calculated to represent the internal training load by using the RPE score and multiplying it by the duration of the practice (in minutes) to create "calculated TRIMP" or cTRIMP for short. The information collected by the Firstbeat™ software provided the duration of each day of pre-season and mid-season practice in hours. In order to calculate the internal training load, the duration of all the practices were converted to minutes for each player. The duration of practice in minutes was then multiplied by the RPE score recorded for each player to calculate their own training load for that particular practice. This method was then repeated to determine the TRIMP score for all of the other practice sessions. We then compared TRIMP versus cTRIMP for all players total, and also by sex (male and female). Also, we analyzed data using statistical software programs and set statistical significance a priori at $p<0.05$.

Results

A total of 25 NCAA DII athletes participated in this study, their body composition was recorded using our DXA scan table. Table 1 provides the demographics of our sample and it is separated by sex. The average of each measurement was taken for male and female participants and the entire sample of players.

Table 1: Demographics

	Male (n = 11)	**Female = (n 14)**	**Total Players (N = 25)**
Age	19 ± 1.47	19 ± 1.38	19 ± 1.39
Height (cm)	1.86 ± 0.08	1.73 ± 0.05	1.79 ± .09
Weight (kg)	88.71 ± 15.31	68.82 ± 8.84	77.57 ± 15.54
BMI (kg/m^2)	24.93 ± 2.59	22.75 ± 2.31	23.71 ± 2.63
Total Body Fat (%)	19.90 ± 2.62	27.78 ± 2.86	24.31 ± 4.82
Total Body Lean Mass (kg)	67 ± 9.99	46.88 ± 4.78	55.74 ± 12.56
Total BMD (g/cm^2)	1.39 ± .11	1.21 ± 0.09	1.29 ± .13

The results in Table 2, excluding session RPE, were calculated using the Firstbeat™ heart monitoring software. The session RPE was recorded by the researchers and calculated by hand to determine the averages. The average HRR and HRmax have been converted to a scale similar to RPE so that they can be compared. Table 2 provides the averages for each measurement and it is separated by sex.

Table 2: Cardiovascular and Training Effort Variables

	Male (n = 11)	**Female = (n 14)**	**Total Players (N = 25)**
Average HR (bpm)	149.28 ± 6.95	138.98 ± 9.25	143 ± 9.70
Session RPE (sRPE)	7.10 ± 0.97	4.39 ± 0.71	5.52 ± 1.58
Average HRR (sRPE)	6.27 ± 0.44	5.37 ± 0.79	5.75 ± 0.80
Average HRmax (sRPE)	7.10 ± 0.35	6.58 ± 0.39	6.80 ± 0.45
TRIMP	206.79 ± 29.41	177.08 ± 30.61	189.43 ± 33.04
QRT (%)	0.48 ± 0.26	0.58 ± 0.16	0.57 ± 0.17

With regards to correlational analyses, when male and female data were combined for all timepoints (N=96), a statistically significant (<0.0001) positive correlation (r=0.62) was noted between the TRIMP value calculated by the heart-rate monitoring system (TRIMP) versus the TRIMP score that was calculated using sRPE and duration (cTRIMP). This relationship is illustrated in Figure 1.

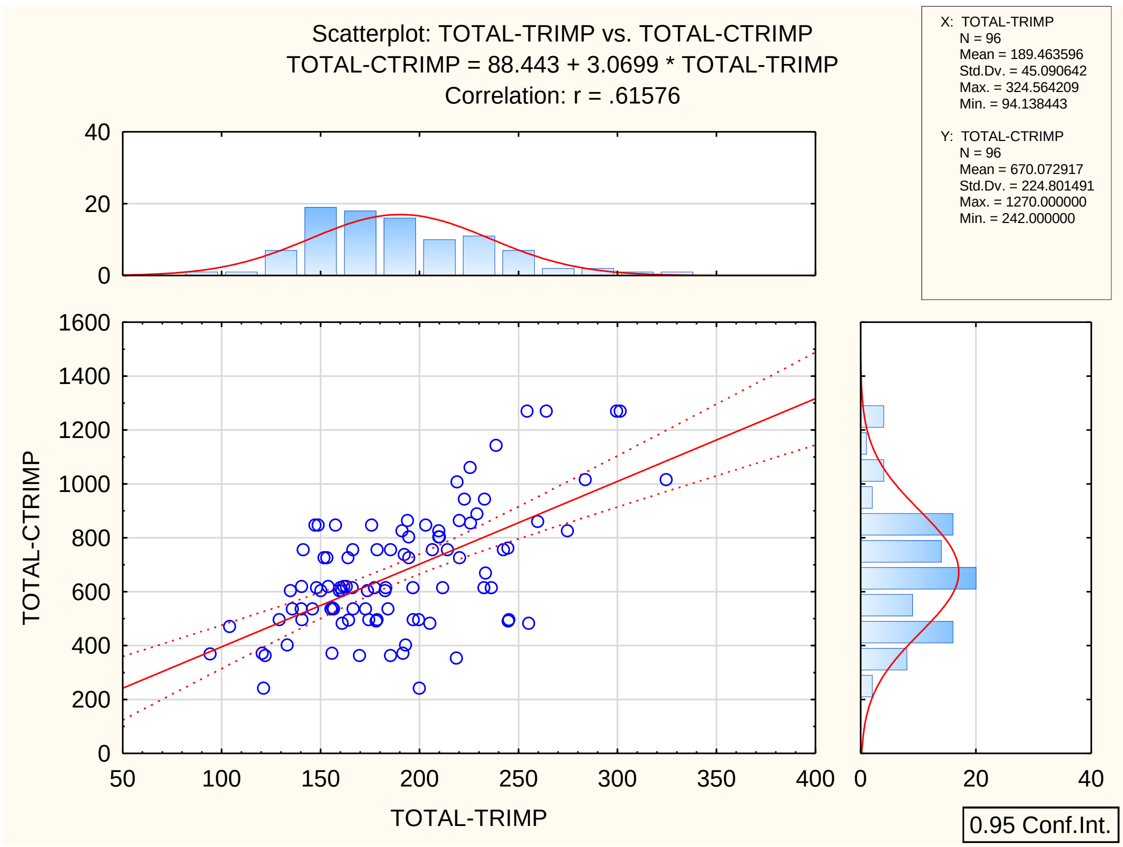

Figure 1: Significant relationship for TRIMP versus cTRIMP, when all datapoints combined for males and females

Additionally, this significant positive relationship between TRIMP vs. cTRIMP (Figure 1) was stronger for male basketball players (r=0.69; p<0.0001; n=40; Figure 2) than for female basketball players (r=0.33; p=0.01; n=56; Figure 3).

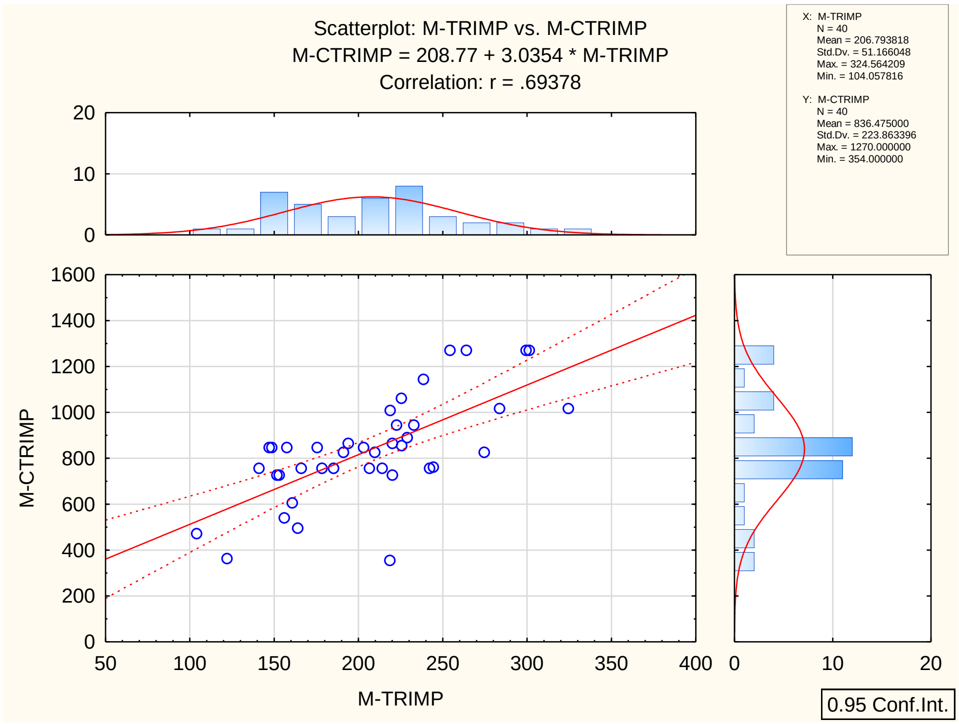

Figure 2: Significant relationship for TRIMP versus cTRIMP, for male basketball players

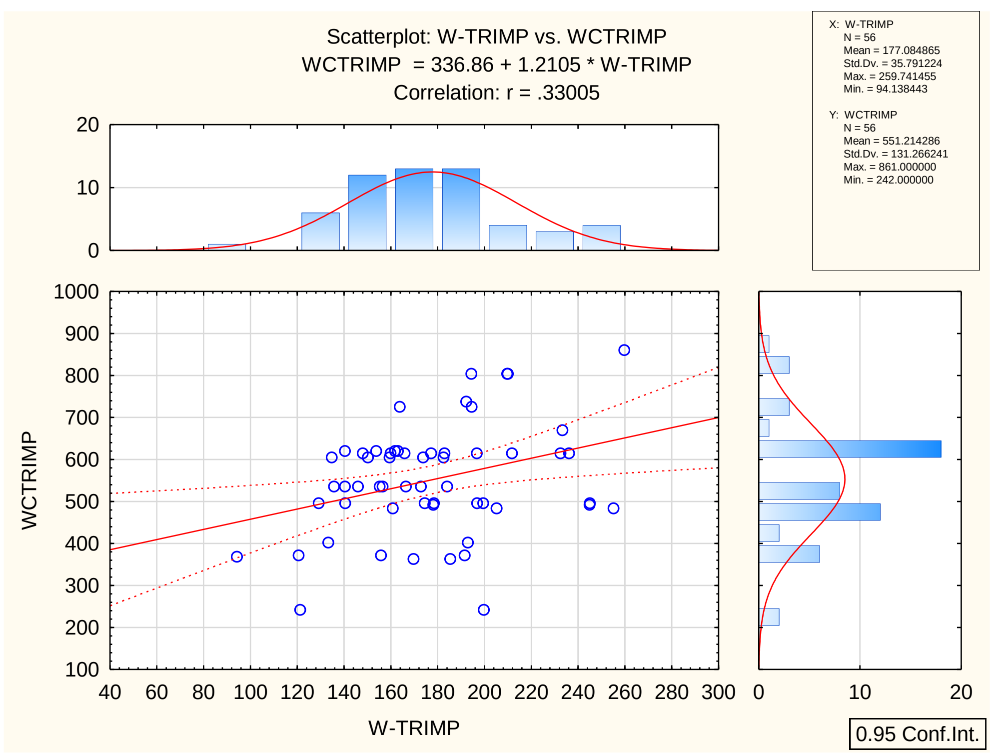

Figure 3: Significant relationship for TRIMP versus cTRIMP, for female basketball players.

There were also significant positive correlations between sRPE and TRIMP for all datapoints ($r=0.59$; $p<0.0001$; $N=96$), and when separated into male basketball ($r=0.65$; $p<0.0001$; $n=40$) and female basketball ($r=0.33$; $p=0.01$; $n=56$).

Discussion

The main purpose of this study is to compare two valid methods of measuring internal load in collegiate basketball players. The data in Table 2 shows the results from sRPE and the Firstbeat™ heart rate monitoring software. The results give us information such as QRT and TRIMP, that can be compared to examine the amount of recovery and internal load that each collegiate team is experiencing throughout the season. That is extremely beneficial in determining if players may be experiencing overtraining because the recovery scores will be low and the TRIMP scores may be higher than normal. These are essential variables for coaches and trainers to monitor in order to prevent players from becoming injured.

In addition, Table 2 highlights the average RPE scores and the heart rate measurements. For the male participants, the sRPE session and average HRmax were identical besides the differences in standard deviation. The male participants also reported a higher sRPE than the average HRR. For the female participants, they reported a lower sRPE score than both the average HRR and HRmax. In addition, the overall sRPE for total players was also less than both the average HRR and HRmax. This data suggests that there is some discourse when measuring internal load using a physiological and psychological method. The fact that sRPE is a subjective method, it could mean that the female participants have a tendency to underrate the intensity for a workout session. However, it is also possible that heart rate monitors may have produced inaccurate measurements of the heart simply because basketball can be such an intense sport. It is difficult to discern which method may be inaccurate when both methods have variables that can alter the results.

Our study produced data that indicated a moderate, but statistically significant, correlation between cTRIMP and Total TRIMP for all of the athletes that participated. This means that both the men and women basketball teams were able to provide a similar perceived rating of exertion when compared to the internal load reading that the heart rate monitor recorded. These are statistically significant results which means that using the sRPE method or heart rate monitor independently can provide reliable insight on the internal load of athletes. The results did show that men’s basketball team had a stronger correlation (r=0.69) between cTRIMP and TRIMP than the women’s basketball team (r=0.33). Initially, we believed the difference in correlation between the men and women was due to women having a higher pain tolerance than men thus leading to lower sRPE scores but that hypothesis has not been previously validated in other studies (Hall & Davies, 1991). Our data did contradict research done on athletes that which indicates that male athletes tend to have a higher tolerance of pain than female athletes (Hall & Davies, 1991).

It is possible that the men had a higher correlation between cTRIMP and TRIMP because men experience pain/fatigue differently than women do. The following speculations made upon the differences in RPE scores were made while acknowledging the limitation that the practices for the men and women’s basketball teams were not the same. Initially, it is true that women are more sensitive to pain than men are at first. However, when men and women are exposed to the same stimulus again, men become hypersensitive to it because they anticipate the pain they're about to experience (Martin, et al., 2015). Their body is flooded with stress hormones that actually make men feel pain or the fatigue of their workout more intensely (Martin, et al., 2015). Therefore, this could be part of the reason why the men's basketball team was rating their practices to be much more intense than the women's practice.

The other factor that could've been at play was the fact the women's basketball team was in better shape than the men's basketball team so they didn't think their practices were that difficult because they had the aerobic endurance to withstand a two-hour practice. However, there were two men on the team that had been playing college basketball for more than one year like some of the women. Those two men also thought their practices were very tough and they had the same aerobic endurance as the women. So, it is logical to conclude that the hypersensitivity men experience after being exposed to a painful stimulus can be the reason they rated these pre-season practices with higher sRPE scores.

The sRPE can suffer from its subjectivity at times because an athlete's perception of how hard they were working in a workout may not align with the physiological responses of the body but the heart rate monitor can fill the gaps. sRPE can indicate the intensity level for a practice session but it is solely based on the idea that the athlete can monitor their own psychological stress. However, some athletes will not be able to do this and it can lead to the collection of skewed information that coaches will be receiving back from the player. For example, sleep is very important for the well-being of our physical and mental health. In addition, sleep deprivation can lead to a decline in mood and cognitive performance which can directly affect the RPE for a workout session (Myles, 1985). College athletes are also college students and it is well known that this demographic does not get a lot of sleep due to academic, social or financial stress (Hamlin, Wilkes , Elliot, Lizamore, & Kathiravel, 2019). If a collegiate athlete is suffering from sleep deprivation it can lead to an increased RPE score because they are lacking the energy they need to perform at their best and this will make them perceive their work out to be more intense/difficult (Myles, 1985). This is an important factor for coaches to be aware of because RPE can be influenced by sleep so it is encouraged to monitor the athletes sleep patterns to ensure that it’s not impacting their RPE scores. It is also in the best interest of the player for coaches to monitor sleep because sleep deprivation can increase the risk for injury during a game or practice (Milewski, et al., 2014). The players could simply fill out simple questionnaires before or after practice that just ask for how much sleep they’re getting every night. If it is left unchecked in this population it could be appear within the data that the players are being overworked but in reality, they are just tired from sleep deprivation.

The fitness level of the athletes is another factor that can influence the rating of perceived exertion for a training session. The fitness level of an athlete essentially reflects their overall aerobic fitness which can differ from person to person (Garcin, 2004). The athletes that have a low or moderate fitness level may struggle more to perform at high intensity levels during practices or workouts (Garcin, 2004). This can impact the overall the data being collected by the coaches because there may be a few individuals that rate the intensity of the workouts higher than others. In the same regard, if athletes with a low fitness level can rate practices to be more intense then athletes with a high fitness level can potentially rank practices to be less intense.

This is why it’s critical to do fitness assessments with players prior to starting a training program to ensure that they are being trained the appropriate way on an individual level but also as a team.

Heart rate monitors are great tool to use with RPE because it does indicate the internal load of athletes by measuring physiological responses of the body. However, heart rate monitors can be used by themselves to help monitor intensity levels, heart rate recovery, and heart rate variability which all are essential to help athletes from sustaining injuries due to fatigue. Overall, this is a practical tool that can be bought with a software that makes it easier for coaches to collect all of the data. The devices are noninvasive, convenient and are simple to attach to players before a practice session begins. It is important to be aware that heart rate can be affected by factors such as hydration, fatigue, mental state and the environment.

If coaches determine the maximum heart rate for all of their players then they have the ability to actually set a specific intensity level for each practice session. They simply just have to choose a certain percentage of maximum heart and then monitor heart rates during the practice session to ensure that they are hitting the chosen benchmark. This will provide coaches and trainers the opportunity to design better training programs that are more tailored to the needs of the players. If they are aware that a few players are fatigued on a physiological level then they can be more cautious about how much they want to let that players heart rate increase. If an individual’s heart rate is high then there will be more strain put on the cardiovascular and musculoskeletal system. If a player is already fatigued and then encouraged to push themselves to keep up with the high intensity practice it will increase their risk for sustaining an injury. That is why it is essential to not only monitor but prescribe specific intensity levels for specific players to avoid injuries.

Just as we can use heart rate monitors to maintain a certain intensity level during a practice, we can also use heart rate to determine the physiological toll that a practice has had on an athlete. Heart rate recovery is the rate at which heart rate declines at the end of exercise session and it’s related to autonomic function and training status in athletes (Halson, 2014). The autonomic nervous system is made up of two systems: parasympathetic and sympathetic. The sympathetic nervous is activated when one is exercising and causes the heart rate to increase; while the parasympathetic nervous system has a reduction in activity (Halson, 2014). Heart rate recovery is essentially the ability for the body to reactivate the parasympathetic and reduce activity of the sympathetic system so that the heart rate will decrease after exercise (Halson,2014). Therefore, the more quickly that your heart rate can decline to its resting pace means that your body is at a higher training status. Determining heart rate recovery provides insight on the ability for our cardiovascular system to adjust to the accumulation of training we are undergoing (Berkelmans, et al., 2018). Heart rate recovery can indicate whether athletes are experiencing fatigue if it takes the heart rate a long to return to resting heart rate. It is critical to pay attention to the signs that will increase the risk of injury in athletes and heart rate recovery is an easy way to monitor the physiological systems.

Heart rate variability is the changing of the time intervals between each heat beat. This means that not every heart beat occurs evenly spaced out over the course of a minute. Heart rate variability is another method that can indicate positive or negative adaptations to training (Plews, Laursen , Stanley, Kilding , & Buchheit, 2013). It can be done by monitoring the resting heart rate or heart rate after exercise. It is best for heart rate variability to be analyzed over the course of weeks instead of day-to day to ensure more valid results (Halson, 2014). This is due to the fact that heart rate can fluctuate throughout the day based upon environmental or homeostatic factors (Halson, 2014). It is suggested that within elite athletes, heart rate variability can decrease when the body is put under stress such as an intense couple of weeks of training for pre-season in collegiate athletes. If one notices trends of high heart rate variability over time, this could reveal that the athletes' bodies are more readily able to recover from and tolerate the stress that is being imposed upon them during intense training sessions (Plews, Laursen, Stanley, Kilding , & Buchheit, 2013) . Heart rate variability is definitely more significant if monitored over time and it is another way to ensure that athletes are responding well to their year long training. However, it cannot be connected to overtraining because the fluctuations within the data is just too great to provide significant findings.

RPE and heart rate monitoring both have the capability to measure the internal load either subjectively or objectively. Neither one of these methods were originally created to measure if an athlete was experiencing overtraining or underrecovery. However, RPE is crucial because it uses the perception of the athlete to rank the intensity of the exercise session and that provides an accurate assessment of the training load (Kellmann, 2010). This means that coaches could potentially have information about how hard the athletes feel they are training before the athletes start to experience symptoms of fatigue (muscle soreness or pain) days later. RPE is also known to be a sound indicator for the body's adaptation to a training program for the normal, cardiac and hypertensive population (Kellmann, 2010). Therefore, if a few athletes are consistently reporting very intense practices throughout a training program while other players are not, then that could be a representation of athletes struggling with recovery and adaptation.

Heart rate monitors do have the ability to capture data on the heart rate before and after exercise. Based on the results from each session, heart rate monitors can indicate signs of fatigue which could potentially translate to an athlete being underrecovered. Specifically, they can be used to measure heart rate recovery which provides information about if the body is adapting well to the current training program. If the heart rate is not returning to the resting heart rate fast enough it could be depicting that the athlete is experiencing fatigue.

Limitations

There were several limitations in this study. First the subject numbers were small, which may skew the overall conclusions. Second, the workouts for the men and women were not standardized, so it is difficult to compare female versus male players in response to different stressors. In addition, the heart rate monitor may malfunction when used at high intensities but the sRPE scale can provide insights on the intensity for the workout sessions when those technical problems do occur. Finally, we had no control of what the players did outside of training which may have influenced stress and recovery. In future, a larger cohort of collegiate basketball players tested in a more standardized environment may assist with delineating possible differences in subjective (sRPE) versus objective (TRIMP) measures of exercise intensity in males versus female basketball players. A longitudinal study, across the entire season, would enhance our understanding of the relationship between training load and recovery on injury and prevention.

Conclusion

In conclusion, the purpose of this study was to investigate the effectiveness of the sRPE method compared to heart rate monitors when calculating TRIMP for an athlete's workout session. We discovered that there is a moderate correlation between using sRPE method and heart rate monitors to determine TRIMP for an athlete during their practice session. This means that if a college coach lacks the monetary resources to purchase heart rate monitors for their team but they still want to track internal load then they could use the sRPE method. It’s reliable, non-invasive, easy to use and it’s cost effective. However, if one has the resources and time to use both a heart rate monitor and the sRPE scale then we recommend them to do so. By using the heart rate monitor and the sRPE scale it allows coaches to evaluate both the objective and subjective experience of the athlete. The heart rate monitor will show the internal load on a physiological level and the sRPE scale will indicate how the athlete feels about the workout session on a psychological level. The sRPE and heart rate monitors are essential tools that should be used synergistically to help monitor and prevent fatigue, that ultimately can lead to athletes sustaining injuries.

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