Monitoring Recovery in Collegiate Strength and Conditioning

Alice Read
MONITORING RECOVERY IN COLLEGIATE STRENGTH AND CONDITIONING

By

ALICE JENNER PARRISH READ

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Approved by:

Sandy Ross, Dean of The Graduate School
Graduate School

Steven Gaskill, Chair
Health and Human Performance Department

Charles Palmer
Health and Human Performance Department

Charlie Woida
Director of Athletic Performance Center
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Abstract:

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Health and Human Performance

Monitoring Recovery in Collegiate Strength and Conditioning

Chairperson: Steven Gaskill

**Introduction:** Student-athletes at the NCAA Division I level experience high levels of both physical and mental stress associated with training and competing at the highest level of collegiate athletics. In order for strength and conditioning coaches at the NCAA Division I level to maximize training sessions many utilize techniques to monitor athlete recovery status between training sessions. Unfortunately, little data exists on what monitoring methods are in current use and the validity of those methods. **Purpose:** The purpose of this study was to assess what recovery monitoring tools are currently being utilized by strength and conditioning coaches around the United States. **Methods:** Twenty NCAA Division I conferences were randomly selected to receive a survey asking about their monitoring of recovery in their strength and conditioning program. All colleges and universities within each conference were included and every full time strength and conditioning coach was included. **Results:** 240 strength coaches completed the survey. 75% reported current monitoring of recovery between training sessions. The most commonly reported methods included: lifestyle tracking (82%), rate of perceived exertion (54%), vertical jump (41%), and perceived recovery questionnaire (39%). Results indicated that 87% of respondents change their training plans based on their monitoring. The most common reason for not currently monitoring was due to a lack of budget or resources. **Conclusion:** The majority of strength and conditioning coaches currently monitor recovery and the most common monitoring method is tracking lifestyle traits.
Chapter One: Introduction

Statement of Problem:

There is little summarized scientific information on monitoring athletes’ recovery between training sessions available to current strength and conditioning coaches either in book or online format. Many of the tools commonly used or recommended for monitoring recovery have not been validated or supported by research. Unfortunately, of the few validated recovery monitoring techniques, most are expensive or unrealistic to monitor on a daily basis within a strength and conditioning setting.

Purpose of Study:

The purpose of this analysis is to determine what monitoring methods are currently being implemented in collegiate performance centers across the United States. Conclusions drawn from this research will help guide future scientific efforts to better understand athlete monitoring tools and to give professionals an understanding of what tools are currently being used daily in practical applications.

Significance of Study:

Strength and conditioning coaches at the collegiate level are responsible for building training programs to assist student-athletes in achieving the highest level of physical ability possible for their given sport. Within these training programs, the objective is to increase strength and power while decreasing injury. In recent years injury prevention has surfaced as a key element in optimizing performance (Halson, & Jeukendrup, 2004). Monitoring recovery can be a valuable tool in injury prevention as it allows professionals to evaluate day-to-day changes in an athlete and may give early indication of decrements in performance, which can lead to injury (Halson, 2014). Additionally, monitoring recovery can provide an indication for when an
athlete is overtraining or peaking and what variables assisted in this problem or success (Halson, 2014; Halson & Jeuendrup, 2004; Kenttä & Hassmén, 1998; Kellmann, 2010).

The main significance of this study is to increase a strength coach’s ability to provide individualized training through the use of monitoring recovery. This research has significant implications for both researchers and coaches. Researchers are able to use this survey data and create new research questions and projects around the currently applied monitoring tools, many of which are not validated. This project has begun to bridge the gap between science and real life application. Scientists will be able to develop projects to support, enhance, or refute what coaches already are doing to monitor recovery. Coaches and professionals using these tools will gain information about the scientific evidence to support good methods or untested procedures they may be using.

I hypothesize that the majority of strength and conditioning coaches do not currently monitor recovery but have an interest in learning more. My secondary hypothesis states that there will be a difference between validated recovery monitoring techniques and those in current practice at collegiate strength and conditioning centers.

Limitations & Delimitations:

The major limitation of this study was the limited research on currently utilized monitoring tools and the seeming disconnect between science and practice. Additionally, the term “recovery monitoring” is often confused with the related terms of overtraining and overreaching. Most related research has thus been closely associated with overtraining and overreaching, and I used these terms to help support my literature search on background data.

The delimitations for this study were practical recovery monitoring tools. While many aspects of exercise physiology can be monitored in a laboratory setting, this project focuses on
techniques of monitoring that can be used by strength and conditioning coaches in a weight room or performance center setting. Additionally, while recovery strategies, such as compression garments, ice treatment, etc., are closely connected with enhancing monitoring recovery, they were not considered in this project.

Finally, the results of the survey from collegiate strength and conditioning professionals may not be applicable to other levels of sport where more or less resources may be available to support athletes.

Basic Assumptions:

A basic assumption is that it is reasonable to relate past research on monitoring recovery and overtraining with current recovery monitoring practices. While these are related terms, overtraining and overreaching refer to longer durations and greater stress whereas monitoring recovery occurs on a daily basis. Most prior research focused on observing indicators for overreaching and overtraining often with long time lag between observation or measurement and analysis. In the current study, monitoring recovery was assessed for current, practical monitoring tools that assist strength and conditioning coaches in providing athletes with the best possible training program for their individual needs and can give feedback on a daily or nearly daily basis with little or no time lag. Thus, in this review of literature, overreaching and overtraining studies were used to support the monitoring tools under examination. It is assumed that if a study is monitoring for overreaching and overtraining, they are in turn monitoring for recovery even if they do not directly refer to recovery in their study.

Definitions of Terms:

Overtraining & Overreaching

Overtraining is defined as “an accumulation of training and/or non-training stress
resulting in long-term decrement in performance capacity with or without related physiological and psychological signs and symptoms of overtraining in which restoration of performance capacity may take several weeks or months”. Overreaching is defined as “an accumulation of training and/or non-training stress resulting in short-term decrement in performance capacity with or without related physiological and psychological signs and symptoms of overtraining in which restoration of performance capacity may take from several days to several weeks” (Halson and Jeukendrup, 2004, p.969). In both definitions the important indicator is decrement in performance, with the only difference being the length of time necessary to re-establish peak performance.

It is generally agreed that periods of overreaching are necessary to achieve optimal performance, but that overtraining is a state, which results in long-term performance decrements that are non-beneficial and generally harmful to the athlete. Thus, recovery monitoring is necessary to distinguish the fine line between overreaching and overtraining.

**Monitoring Recovery:**

Monitoring recovery is the tracking of an individual’s physiological and psychological characteristics in order to prescribe an optimal training load leading to peak performance while avoiding long term or undesirable performance decrements. Monitoring recovery can be conducted using a variety of techniques, including the use of subjective scales and questionnaires such as rate of perceived exertion (RPE) scale and perceived recovery questionnaires; the use of objective measurement of physical characteristics such as jump performance, submaximal heart rate and/or heart rate variability (HRV) and finally; tracking of lifestyle traits such as nutrition, sleep habits, body weight and record of injury. A large number of additional methods have been reported in scientific literature, but most are impractical for the daily performance center setting.
These methods, such as changes in blood chemistry, hormonal changes, clinical measures and other invasive or expensive measures will not be considered in this literature review.

**Collegiate Strength and Conditioning Coach:**

A strength and conditioning coach is a trained and generally certified professional who works with student-athletes and sports coaches to develop and implement comprehensive training programs to increase strength, speed and power in addition to reducing the risk of injury (Tod, Bond, & Lavallee, 2012).

**Periodization of Training:**

Periodization of training is the development of planned variation in a structured training program to meet “specific physiological requirements of a sport and… must result in the highest development of either power, power endurance, or muscular endurance” (Bompa & Buzzichelli, 2005, p.6). According to Bompa and Haff (2009) periodization of training is comprised of two elements. First, it is the division of an annual training plan into smaller training phases, and second, it structures these training phases to target specific “biomotor abilities” which enable athletes to achieve the highest level of speed, strength, power, agility and endurance one needs for their given sport.

**Perceived Recovery Questionnaire:**

Perceived recovery questionnaires are subjective surveys with questions ranging from one to seventy plus questions, regarding individual athlete’s feeling of recovery between training sessions. These questionnaires are based on categories such as mood, general stressors, sports specific stressors, psychological state, physiological state, etc. Examples of perceived recovery questionnaires are as follows: Recovery-Stress-Questionnaire for Athletes (RESTQ-Sport), Kellmann & Kallus, (2001/1965); Total Quality Recovery (TQR), Kenttä & Hassmén (1998),
Rate of Perceived Exertion:

Rate of perceived exertion (RPE) is a score that denotes how hard one feels they are physically exerting themselves. The scale ranges from 6 to 20 where 6 is “very, very light” and 20 is “very very hard” (Borg & Noble, 1974). RPE is used in a variety of setting to assess ones subjective feeling of fatigue during exercise, especially during fixed intensity sessions.

Lifestyle Tracking (Nutrition & Sleep):

Lifestyle tracking is the systematic recording or monitoring of one’s individual daily habits in order to assess their impact on an athlete’s performance and recovery. For example nutrition can be tracked utilizing a food diary or food re-call which asks an athlete to record everything they eat and drink during a set period of time, often 3-4 days. Sleep is another lifestyle trait, which can be monitored with specific monitoring tools (ECG, REM cycle apps, etc.) to establish if proper sleep is being achieved. Both nutrition (Halson, 2014b) and sleep (Samuels, 2008) have been proven to impact athlete’s ability to perform and recover between training sessions.

Vertical Jump:

Vertical jump is a lower body explosive movement that can be measured to establish an athlete’s current power output (Buckthrope, Morris, & Folland, 2012). It can be viewed as a performance indicator, and in recent years performance has been proposed as the primary indicator for overtraining (Halson & Jeukendrup, 2004).

Heart Rate Variability:

Heart rate variability (HRV) is the measurement of variation between subsequent
heartbeats. Variation in HRV can give indication to autonomic nervous system activity, which can impact one’s ability to recover between training sessions. Decreased HRV is related to an increase in sympathetic activity while an increase in HRV is associated with an increase in parasympathetic activity (Wilmore, Costill, & Kenney, 2008). Additionally, an increase in HRV is associated with increased aerobic fitness, suggesting sufficient recovery between training sessions (Plews, Laursen, Stanley, Kilding, and Buchheit, 2013).

**Submaximal Heart Rate:**

Submaximal exercise heart rate is the rate measured during and immediately after low intensity exercise completed at the same time each day following the same activity. Tracking submaximal heart rate over a sustained period can track changes in heart rate and give instant feedback relative to recovery status. A decrease in submaximal exercise heart rate over time gives indication to improvements in aerobic fitness (Wilmore et al., 1996) and thus sufficient recovery. A significant drop in submaximal heart rate has been proposed as a symptom of the onset of serious overtraining while increases in submaximal heart rate are generally indicative of overreaching, but when sustained may be the first warning sign of overtraining (Gaskill, 1999).
Chapter Two: Review of Literature

Importance of Periodization of Training and Impact of Monitoring Training

Periodization of training is the systematic manipulation of one’s annual training plan in order to maximize strength, endurance, and power to peak performance during the competitive stage of the year (Bompa & Buzzichelli, 2005). Periodization of training is comprised of two characteristics. First, it is the division of an annual training plan into smaller training phases, and second, it is the structure of these training phases to target specific “biomotor abilities,” which enable athletes to achieve the highest level of speed, strength, power, agility and endurance needed for a given sport (Bompa & Haff, 2009).

Periodization of training enables strength and conditioning coaches to anticipate specific training gains at different times during their annual plan (year-long training outline). Monitoring recovery throughout the periodization of training allows the coach to get direct feedback on whether or not their training methods are effective. For example, if a coach is seeing athletes fully recovered everyday, he or she might want to increase intensity, as the overload concept indicates that “a training adaptation takes place only if the magnitude of the training load is above the habitual level” (Zatsiorsky & Kraemer, 2006, p. 4). Thus, in order to optimize training athletes need to push themselves out of their comfort zone but not so far that they become symptomatic of overreaching and overtraining. Monitoring recovery is one of the tools that can be used to optimize the training load.

Periodization of training is essential for a successful strength and conditioning program. By monitoring recovery coaches can better implement their programs to optimize training. This review reports on the scientific results of research related to training monitoring tools that could be utilized by strength and conditioning coaches around the United States.
Perceived Recovery Questionnaires

Perceived recovery questionnaires were introduced into monitoring recovery when the connection between mood and stress and optimal performance was made (Kenttä & Hassmén, 2002; Kenttä & Hassmén, 1998; Kellmann, 2001; Kellmann & Gunther, 2000). According to Kellmann, (2002), recovery is based on an individual’s self-regulation, which is possible through one’s subjective views. This concept has inspired researchers and coaches to develop a variety of different questionnaires and/or surveys to assist athletes in optimizing their performance.

Kellmann and Kallus, (2001), compiled one of the first monitoring questionnaires to directly examine the effects of stress on recovery titled the Recovery-Stress-Questionnaire for Athletes (RESTQ-Sport). The RESTQ-Sport is based on stress accumulation from multiple aspects of life that could potentially affect an athlete’s performance (Kenttä and Hassmén, 1998). The RESTQ-Sport consists of 77 items broken down into modules with 12 different general Recovery-Stress-Questionnaires and an additional 7 sports-specific modules. All the questions are phrased in a Likert-type scale from 0 (never) to 6 (always) with reference to how often one participated in various activities over a 3-day period (Kellmann & Gunther, 2000; Kellmann, 2010).

Kellmann and Günther (2000) conducted a study on the effects of stress and recovery on elite rowers in training camp before the Olympic games. They analyzed the results from the RESTQ-Sport from four different times over a 3-week period of training leading up to the Olympic games. The results from this study found significant alterations in somatic components of stress (lack of energy, somatic complaints, fitness/injury) and recovery factors (fitness/being in shape) over the course of the 3-week training camp. Significant changes in the conflict/pressure and social relaxation scales were also found within the team (Kellmann &
Günther, 2000). These results strongly support that the RESTQ-Sport can assist coaches and athletes in monitoring both stress and recovery during training sessions lasting at least 3 weeks. Nunes, Moreira, Crewther, Nosaka, Viveros, and Aoki (2014) found similar results in a study monitoring training load and recovery-stress state in elite female basketball players during a periodized training program. The results from this study showed a significant decrease in RESTQ-Sport scores in weeks 8 and 10 (the second overload phase) compared with week 2 (the preparatory phase). Conclusions drawn from this study support the previous research in stating that the RESTQ-Sport can be a useful monitoring tool for tracking stress and recovery in elite athletes (Nunes et al., 2014).

Meister, Faude, Ammann, Schnittker and Meyer, (2011), found results in contrast with the previous findings, stating there was no significant difference in RESTQ-Sport scale in elite football (soccer) players over a 3-week period. Subjects were asked to complete the questionnaire before all training sessions over the course of a competitive season separated into two groups: high match exposure (HE: >270 min played during 3 week span) and low match exposure (LE:<270 min played during a 3 week span). No significant difference was found between groups (Meister, et al., 2011). These disparate results suggested that further research is needed to identify conditions and parameters under which the RESTQ-Sport scale should be used.

Recognizing the need for a shorter, more practical recovery scale than the RESTQ-Sport originally designed in 1965, Kenttä and Hassmén (1998) introduced the Total Quality Recovery (TQR), which focuses specifically on monitoring the relationship between training and recovery. The TQR scale is divided into two subcategories: TQR perceived (TQRper) and TQR action (TQRact). TQRper scale is suggested to use before bed to assess the previous 24 hours and
focuses on the athletes’ perception of how recovered they feel. TQRact scale grades and monitors action based on four categories: nutrition and hydration (10 points), sleep and rest (4 points), relaxation and emotional support (3 points), and stretching and active rest (3 points), which provides information about the recovery actions the athletes took in the previous 24 hours (Kentta & Hassmen, 1998). Both scales are based on a 6 to 20 scale similar to that of Borg’s RPE scale (Borg, 1962).

Few studies have been conducted using the TQR scale aside from Brink, Nederhof, Vosscher, Schmikli, & Lemmink, (2010), who conducted a study on monitoring load, recovery and performance in young elite soccer players. In this non-experimental cohort design study, both RPE and TQR were used to assess recovery before using TQR and after each training session, using RPE for the entirety of the competitive season (Brink et al., 2010). The authors wanted to know if increased recovery would lead to improved performance, which was measured by a submaximal heart rate during an interval shuttle run test every month. The average TQR from weeks 1 and 2 prior to testing was 14.7±1.3 and 14.6±1.3, which corresponds with “good recovery” on the TQR scale. This did not prove to be a significant predictor of submaximal heart rate; thus the results from this study were inconclusive (Brink et al., 2010).

Thus, while the TQR scale was established to be a practical and simple tool to monitor recovery (Kenttä & Hassmén, 1998), research has not provided significant support to state that it can predict performance (Brink et al., 2010). Additional research is needed to support the use of TQR as a monitoring tool for recovery to assist athletes in improving their performance.

Kölling, et al., (2015), also saw the need for a shorter and more concise method to monitor recovery than the RESTQ-Sport scale. Thus, they created and tested the Acute Recovery and Stress Scale (ARSS) in 2015 and compared it to the RESTQ-Sport scale. The researchers
asked members of a junior national field hockey team to fill out the ARSS in the morning and evening each day over a 5-day training camp. They also had the athletes fill out the RESTQ-Sport at the start and end of camp. The ARSS consists of 32 descriptions about physical, emotional, mental, and overall aspects of recovery and stress. Each question is answered on a Likert-type scale from 0 (does not apply) to 6 (fully applies). The results from this study showed a decrease in ARSS from morning to night on days 1 and 2. They also found a significant decrease in ARSS scores from morning testing throughout the entire week. Conclusions drawn from this study indicate that the preliminary findings for the ARSS scale are positive and suggested that it could prove to be a practical tool to monitor recovery (Kölling, et al., 2015).

In terms of expanding other techniques of monitoring recovery through questionnaires, Russell (1990) was the first to introduce the Daily Analysis of Life Demands for Athletes (DALDA), which is comprised of two parts. Part A asks questions regarding sources of stress within an athlete’s life, for example diet, home-life, school work, friends, etc., while Part B asks questions about specific symptoms of stress an athlete might feel on a scale from “worse than normal”, “normal”, or “better than normal”. The DALDA has subsequently been used on studies researching life-demands, such as air travel on elite athletes (McGuckin, Sinclair, Sealey, & Bowman, 2014) and on stress and upper respiratory tract infections (Freitas, Aoki, Arruda, Nakamura, & Moreira, 2012), in addition to studies measuring performance and/or recovery while training (Coutts, Slattery & Wallace, 2007; Nicholls, Backhouse, Polman, & McKenna, 2009).

The results from Coutts, et al., (2007) on monitoring triathletes over a 6-week period found that those in the “intensified training group” demonstrated increased stress reaction symptoms (Part B) on the DALDA assessment. These results in conjunction with Nicholls et al.,
(2009), who found similar results in rugby players over a month period, demonstrate the effectiveness of the DALDA as a monitoring tool for athletes between training sessions.

While the previous surveys and questionnaires have focused on life-demands, physical stress and emotional stress to compare rates of recovery between training, the Profile of Mood States (POMS) inventory focuses solely on mood. However, since mood has been closely linked to stress and the state of psychological recovery, (Kenttä & Hassmén; 2002; Kenttä & Hassmén, 1998; Kellmann, 2001), many studies have been conducted to investigate the use of POMS as a means of monitoring recovery.

Kenttä & Hassmén, (2006), conducted a study on elite kayakers during a 3-week long training camp to assess how mood was affected by training and its effects on recovery. They found that from the first to last week of the training camp the POMS “energy index” (ratio of POMS vigor to POMS fatigue) was significantly decreased (p<0.01). This could provide evidence to support the use of POMS as a means to monitor recovery; however, multiple studies have produced results stating the there was no significant difference in the POMS inventory over a training period (Martin, Andersen, & Gates, 1999; Arruda, et al., 2013). In both studies Martin et al., (1999), and Arruda et al., (2013) studied the results of the POMS inventory over an extended period of time (± 6 weeks). Neither found any significant difference in the POMS during the heightened training periods. These results, in conjunction with the significant difference found by Kenttä & Hassmén, (2006), suggest that more research is needed on the POMS inventory and its effectiveness as a tool for monitoring recovery during training.

From the research completed on perceived recovery questionnaires, it can be concluded that monitoring mood, stress, emotional state and life-demands can play an important role in assisting athletes in achieving their optimal performance. However, with the variety of surveys
and questionnaires and their varying results, it is difficult for coaches and researchers to establish one particular questionnaire as the gold standard. More research is needed to establish the most reliable and practical perceived recovery questionnaire that would be best suited for strength and conditioning coaches.

Rate of Perceived Exertion

Borg (1962) introduced rate of perceived exertion (RPE) as a means to subjectively perceive a physical performance. RPE is a scale from 6 to 20 where 6 is “very, very light” and 20 is “very very hard” (Borg & Noble, 1974). Over the years RPE has been used in various settings to help researchers understand what subjects perceive their level of work to be (Halson, 2014). In recent years RPE has recently become increasingly important in sports training as it has been proven to be a valid indicator of training load and intensity (Minganti, Capranica, Meesusen, & Piacentini, 2011; Minganti, Capranica, Meesusen, Amici, & Piacentini, 2010; Foster, et al., 2001; Foster, 1998).

RPE is often used in studies and in training to quantify training intensity, which, if tracked over time, can assist athletes and coaches alike in peaking performance through optimized training loads (Kenttä & Hassmén, 1998). RPE can serve as an early indication of overtraining. For example, if one is training a constant workload and RPE is increasing, it shows the individual if becoming fatigued (Morgan, 1994). This would indicate that the athlete is feeling more fatigued when completing the same amount of work compared with a prior session of the same intensity. This early indication of overreaching or overtraining is the key factor when utilizing RPE as a recovery-monitoring tool.

Lifestyle Tracking (Nutrition & Sleep)

The tracking of lifestyle characteristics such as nutrition and sleep can play an important
role in better understanding the factors impacting an athlete’s ability to recover. Nutrition has been proven to be an important element in recovery for athletes between training sessions (Halson, 2014b). In recent years nutritionists, coaches, and athletes have utilized tracking mechanisms to ensure proper nutrition is maintained during training.

Magkos and Yannakoulia (2003) analyzed various methods of dietary assessment in athletes in order to better understand what monitoring tools are most common and easiest to use. In this review the most common nutrition assessment utilized was a 3-4 day diet record (Magkos, et al., 2003). In these diet records, referred to as food diaries, individuals are asked to keep a detailed record of all food and drink that they consume over the specified days. Often a 3-day record minimum is recommended with at least one weekday and one weekend day included to get a well-rounded image of an individual’s diet (Magkos, et al., 2003). Food-frequency questionnaires (FFQs) have been created to make this tracking process easier (Mullen, Karntzler, Grivetti, Schutz, & Meiselman, 1984). However, in recent years with advances in technology there is potential for these types of questionnaires to be replaced by application-based (app) software.

 Monitoring nutrition has also been indicated to play an important role in sleep habits (Halson, 2014b). Sleep alteration or deprivation may be a result of athletes’ diets. Lindseth, Lindseth, and Thompson (2013) conducted a study where subjects were given diets with high protein (56% protein, 22% carbohydrate, 22% fat), high carbohydrate (22% protein, 56% carbohydrate, 22% fat), or high fat (22% protein, 22% carbohydrate, 56% fat) over 4 days. The results indicate that those who ate a high carbohydrate diet resulted in shorter sleep-onset latencies, while those who ate a high protein diet experienced fewer wake episodes during sleep (Lindseth et al., 2013). These results give indications of the importance of diet and how it can
affect sleep.

The sleep component is important to monitoring recovery in athletes because alterations in sleep have been linked to decrements in performance and recovery (Samuels, 2008; Halson, 2008; Reilly & Edwards, 2007). Variables such as sleep-wake cycles and deprivation (Reilly et al., 2007), monitoring methods (Kölling et al., 2015), sleep disorders (Samuels, 2008) have all been proven to impact recovery during performance training.

Reilly and Piercy (1994) conducted a study on eight male subjects who were restricted to 3 hours of sleep a night for 3 days and found that there was a significant decrease in performance in bench press, leg press and dead lift. These results indicate that athletes who try to complete strength and conditioning programs on minimal sleep will not be able to perform as well as they could with a full night’s rest.

Samuels (2008) supported this notion by conducting several case studies on the effects of sleep disorders on performance. In these case studies chronic sleep restriction, insomnia/delayed sleep phase, and sleep apnea were all shown to have detrimental effects on training. In each case study when measures were taken to assist athletes with their sleep disorders, both physical and cognitive benefits were observed. These cases studies supported the importance of sleep quality on performance. Thus, it is important that sleep be accounted for when investigating recovery between training sessions.

*Vertical Jump*

Halson and Jeukendrup (2004) indicate that one of the primary indicators of overreaching and overtraining is a decrement in performance. While performance can be measured in many ways one of the simplest is vertical jump. Vertical jump has been proven to be a valid measurement of lower body explosive power (Buckthrope, et al., 2012). By using this
information, recent research has focused on the utilization of vertical jump as a recovery-monitoring tool.

Sjökvist, et al. (2011) conducted a study on soccer players and recovery from high-intensity training sessions. In this study, vertical jump was measured pre, 24 hours, 48 hours and 72 hours after high-intensity intervals. The results indicate a significant decrease ($p < 0.04$) in vertical jump height 24 hours after exercise and no significant difference 48 and 72 hours post exercise compared with the baseline jump. Conclusions drawn from this study suggest that soccer players were not fully recovered from the high intensity exercise 24 hours post and that vertical jump and session RPE could be more sensitive performance indicators when compared with 5-bound test, 20-m sprint time, and heart rate (Sjökvist, et al., 2011). These conclusions support the utilization of vertical jump as an indicator of recovery and performance in athletes.

In contrast to these findings, Malone et al. (2015) and Meister et al. (2013) found that monitoring vertical jump during the competitive soccer season did not show significant day-to-day change. These results were suggested to be a consequence of low training volume during the in-season, and thus, the training stimulus might not have been great enough to elicit a difference. This is an important consideration, as individual athletes have particular stress thresholds that they need to meet before physiological change can be seen. Additionally, since both of these studies were conducted during the in-season the coaches’ goals were to maintain a constant state of high performance throughout the season and therefore the lack of change in vertical jump can be viewed as a good indication. In either case, it is clear that more research is needed to validate vertical jump as a means of monitoring recovery between training sessions.

*Heart Rate Variability*

Heart rate variability (HRV) is the measurement of variation between subsequent heart
beats (R-R intervals). Changes in HRV have been well documented to indicate changes in the autonomic nervous system (Plews, et al., 2013). The autonomic nervous system (ANS) is responsible for the body’s regulation of involuntary functions such as heart rate. In response to overtraining, the ANS can cause both sympathetic (increase in resting heart rate, increased blood pressure, loss of appetite and elevated basal metabolic rate) and parasympathetic reactions (early onset of fatigue and increase in heart rate recovery after exercise) (Wilmore, et al., 2008). The ANS can also play a role in some of the positive adaptations to training through parasympathetic reactions such as a decrease in resting heart rate and blood pressure (Wilmore et al., 2008). Thus, the monitoring of the ANS system though the utilization of HRV could provide athletes with valuable information about how they are adapting to their training.

The European Society of Cardiology and the North American Society of Pacing and Electrophysiology first developed recommendations for the use of HRV in 1996, which have since been widely used as a measure to monitor recovery (TaskForce, 1996). In recent research, Morales, et al. (2014) studied the difference in HRV between high training load and moderate training load in judo athletes. The results of this 4-week study indicated that those who trained in the high training load group showed significant difference in HRV from pretest to posttest as well as a significant difference from the moderately trained group ($p \leq 0.05$). These results demonstrated an increase in sympathetic activity and a decrease in parasympathetic activity.

Vaz, Picanço, and Del Vecchio (2014) conducted a study on young rowers where conclusions were drawn regarding level of individual recovery after exercise with the use of HRV. In this study HRV was measured before, during, and after exercise in addition to 24 hours post during three different trials at varying intensities. The results from this study showed no significant difference in HRV throughout the trials. Researchers indicated that the rowers were
completely recovered 24 hours after exercise at all 3 intensities and attributed the subjects young training age as an indication as to why there was no significant difference in HRV between intensities (Vaz, et al., 2014). This study, in addition to the previous one, provides support for the use of HRV as a recovery-monitoring tool in athletes. In conclusion, increases in HRV can be associated with positive adaptations to training (Morales, et al., 2014, & Plews et al., 2013) while decreases in HRV can indicate decrements in performance (Leite, et al., 2012 & Plews et al., 2013), and finally no change in HRV can provide support that an athlete is fully recovered or that they could train harder to stimulate overreaching and a better training effect (Vaz, et al., 2014). Consequently, monitoring recovery with the utilization of HRV can be an effective monitoring tool.

*Submaximal Heart Rate*

In addition to HRV, monitoring heart rate during submaximal exercise on a daily basis has been suggested to indicate markers of overtraining (Jeukendrup & Van Diemen, 1998). Little research has been completed on the utilization of submaximal heart rate monitoring to measure recovery or overtraining. The research that has been conducted on submaximal heart rate has examined the variation in heart rate during submaximal exercise at fixed work rates related to prior training stress.

Lamberts, Lemmink, Durandt, and Lambert (2004) conducted a study to monitor variation in heart rate during submaximal exercise over 5 days. The purpose of the study was to quantify the changes in heart rate on a day-to-day basis during a fixed submaximal shuttle test and interpret the variation. The main finding of this study was that when utilizing an incremental shuttle test, one can anticipate the heart rate to fluctuate approximately 5±2 beats per minute during the fourth stage of the test. These results indicate that individuals could establish a change
in submaximal heart rate if the change in heart rate during the fourth stage differed by 7 beats per minute (Lamberts, et al., 2004).

Ruby et al. (2002) evaluated salivary IgA and submaximal HR each morning and evening on a wildland fire crew during 12 days of extremely arduous work (2,000-4,500 Kcal of physical activity per day). During the lighter work days (2,000-2,500 kcal/day) the firefighters had recovered by the following morning to pre-work levels during the submaximal HR test but on days of with more than 2,500 Kcal of work there was an excellent relationship between Kcal of daily work and next morning submaximal HR scores. More fit firefighters (higher VO2max) recovered better and at higher workloads than did less fit firefighters.

These studies, in conjunction with the assumption that submaximal exercise heart rate will decrease with an increase in aerobic fitness (Wilmore et al., 1996), leads to the conclusion that submaximal exercise heart rate could be potentially beneficial in monitoring recovery and training adaptations. However, more research is needed to support these initial findings and measure the specific relationship between submaximal heart rate and recovery.
Chapter Three: Methodology

Research Design

The research design for this project had two components. The first aspect of this project was a review of current literature on monitoring recovery. By using the key terms “monitoring recovery,” “overreaching,” and “overtraining” in addition to the key terms that define monitoring tools such as heart rate variability, RPE, etc., a comprehensive review of previously researched monitoring tools will be completed. Literature sourcing took place from two databases: PubMed and SPORTDiscus.

The second aspect of this study was the distribution of a survey on current monitoring recovery tools used by Division I collegiate strength and conditioning coaches. This survey asked collegiate strength and conditioning coaches if they are currently monitoring recovery between training sessions and if yes, what they were currently doing. The results from this survey have helped to identify current monitoring methods and expose the gaps between these methods and those that have been previously scientifically researched.

Research Procedures

Review of Literature:

PubMed and SPORTDiscus were searched using the following key terms: monitoring training, monitoring fatigue, overreaching, overtraining, heart rate variability, rate of perceived exertion, perceived recovery questionnaire, vertical jump, and nutrition, body weight, sleep, and injury tracking. Each monitoring tool was reviewed and provided evidence to illustrate how it can be used to monitor recovery between exercise sessions.

Survey of Current Collegiate Strength and Conditioning Coaches:

Current Division I collegiate strength and conditioning coaches were randomly selected
to receive my survey on monitoring recovery. Each division I conference (33) was assigned a number, and a random number generator was used to select 20 of the conferences. Once the conferences had been selected, each college or university in each conference was compiled into a list of subject schools. Each school’s staff directory athletics page was viewed to retrieve the names and emails of the strength and conditioning coaches. If a school had more than one strength and conditioning coach listed on the staff directory, then all coaches at that respective school were added to the subject pool. Once contact emails have been established for each subject, a mass email will be sent to all the strength and conditioning coaches from all of the schools in each of the 20 conferences. Subjects were given information about the survey and a link to the Qualtrics survey. Please see the attached copy of survey questions.

The survey remained open for two weeks after the distribution email. A follow-up email was sent three days before the survey closed, again reminding potential participants and encouraging them to complete the survey if they have not already done so. Once the survey had been closed, the results of the study were analyzed. The results indicated how many coaches are currently monitoring recovery and what tools they are using. From these a comparison was conducted between the results and the review of literature on scientifically supported monitoring tools.

Analysis of the Survey:

The survey results are presented as descriptive data reporting the population demographics and frequency of recovery monitoring techniques.
Treatment of Research

The results from this study are the first to demonstrate how strength and conditioning coaches monitor recovery between training sessions. In past research, laboratory studies have validated monitoring tools, but following a literature review, to the knowledge of this investigator, there has been no research conducted to see if these tools are actually being used in an applied setting. The results will be used to inform current strength and conditioning coach about the applied use of monitoring recovery tools at the Division I level and to help develop needed future research to evaluate tools in use but not yet validated.
Chapter Four: Results

Results section completed in appendix labeled “Results Report” page 38.
Chapter 5: Discussion & Conclusion:

NCAA Division I student-athletes experience high levels of both physical and mental stress associated with training and competing at the top tier of collegiate athletics. In order for NCAA Division I strength and conditioning coaches to maximize training sessions, many utilize techniques to monitor athlete recovery between training sessions. Unfortunately, little data exist on what monitoring methods are in current use and the validity of those methods. The purpose of this study was to assess what recovery monitoring tools are currently being utilized by strength and conditioning coaches around the United States.

The major finding of this study disproved my initial hypothesis, that the majority of strength and conditioning coaches do not currently monitor recovery. The results showed that 75 percent of strength coaches sampled are currently monitoring recovery between training sessions. The second part of my hypothesis stated that of those who do not currently monitor recovery the majority would have interest in monitoring in the future. This portion of my hypothesis was supported by 98 percent of coaches who are not currently monitoring recovery.

My secondary hypothesis, stating that there is a difference between validated recovery monitoring techniques and those in current practice at collegiate strength and conditioning facilities, was supported. The results of the survey indicated many computer applications and monitoring techniques that have yet to be scientifically tested and supported are in use. Additionally, strength coaches in an applied setting are not frequently utilizing validated monitoring tools such as submaximal heart rate and heart rate variability. These results indicate the need for future research to evaluate proposed monitoring tools being utilized by professionals in the field of strength and conditioning.

The result from this survey indicated the four most common methods of monitoring
recovery are, lifestyle tracking, rate of perceived exertion, vertical jump and perceived recovery questionnaires, few of which have been evaluated for validity or reliability.

**Lifestyle Tracking:**

Lifestyle tracking was the most commonly utilized recovery monitoring technique with 82 percent of coaches indicating use of these methods with their athletes. Body weight, sleep, nutrition and injuries followed by stress and mood were the most common traits tracked. The use of lifestyle tracking is scientifically supported, as daily living has a subsequent impact on athletic performance (Halson, 2014b). By tracking lifestyle traits coaches can more effectively document changes in athletes’ health and how those changes correlate with peaks or decrements in performance. Over time this documentation could assist with programming strategies and athlete development.

The survey indicated that a 52 percent majority of coaches are currently monitoring lifestyle traits with an individualized manual log. The remaining 48 percent of coaches use a previously established computer application or “other” method of monitoring. Whether a coach chooses to buy an application or manually enters lifestyle trait data, it can be concluded that tracking lifestyle traits is a time efficient, low cost and popular method of monitoring recovery between training sessions.

**Rate of Perceived Exertion:**

Rate of perceived exertion (RPE) has been used in clinical settings for years to monitor individual’s perception of exercise difficulty (Kenttä & Hassmén, 1998). Only in recent years has it been introduced in the strength and conditioning context as a means of assessing training session difficulty. The popularity of RPE monitoring by strength coaches was shown by the 54 percent of coaches who currently use RPE to monitor recovery. This survey did not include
follow up questions regarding how coaches used RPE but more research should be conducted to better understand the timing and methods of the RPE monitoring. It would be helpful to know if coaches are using RPE scales after each exercise or as an overall reading for the total training session or in relation to a fixed workload exercise.

*Vertical Jump:*

Vertical jump monitoring can identify fatigue in lower body power output and can be used as a performance test (Buckthrove, et al., 2012). Performance tests have been shown to be one of the primary methods of monitoring for overtraining and overreaching (Halson and Jeukendrup, 2004). This survey found that 41 percent of coaches used the validated method of vertical jump to monitor recovery.

The method of monitoring vertical jump was also analyzed in this survey. Results show that 70 percent of coaches who use vertical jump utilize a Just Jump Mat to measure vertical jump while 36 percent use a Vertec, 15 percent use a force plate and 7 percent use an “other” form of measuring. This evidence provides support for the utilization of vertical jump as a valid, cost effective, and time efficient means to monitor recovery. The survey did not provide information about how coaches use the vertical jump information to adjust training.

*Perceived Recovery Questionnaire:*

Perceived recovery questionnaires can include various questions regarding energy or fatigue level, readiness to compete, stress levels, mood, etc. All of these factors can be used to subjectively assess how ready an athlete is to complete training. It has been shown that there is a connection between subjective feelings of stress and mood along with other factors to performance (Kenttä and Hassmén, 1998). This connection has been known for some time yet application of these technologies in the strength and conditioning setting were undocumented
prior to this survey. The results of this survey indicate that 39 percent of coaches who monitor recovery utilize a perceived recovery questionnaire. Of those coaches who use a questionnaire 90 percent create their own questions.

These results showing the use of non-validated or standardized questionnaires provide an interesting split between the research and application of perceived recovery questionnaires. The review of literature provided several examples of scientifically valid questionnaires that have assisted researchers in creating a link between subjective feelings of recovery and performance. However, the results of this survey show that while coaches utilize subjective questionnaires, few use validated questionnaires, opting instead for ones they create themselves. One theory is that many of these scientifically validated questionnaires are lengthy and would require more time than a strength coach is willing to allow for athletes to complete. More research is needed to assess what questions coaches are asking their athletes and why they are not using scientifically validated questionnaires.

Practical Application:

Based on the results of this review of literature and survey on monitoring recovery by collegiate strength and conditioning coaches it is suggested that strength coaches implement recovery-monitoring techniques. This study was designed as exploratory research, to discover what recovery monitoring tools are being utilized in performance centers around the United States. However, more information is need on how monitoring can directly effect athletes and training. Strength and conditioning coaches are encouraged to start implementing monitoring techniques to further this understanding.

The limited research available demonstrates the need for collection of data on monitoring throughout the competitive year. In order to advance our understanding of monitoring recovery
the gap between research and science needs to be eliminated. Strength and conditioning coaches are encouraged to collect data on recovery monitoring and share this information with other coaches and scientist in order to validate techniques and better understand how monitoring changes throughout the year.

The results of this study and review of literature suggest that the utilization of lifestyle tracking and vertical jump are currently valid, time efficient and cost effective methods to start monitoring athlete recovery. These techniques would provide a basis for which coaches can start monitoring recovery. The majority (52%) of coaches who do not monitor stated lack of budget or resources as the primary reason why they do not currently monitor. However, lifestyle traits can be tracked for free and vertical jump “Just Jump Mats,” which were the most popular method of monitoring, only cost $600 dollars. While the initial installment of monitoring techniques might require some upfront cost and take some time to get used to, the information gathered could prove to be valuable. Little is known about longitude tracking of athletes however, it can be theorized that the more information we gather on our athletes the better we will understand their performances. Methods such as RPE and perceived recovery questionnaire, while popular, need more research regarding method of use prior to being validated.

Proper documentation and recording of data is encouraged. Tracking changes in recovery monitoring is only possible with good baseline information and the ability to evaluate trends over time. Coaches can use either individually developed monitoring sheets or hire out data collection to any number of companies suggested by coaches on the survey (*see “Results Report”). Little is known about the effectiveness of either method.

Conclusion:

The majority of strength and conditioning coaches currently monitor recovery with a
variety of monitoring tools. The most common method is tracking of lifestyle traits and the currently validated techniques are lifestyle traits and vertical jump. Strength and conditioning coaches are encouraged to implement recovery-monitoring techniques to help in the continuing research on monitoring recovery between training sessions. Longitudinal data on monitoring tools is needed to better understand the best methods and how to adjust training based on the results of monitoring.

In conclusion, the results of this survey and review of literature give introductory information regarding methods of monitoring recovery between training sessions in collegiate strength and conditioning however, future research is needed to establish the most effective and valid recovery monitoring tools. Additionally, more information is needed on how coaches should adjust their training programs based on their monitoring.
Bibliography:


Appendix(s):

Survey Outline:

Are you interested in receiving more information about monitoring recovery?  
YES or NO  (Yes = link to new survey for contact info)  
Thank you for your participation in this survey.
Results Packet:

Monitoring Recovery in Collegiate Strength and Conditioning

A Survey of 20 NCAA Division I Conferences on monitoring recovery between training sessions in collegiate strength and conditioning.

Graduate Student Research Project

By
Alice Read

University of Montana
Health and Human Performance Department
Exercise Science
Executive Summary

Introduction: NCAA Division I student-athletes experience high levels of both physical and mental stress associated with training and competing at the top tier of collegiate athletics. In order for NCAA Division I strength and conditioning coaches to maximize training sessions, many utilize techniques to monitor athlete recovery between training sessions. Unfortunately little data exist on what monitoring methods are in current use and the validity of those methods. The purpose of this study was to assess what recovery monitoring tools are currently being utilized by strength and conditioning coaches around the United States.

Methods: Twenty NCAA Division I conferences were randomly selected to receive a survey asking about monitoring of recovery in their strength and conditioning program. All colleges and universities within each conference were included and every full time strength and conditioning coach was included.

Results: 240 strength coaches completed the survey. 75% reported current monitoring of recovery between training sessions. The most commonly reported methods included: lifestyle tracking (82%), rate of perceived exertion (54%), vertical jump (41%), and perceived recovery questionnaire (39%). Results indicated that 87% of respondents change their training plans based on their monitoring. The most common reason for not currently monitoring was a lack of budget or resources.

<table>
<thead>
<tr>
<th>Lifestyle Tracking: 82%</th>
<th>Rate of Perceived Exertion: 54%</th>
<th>Vertical Jump: 41%</th>
<th>Perceived Recovery Questionnaire: 39%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MODE:</strong> Manual Log</td>
<td>52%</td>
<td><strong>MODE:</strong> Just Jump Mat</td>
<td>70%</td>
</tr>
<tr>
<td>Computer App* 40%</td>
<td></td>
<td>Vertec 36%</td>
<td>Individualized 90%</td>
</tr>
<tr>
<td>Other 8%</td>
<td></td>
<td>Force Plate 15%</td>
<td>Established 10%</td>
</tr>
<tr>
<td></td>
<td>No follow up question as RPE Scale is universally understood.</td>
<td>Other 7%</td>
<td></td>
</tr>
</tbody>
</table>

*An appendix of computer applications utilized can be found at the end of the packet.

Conclusion: The majority of strength and conditioning coaches currently monitor recovery with a variety of monitoring tools. The most common method is tracking lifestyle traits. Future research is needed to establish the most effective and valid recovery monitoring tools.
Demographic Information

The demographic information gathered:

- Age
- Gender
- Years of Coaching Experience
- Education Level
- Sports Coached
- Conference

*A total of 230 strength and conditioning coaches filled out demographic information.

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>32</td>
<td>30</td>
<td>26</td>
</tr>
<tr>
<td>Number of years experience as a Collegiate</td>
<td>8</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Strength and Conditioning Coach:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Education Level

<table>
<thead>
<tr>
<th>Education Level</th>
<th>High School Degree/ GED</th>
<th>Bachelors Degree (B.A./ M.S.)</th>
<th>Masters Degree (M.A./ B.S.)</th>
<th>Doctoral Degree (Ph.D.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>62</td>
<td>164</td>
<td>4</td>
</tr>
</tbody>
</table>
Sport Team Coached

<table>
<thead>
<tr>
<th>Team</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men's Basketball</td>
<td>80</td>
</tr>
<tr>
<td>Women's Basketball</td>
<td>79</td>
</tr>
<tr>
<td>Women's Track and Field</td>
<td>78</td>
</tr>
<tr>
<td>Women's Soccer</td>
<td>75</td>
</tr>
<tr>
<td>Women's Volleyball</td>
<td>74</td>
</tr>
<tr>
<td>Football</td>
<td>72</td>
</tr>
<tr>
<td>Softball</td>
<td>62</td>
</tr>
<tr>
<td>Men's Track and Field</td>
<td>60</td>
</tr>
<tr>
<td>Women's Tennis</td>
<td>59</td>
</tr>
<tr>
<td>Baseball</td>
<td>58</td>
</tr>
<tr>
<td>Men's Soccer</td>
<td>51</td>
</tr>
<tr>
<td>Men's Golf</td>
<td>50</td>
</tr>
<tr>
<td>Men's Tennis</td>
<td>44</td>
</tr>
<tr>
<td>Women's Golf</td>
<td>40</td>
</tr>
<tr>
<td>Women's Swim and Diving</td>
<td>32</td>
</tr>
<tr>
<td>Men's Swim and Diving</td>
<td>31</td>
</tr>
<tr>
<td>Men's Lacrosse</td>
<td>30</td>
</tr>
<tr>
<td>Field Hockey</td>
<td>23</td>
</tr>
<tr>
<td>Women's Crew</td>
<td>18</td>
</tr>
<tr>
<td>Men's Ice Hockey</td>
<td>11</td>
</tr>
<tr>
<td>Gymnastics</td>
<td>11</td>
</tr>
<tr>
<td>Wrestling</td>
<td>10</td>
</tr>
<tr>
<td>Women's Lacrosse</td>
<td>9</td>
</tr>
<tr>
<td>Women's Ice Hockey</td>
<td>8</td>
</tr>
<tr>
<td>Cheer and Dance</td>
<td>8</td>
</tr>
<tr>
<td>Men's Crew</td>
<td>7</td>
</tr>
<tr>
<td>Water Polo</td>
<td>4</td>
</tr>
<tr>
<td>Cross Country</td>
<td>4</td>
</tr>
<tr>
<td>Women's Rugby</td>
<td>3</td>
</tr>
<tr>
<td>Men's Volleyball</td>
<td>3</td>
</tr>
<tr>
<td>Men's Rugby</td>
<td>3</td>
</tr>
<tr>
<td>Skiing</td>
<td>3</td>
</tr>
<tr>
<td>Equestrian</td>
<td>2</td>
</tr>
<tr>
<td>Squash</td>
<td>2</td>
</tr>
<tr>
<td>Bowling</td>
<td>1</td>
</tr>
<tr>
<td>Synchronized Ice Skating</td>
<td>1</td>
</tr>
<tr>
<td>Beach Volleyball</td>
<td>1</td>
</tr>
<tr>
<td>Rifle</td>
<td>1</td>
</tr>
</tbody>
</table>
Conference information, like all questions, was optional so not every coach who filled out a survey provided their conference.
Monitoring recovery may be defined as:
“The tracking of an athlete's recovery from physiological and psychological training and life stress.”

The recovery data are generally used to evaluate the balance between training load and recovery in order to optimize training and performance or avoid long term or undesirable performance decrements.

For this survey, monitoring recovery techniques include but are not limited to: subjective scales and questionnaires (RPE & perceived recovery questionnaires) and objective characteristics (vertical jump, heart rate variability, submaximal heart rate, or lifestyle tracking (nutrition, sleep, body weight or injury).

Do you currently monitor recovery with your athletes between training sessions?

Results:

Of the 240 total responses, 180 (75%) stated they do monitor recovery while 60 (25%) stated they did not.

Conclusion:

The majority of Division I NCAA strength and conditioning coaches currently monitor recovery between training sessions.
Question Number 2: *How often do you monitor recovery?*

Once a coach had indicated they do monitor recovery the question was asked as to how often.

**Results:**
Of the 177 total responses, 97 (55%) monitor daily, 60 (34%) monitor weekly, 5 (3%) monitor monthly, and 15 (8%) indicated another amount.

**Sample results from the Other category:**
- Multiple times a week (3x).
- Whenever the athletes train directly with me.
- Sport and time of year dependent.
- Bi-monthly
- Daily and weekly measurements.
Conclusion:

Based on the results of this survey, it can be concluded that the four most common methods of monitoring recovery are:

1. Lifestyle Tracking
2. Rate of Perceived Exertion (RPE)
3. Vertical Jump
4. Perceived Recovery Questionnaire
Conclusion:

Based on these results it can be concluded that the Just Jump Mat is the most common method of measuring vertical jump by strength and conditioning coaches who monitor recovery between training sessions.
Question Number 5: *Do coaches create their own perceived recovery questionnaire?*

Coaches That Create Their Own Perceived Recovery Questionnaire

![Pie chart showing 90% of coaches create their own perceived recovery questionnaire and 10% don't.]

Question Number 6: *If you did not create your own what is the name of the questionnaire you utilize?*

Results:

Examples of questionnaires provided:

- Fit for 90 (2 responses)
- Sportably.com
- Metrifit
- SpartaTrac Regen
- Adapted from McClean & Coutts (Int J Sports Phys Perf 2010)

*See appendix at end of packet for more information on specific computer applications.*

39% of Coaches Utilize a Perceived Recovery Questionnaire.
## Conclusion:

These results indicate that the most common method of monitoring heart rate variability (HRV) is with the use of a heart rate watch. However, these results also indicate that there is a large variety of techniques utilized to monitor HRV.

17% of Coaches Utilize Heart Rate Variability.
**Question Number 8:** What method do coaches use to measure submaximal heart rate?

### Mode of Monitoring Submaximal Heart Rate

<table>
<thead>
<tr>
<th>Method</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step Test</td>
<td>1</td>
</tr>
<tr>
<td>Interval Run Test</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>8</td>
</tr>
</tbody>
</table>

**Conclusion:**

Coaches who monitor submaximal heart rate use various methods of monitoring. No single method stood out as the most commonly utilized.

*“Other” methods are indicated in the table to the right.*

---

**Other**

- **Resting Heart Rate**
- **Zephyr Omni Sense Monitoring System**
- **First Beat Sports HR System Quick Readiness Test (Resting HR)**
- Calculation of practice load via heart rate tracking.
- 5 minute resting heart rate in the morning prior to lift.

---

**9% of Coaches Utilize Submaximal Heart Rate**
Question Number 9: What lifestyle traits do coaches monitor?

**Lifestyle Traits Monitored**

<table>
<thead>
<tr>
<th>Lifestyle Traits</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Weight</td>
<td>129</td>
</tr>
<tr>
<td>Sleep</td>
<td>112</td>
</tr>
<tr>
<td>Nutrition</td>
<td>109</td>
</tr>
<tr>
<td>Injuries</td>
<td>108</td>
</tr>
<tr>
<td>Stress</td>
<td>12</td>
</tr>
<tr>
<td>Other</td>
<td>12</td>
</tr>
<tr>
<td>Mood</td>
<td>10</td>
</tr>
<tr>
<td>Soreness</td>
<td>9</td>
</tr>
<tr>
<td>Hydration</td>
<td>6</td>
</tr>
<tr>
<td>Fatigue</td>
<td>4</td>
</tr>
</tbody>
</table>

**Conclusion:** Based on the results indicated in the bar graph above, of the 147 coaches who answered this question the most commonly tracked lifestyle traits are body weight, sleep, nutrition, & injury. It is important to note that these were all the multiple-choice answers while other traits where filled in utilizing an “other” category.

Question Number 10: How do coaches track these lifestyle traits?

**Lifestyle Tracking Mode**

- Manual Log: 52%
- Computer or Smartphone App: 40%
- Other: 8%

**82% of Coaches Utilize Lifestyle Monitoring**

**Tracking Mode:**
- Coach Me Plus
- Consultation w/ Athletic Training
- Google Docs Questionnaire
- Conversation w/ Athlete
- METRIFIT Application
- My Fitness Pal
- Sparta Science
- Team Builder

*For full list and more application information see appendix at end of packet.*

**Conclusion:** 145 coaches indicated how they track lifestyle traits. The majority, 52%, utilize a manual log while 40% use computer or smartphone applications.

*Tracking modes indicated in list above.*
Question Number 11: *Do you change your strength and conditioning plan based on the results of your monitoring?*

![Pie chart showing 87% Yes, 13% No]

**Conclusion:**
The majority of strength and conditioning coaches who monitor recovery will alter their training based on the results of their testing.

**Question Number 12: *Under what basis do you alter your training plan?***

A total of 82 coaches indicated the basis as to which they would alter their training plan. Examples of the most common answer are as follows:

- Athletes Fatigue/ Appearance of under-recovery
- Competitive Sport Schedule
- Indicators of Performance Decrement  
  (*force plate reading, bar velocity, etc.*)
- Red Flags in Lifestyle Traits  
  (*under weight, increase in stress, lack of sleep, etc.*)
- Increase in Injury or Symptoms of Overtraining
- Responses to “perceived recovery questionnaires”
Question Number 13: What are the reason coaches do not currently monitor recovery?

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>I do not have the budget or resources</td>
<td>29</td>
</tr>
<tr>
<td>I do not have enough time</td>
<td>20</td>
</tr>
<tr>
<td>Other</td>
<td>15</td>
</tr>
<tr>
<td>I am not sure of the best methods to monitor recovery</td>
<td>13</td>
</tr>
<tr>
<td>I think monitoring recovery is up to the head coach or athletic training staff</td>
<td>2</td>
</tr>
</tbody>
</table>

Conclusion: Based on the results from 56 coaches as to why they do not currently monitor recovery, the majority of coaches cited lack of budget/resources and lack of time as the primary reason.

Question Number 14: Do coaches have interest in monitoring recovery in the future?

<table>
<thead>
<tr>
<th>Are you interested in monitoring recovery in the future?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, 98%</td>
</tr>
<tr>
<td>No, 2%</td>
</tr>
</tbody>
</table>

25% of Coaches Do Not Currently Monitor Recovery

Conclusion: Of those coaches who do not currently monitor recovery the vast majority, 98%, indicated interest in monitoring recovery in the future.
Recovery resources are services provided within a performance center that assist directly in the recovery of athletes between training sessions. For this survey recovery resources include but are not limited to nutrition/food stations, nutritional information, compression garment, and athletic training service (ice, heat, electric stimulation etc.).

Do you provide recovery resources for your athletes?

**Conclusion:**

Based on these results it can be concluded that the majority of strength and conditioning facilities provide recovery resources to their athletes.

**“Other” Resources Indicated:**

- Manual Therapy/Massage
- Soft Tissue Work
- Supplements
- Hot/Cold Soaking Tubs
- Extra Stretching
- Yoga
- Sports Psychology
<table>
<thead>
<tr>
<th>Application</th>
<th>About</th>
<th>Price</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beddit</td>
<td>Beddit is a product developed by Misfit that tracks sleep quality. It is a strap placed on the mattress under the sheets that tracks sleep quality, duration, sleep cycle, time to fall asleep, heart rate, respiration rate and snoring.</td>
<td>$74.99</td>
<td><a href="http://misfit.com/products/beddit?locale=en#beddit-spec">http://misfit.com/products/beddit?locale=en#beddit-spec</a></td>
</tr>
<tr>
<td>Catapult GPS</td>
<td>Catapult GPS system was invented by the Australia Institute of Sport and Cooperative Research Centers to better understand and track athlete’s movements and vitals during competition and training. Catapult provides instant feedback in the form of an athlete analysis for each member of your team.</td>
<td>estimated around $100,000 per year</td>
<td><a href="http://www.catapultsports.com/">http://www.catapultsports.com/</a></td>
</tr>
<tr>
<td>Coach Me Plus</td>
<td>Coach Me Plus is a flexible computer software application that can be customized to teams’ needs. Coach Me Plus is an application that can be used in place of Excel to track the variables you wish to monitor in addition to building your workout sheets, if desired.</td>
<td>unknown, contact company</td>
<td><a href="https://coachmeplus.com/">https://coachmeplus.com/</a></td>
</tr>
<tr>
<td>DRIVN</td>
<td>DRIVN is a mobile application to keep teams connected on all aspects of team training. Coaches can communicate with athletes, upload workouts, or track athlete performance within the application.</td>
<td>unknown, contact company</td>
<td><a href="http://drivn.today/">http://drivn.today/</a></td>
</tr>
<tr>
<td>Fit for 90</td>
<td>Fit for 90 is a computer or smartphone application that allows a coach to monitor lifestyle traits that could indicate overtraining and it provides a platform for practice planning. In addition Fit for 90 is an easy way to get feedback from athletes on how they feel and how training sessions have been affecting them. Some features seem to be soccer specific.</td>
<td>$149 per year</td>
<td><a href="https://fitfor90.com/">https://fitfor90.com/</a></td>
</tr>
<tr>
<td>Ithete</td>
<td>Ithete is a company that has developed various tools for monitoring heart rate and heart rate variability specifically in order to help coaches and athletes better identify when to train. They sell both finger and chest strap monitors which can be used with multiple versions of their app.</td>
<td>Monitors $55-$60, App $8.99 or free</td>
<td><a href="http://www.myithlete.com/">http://www.myithlete.com/</a></td>
</tr>
</tbody>
</table>
Kinduct:
About: Kinduct is a software platform that allows you to centrally locate all your athlete’s data and information. Individual athletes and team profiles can be created and training programs can be built right into their software. Communication and team planning can be done from within the app as well. This is another full service software platform for training.
Price: unknown, contact company
Website: https://www.kinduct.com/

Metrifit:
About: Metrifit is a monitoring system that gathers both subjective and objective information on athletes during training and competition in order to better understand and predict performance. This software can be used on both computers and smartphones.
Price: $299 per year for up to 30 athletes.
Website: http://www.metrifit.com/

My Fitness Pal:
About: My Fitness Pal is a free online or app based program that provides a platform for counting calories and tracking exercise.
Price: Free
Website: https://www.myfitnesspal.com/

Omegawave:
About: Omegawave is a team and athlete monitoring system which allows coaches to assess the readiness of their athletes to train and compete. Omegawave uses training load, volume, stress, etc. to develop individualized profiles for each athlete. Omegawave focuses on multiple physiological (central nervous system, cardiac, and fuel sources) systems that can play an important role in performance.
Price: unknown, contact company
Website: https://www.omegawave.com/

Sparta Science:
About: Sparta Science is a company with a performance training center, but more importantly it has built software to assist in the tracking of an athlete’s performance. Their software provides an all in one platform for programing and tracking athletes. Sparta Science has recently become more popular because of their use of force plates and monitoring vertical jump to assess recovery.
Price: unknown, contact company
Website: http://www.spartatrac.com/

TeamBuildr:
About: TeamBuildr is software that allows coaches to build their strength and conditioning program online while also tracking progression. It also has built in communication portals which allow you to easily share workouts and communicate with your athletes.
Price: $500-$1,000 per year
Website: http://teambuildr.com/
At the University of Montana (UM), the Institutional Review Board (IRB) is the institutional review body responsible for oversight of all research activities involving human subjects as outlined in the U.S. Department of Health and Human Services’ Office of Human Research Protection and the National Institutes of Health, Inclusion of Children Policy Implementation.

**Instructions:** A separate application must be submitted for each project. IRB proposals are approved for no longer than one year and must be continued annually (unless Exempt). Faculty and students may email the completed form as a Word document to IRB@umontana.edu, or submit a hardcopy (no staples) to the Office of the Vice President for Research in University Hall 116. Student applications must be accompanied by email authorization by the supervising faculty member or a signed hard copy. All fields must be completed. If an item does not apply to this project, write in: N/A. Questions? Call the IRB office at 243-6672.

### 1. Administrative Information

<table>
<thead>
<tr>
<th>Project Title: Monitoring Recovery in Collegiate Strength and Conditioning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Investigator: Alice Read</td>
</tr>
<tr>
<td>UM Position: Graduate Student</td>
</tr>
<tr>
<td>Department: Health and Human Performance</td>
</tr>
<tr>
<td>Office location: N/A</td>
</tr>
<tr>
<td>Work Phone: N/A</td>
</tr>
<tr>
<td>Cell Phone: 207-240-9686</td>
</tr>
</tbody>
</table>

### 2. Human Subjects Protection Training

*(All researchers, including faculty supervisors for student projects, must have completed a self-study course on protection of human research subjects within the last three years and be able to supply the “Certificate(s) of Completion” upon request. If you need to add rows for more people, use the Additional Researchers Addendum.)*

<table>
<thead>
<tr>
<th>All Research Team Members (list yourself first)</th>
<th>PI</th>
<th>CO-PI</th>
<th>Faculty Supervisor</th>
<th>Research Assistant</th>
<th>DATE COMPLETED IRB-approved Course mm/dd/yyyy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name: Alice Read Email: <a href="mailto:alice.read@umontana.edu">alice.read@umontana.edu</a></td>
<td>☒</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>9/20/2014</td>
</tr>
<tr>
<td>Name: Steven Gaskill Email: <a href="mailto:steven.gaskill@mso.umt.edu">steven.gaskill@mso.umt.edu</a></td>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>☐</td>
<td>10/29/15</td>
</tr>
<tr>
<td>Name: Charles Palmer Email: <a href="mailto:charles.palmer@umontana.edu">charles.palmer@umontana.edu</a></td>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>☐</td>
<td>6/10/2015</td>
</tr>
<tr>
<td>Name: Email:</td>
<td>☐</td>
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</tbody>
</table>

### 3. Project Funding

*(If federally funded, you must submit a copy of the abstract or Statement of Work.)*

<table>
<thead>
<tr>
<th>Is grant application currently under review at a grant funding agency? Yes (If yes, cite sponsor on ICF if applicable) ☒ No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agency</td>
</tr>
</tbody>
</table>

**IRB Determination:**

- ☒ Not Human Subjects Research
- ☒ Approved by Exempt Review, Category # (see memo)
- ☒ Approved by Expedited Review, Category # (see Note to PI)
- ☒ Full IRB Determination
_____ Approved (see Note to PI)

_____ Conditional Approval (see memo) - IRB Chair Signature/Date: ________________________________

_____ Conditions Met (see Note to PI)

_____ Resubmit Proposal (see memo) 

Risk Level:

_____ Disapproved (see memo)

Final Approval by IRB Chair/Manager: __________________________ Date: ______________ Expires: __________
4. Purpose of the Research Project: Briefly summarize the overall intent of the study. Your target audience is a non-researcher. Include in your description a statement of the objectives and the potential benefit to the study subjects and/or the advancement of your field. Generally included are literature related to the problem, hypotheses, and discussion of the problem’s importance. Expand box as needed.

The overall intent of this research is to increase the availability of information on the use of recovery monitoring by strength and conditioning coaches at the collegiate level. This project has two components. The first, already completed, was review of the current research availability on monitoring recovery. This review focused on the monitoring tools that have been studied and shown to successfully monitor recovery. The second aspect of this study will be the distribution of a survey to current strength and conditioning coaches at the collegiate level around the United States. This survey asks responders to identify monitoring tools they are currently implementing at their collegiate performance center. Our hypothesis is that well researched best practices will not match the current monitoring tools identified in our survey.

The benefits of this research will have implications for both researchers and coaches. Researchers will be able to take the results from this study and be able to create new research questions and projects around the currently applied monitoring tools. They will be able to develop projects to support and enhance what coaches already know about monitoring tools. Coaches and professionals using monitoring tools will gain information about what monitoring tools have been scientifically validated, what is commonly being practiced, and what ones have yet to be studied and supported through research. Additionally, coaches who are not currently monitoring recovery will be given the opportunity to learn more about what tools are available and be given insight into what their peers in the field are doing.

4.1 What do you plan to do with the results? If not discussed above, include considerations such as whether this is a class project, a project to improve a program/school system, and/or if the results will be generalized to a larger population, contribute to the general field of knowledge, and/or be published/presented in any capacity.

The results of this research will be distributed back to any subjects who indicated interests in receiving more information about monitoring recovery when they took our survey. In the results distributed back to subjects no personal information or names will be included. Theses results will help strength and conditioning coaches understand how they can improve their training through monitoring recovery and expose them to the tools currently being used in the field. If applicable, the results of the survey will be published. I further expect that the results of both the literature review and the survey will enhance recovery monitoring at the University of Montana and this researcher's professional development and ability to provide quality programs for athletes.

Is this part of a thesis or dissertation? ☒ Yes ☐ No  If yes and other than the PI’s, then whose?

5. IRB Oversight

Is oversight required by other IRB(s) [e.g., tribal, hospital, other university] for this project? ☐ Yes ☒ No

If yes, please identify IRB(s):

6. Subject Information:

6.1 Human Subjects (identify, include age/gender):

All human subjects will be current strength and conditioning coaches at the division I collegiate level. Both male and female subjects will be utilized from a range of ages (22-65).

6.2 How many subjects will be included in the study? 998

6.3 Are minors included (under age 18, per Montana law)? ☐ Yes ☒ No

If yes, specify age range: to

6.4 Are members of a physically, psychologically, or socially vulnerable population being specifically targeted?
Yes ☐ No 
If yes, please explain why the subjects might be physically, psychologically or socially vulnerable:

6.5 Are there other special considerations regarding this population? ☐ Yes ☑ No 
If yes, please explain:

6.6 Do subjects reside in a foreign country? ☐ Yes ☑ No 
If yes, please fill out and attach Form RA-112, Foreign Site Study Appendix (http://www.umt.edu/research/compliance/IRB/Docs/foreign.doc).

6.7 How will the subjects be selected or recruited? Include a bulleted list of inclusion/exclusion criteria. (Attach copies of all flyers, advertisements, etc., that will be used in the recruitment process as these require UM-IRB approval)

- Twenty NCAA Division I conferences will be randomly selected from a pool of all NCAA Division I conferences.
- All strength and conditioning coaches listed on the athletic staff directory page from the schools within the selected conferences will be emailed and asked if they would be willing to complete our survey. The survey will be open for two weeks and one additional email will be sent with 3 days left to complete the survey before it closes.

6.8 How will subjects be identified in your personal notes, work papers, or publications: (may check more than one)

☐ Identified by name and/or address or other 
(Secure written [e.g., ICF] or verbal permission to identify; if risk exists, create a confidentiality plan.)

☐ Confidentiality Plan 
(Identity of subjects linked to research, but not specific data [e.g., individuals identified in ICF but not included in publications]; identification key kept separate from data; or, data collected by third party [e.g., Select Survey, SurveyMonkey, etc.] and identifiers not received with data.)

☒ Never know participant’s identity 
(An ICF may be unnecessary [e.g, anonymous survey, paper or online] unless project is sensitive or involves a vulnerable population.)

6.9 Describe the means by which the human subject’s personal privacy is to be protected, and the confidentiality of information maintained. If you are using a Confidentiality Plan (as checked above), include in your description a plan for the destruction of materials that could allow identification of individual subject’s or the justification for preserving identifiers.

Qualtrics survey creator will be used to collect all the data, which will not include personal information with the results of the survey. This will completely separate the results from the identity of the subjects. Subjects who request feedback or a results summary will give their name and address via a separate, non-linked survey.

6.9a Will subject(s) receive an explanation of the research – separate from the informed consent form (if applicable) – before and/or after the project? ☐ Yes (attach copy and explain when given) ☑ No

7. Information to be Compiled

7.1 Explain where the study will take place (physical location not geographic). If permission is required to conduct the research at the location or to use any of the facilities, indicate those arrangements and attach copies of written permission:

This study will take place online through the survey creator Qualtrics. Data from the survey will be analyzed at the University of Montana, HHP department. No additional permission is required.
7.2 Will you be working with infectious materials, ionizing radiation, or hazardous materials? Please specify. (Do not include here standard biological samples, such as blood, buccal cells, or urine; specify those in #7.6.)

No.

7.3 Subject matter or kind(s) of information to be compiled from/about subjects:
Demographic information will be collected on gender, years experience as a strength coach, conference affiliation, and sports worked with. See survey. Data focused on the training recovery monitoring methods used by each program.

7.4 Activities the subjects will perform and how the subjects will be used. Describe the instrumentation and procedures to be used and kinds of data or information to be gathered. **Provide enough detail** so the IRB will be able to evaluate the intrusion from the subject’s perspective (expand box as needed):

Subjects will be asked, through email, if they are willing to complete a survey on techniques they use to monitor recovery during collegiate strength and conditioning. If they wish to complete the survey there will be a link to connect them with our survey. If they do not wish to complete the survey they can simply disregard the email.

7.5 Is information on any of the following included? (check all that apply):

- Sexual behavior
- Drug use/abuse
- Alcohol use/abuse
- Illegal conduct
- Information about the subject that, if it became known outside the research, could reasonably place the subject at risk of criminal or civil liability or be damaging to the subject’s financial standing or employability.

7.6 Means of obtaining the information (check all that apply). **Attach questionnaire or survey instrument, if used:**

- Field/Laboratory observation
- Blood/Tissue/Urine/Feces/Semen/Saliva
- Sampling (IBC Application must be submitted)
- In-person interviews/survey
- On-site survey
- Medical records (require HIPAA form)
- Telephone interviews/survey
- Mail survey
- Measurement of motions/actions
- Online survey (attach Statement of Confidentiality)
- Use of standard educational tests, etc.
- Examine public documents, records, data, etc.
- Other means (specify):
- Examine private documents, records, data, etc.

7.7 Will subjects be (check all that apply):

- Videotaped
- Audio-taped
- Photographed
- N/A

(secureing an additional signature is recommended on consent/assent/permission forms)

Explain how above media will be used, who will transcribe, and how/when destroyed:

7.8 Discuss the benefits (does not include payment for participation) of the research, if any, to the human subjects and to scientific knowledge (if the subjects will not benefit from their participation, so state):

Theses results will help strength and conditioning coaches understand how they can improve their training through monitoring recovery and expose them to the tools currently being used in the field. If applicable, the results of the survey will be published. The participants will be asked at the end of the survey if they would like to receive more information on monitoring recovery in collegiate strength and conditioning. If they check yes, a link will be provided to take them to a new survey that will collect their contact information. This information will not be linked to their survey in any way. Following data analysis and completion of the project, those participants who requested feedback will be sent a summary of the results and links to further information.
7.9 Cite any payment for participation (payment is not considered a benefit). If grant funding is not indicated in item #2, please specify the source of the funding and in what form it is to be dispersed.

N/A

7.9a Outline, in detail, the risks and discomforts, if any, to which the human subjects will be exposed (Such deleterious effects may be physical, psychological, professional, financial, legal, spiritual, or cultural. As a result, one can never guarantee that there are no risks – use “minimal.” Some research involves violations of normal expectations, rather than risks or discomforts; such violations, if any, should be specified):

There are no risks associated with this survey and if at any point a subject feels uncomfortable about a question they can choose to leave the survey. This will be made clear in the introduction email.

7.9b Describe, in detail, the means taken to minimize each such deleterious effect or violation:

All questions for the survey have been reviewed by professionals in both the research and coaching setting for possible questions that could be misleading or cause discomfort.

8. Informed Consent

An informed consent form (ICF) is usually required, unless subjects remain anonymous or a waiver is otherwise justified below. (Templates and examples of Informed Consent, Parental Permission, and Child’s Assent Forms are available at http://www.umt.edu/research/compliance/IRB/forms.php).

- A signed copy of the consent/assent/permission form must be offered to all subjects, including parents/guardians of subjects less than 18 years of age (minors).
- Use of minors
  - All minor subjects (under the age of 18) must have written parental or custodial permission (45 CFR 46.116(b)).
  - All minors from 10 to 18 years of age are required to give written assent (45 CFR 46.408(a)).
  - Assent by minor subjects: All minor subjects are to be given a clear and complete picture of the research they are being asked to engage in, together with its attendant risks and benefits, as their developmental status and competence will allow them to understand.
  - Minors less than 10 years of age and all individuals, regardless of age, with delayed cognitive functioning (or with communication skills that make expressive responses unreliable) will be denied involvement in any research that does not provide a benefit/risk advantage.
    - Good faith efforts must be made to assess the actual level of competence of minor subjects where there is doubt.
    - The Minor Assent Form must be written at a level that can be understood by the minor, and/or read to them at an age-appropriate level in order to secure verbal assent.

- Is a written informed consent form being used? ☐ Yes (attach copy) ☒ No (justify below)

Written consent means that physical signatures will be obtained on the informed consent forms.

To waive the requirement for written informed consent (45 CFR 46.117), describe your justification:

Subjects in this study will have the choice to fill out the survey if they like. If they choose to complete the survey than they are giving their consent by completing the questions.

- Is a written parental permission form being used? ☐ Yes (attach copy) ☒ No
  (If yes, will likely require minor assent form)

- Is a written minor assent form being used? ☐ Yes (attach copy) ☒ No
  (If yes, will likely require parental permission form)

Principal Investigator’s Statement

By signing below, the Principal Investigator agrees to comply with all requirements of the University of Montana-Missoula IRB, the U.S. Department of Health and Human Services Office of Human Research Protection Guidelines, and NIH Guidelines. The PI agrees to ensure all members of his/her team are familiar with the requirements and risks of this
I certify that the statements made in this application are accurate and complete. I also agree to the following:

- I will not begin work on the procedures described in this protocol, including any subject recruitment or data collection, until I receive final notice of approval from the IRB.
- I agree to inform the IRB in writing of any adverse or unanticipated problems using the appropriate form. I further agree not to proceed with the project until the problems have been resolved.
- I will not make any changes to the protocol written herein without first submitting a written Amendment Request to the IRB using form RA-110, and I will not undertake such changes until the IRB has reviewed and approved them.
- It is my responsibility to ensure that every person working with the human subjects is appropriately trained.
- All consent forms and recruitment flyers must be approved and date-stamped by the IRB before they can be used. The forms will be provided back to the PI in PDF format with the IRB approval email. Copies must be made from the date-stamped version. All consent forms given to subjects must display the IRB approval date-stamp.
- I understand that it is my responsibility to file a Continuation Report before the project expiration date (does not apply to exempt projects). This is not the responsibility of the IRB office. Tip: Set a reminder on your calendar as soon as you receive the date. A project that has expired is no longer in compliance with UM or federal policy.
- I understand that I must file a Closure Report (RA-109) when the project is completed, abandoned, or otherwise qualifies for closure from continuing IRB review (does not apply to exempt projects).
- I will keep a copy of this protocol (including all consent forms, questionnaires, and recruitment flyers) and all subsequent correspondence with the IRB.
- I understand that failure to comply with UM and federal policy, including failure to promptly respond to IRB requests, constitutes non-compliance and may have serious consequences impacting my project and my standing at the University of Montana.

Signature of Principal Investigator:

Date: ____________________________

(Type for electronic submission; sign for hard copy)

NOTE: Electronic submission of this form must be sent from your University of Montana email account.

Attention Students: If you are submitting your application by hard copy (paper), please have your faculty supervisor sign the statement below. If you are submitting your application electronically (by email), then you must have your faculty supervisor send a separate email to the IRB affirming the statements below.

As the student's faculty supervisor on this project, I confirm that:
1) I have read the IRB Application and attachments.
2) I agree that it accurately represents the planned research.
3) I will supervise this research project.

Faculty Supervisor: ____________________________

(Type or print name)

Faculty Supervisor Signature: ____________________________ Date: ____________________________

(Sign for hard copy)

Department: ____________________________ Phone: ____________________________
Q26 You are invited to participate in a research project about Monitoring Recovery in Collegiate Strength and Conditioning. This online survey should take about 3-5 minutes to complete. Participation is voluntary, and responses will be kept anonymous to the degree permitted by the technology being used. You have the option to not respond to any questions that you choose. Participation or non-participation will not impact your relationship with the University of Montana. Submission of the survey will be interpreted as your informed consent to participate and that you affirm that you are at least 18 years of age. If you have any questions about the research, please contact the Principal Investigator, Alice Read, via email at alice.read@umontana.edu or the faculty advisor, Dr. Steven Gaskill at steven.gaskill@mso.umt.edu. If you have any questions regarding your rights as a research subject, contact the UM Institutional Review Board (IRB) at (406) 243-6672. Please print or save a copy of this page for your records.

Q25 * I have read the above information and agree to participate in this research project.
  ☑ Yes (1)
  ☑ No (2)

If No Is Selected, Then Skip To End of Survey

Answer If * I have read the above information and agree to participate in this research project.

Q1 Monitoring recovery may be defined as: “The tracking of an athlete's recovery from physiological and psychological training and life stress.” The recovery data are generally used to evaluate the balance between training load and recovery in order to optimize training and performance or avoid long term or undesirable performance decrements. For this survey, monitoring recovery techniques include but are not limited to: subjective scales and questionnaires (RPE & perceived recovery questionnaires) and objective characteristics (vertical jump, heart rate variability, submaximal heart rate, or lifestyle tracking (nutrition, sleep, body weight or injury). Do you currently monitor recovery with your athletes between training sessions?
  ☑ Yes (1)
  ☑ No (2)

If Yes Is Selected, Then Skip To How often do you monitor recovery? If No Is Selected, Then Skip To What are the reasons you do not curre...

Q2 How often do you monitor recovery?
  ☑ Daily (1)
  ☑ Weekly (2)
  ☑ Monthly (3)
  ☑ Other: (4) ____________________
Q3 What methods of monitoring recovery do you use?
- Vertical Jump (1)
- Rate of Perceived Exertion (RPE) (2)
- Perceived Recovery Questionnaire (3)
- Heart Rate Variability (4)
- Submaximal Heart Rate (7)
- Lifestyle Tracking: Nutrition, Body Weight, Injuries, and Sleep (5)
- Other: (6) ________________

**Answer If What methods of monitoring recovery do you use? Vertical Jump Is Selected**

Q4 What method do you use to measure vertical jump?
- Force Plate (1)
- Just Jump Mat (2)
- Vertec (3)
- Other: (4) ________________

**Answer If What methods of monitoring recovery do you use? Perceived Recovery Questionnaire Is Selected**

Q5 Did you make your own perceived recovery questionnaire?
- Yes (1)
- No (2)

**Answer If What methods of monitoring recovery do you use? Perceived Recovery Questionnaire Is Selected**

Q6 If not, what was the name of the questionnaire you use?

**Answer If What methods of monitoring recovery do you use? Heart Rate Variability Is Selected**

Q7 What methods do you use to measure heart rate variability?
- Heart Rate Monitoring Watch (1)
- Pulse Oximeter (2)
- Manually (3)
- Other: (4) ________________

**Answer If What methods of monitoring recovery do you use? Submaximal Heart Rate Is Selected**

Q21 What method of monitoring submaximal heart rate do you use?
- Step Test (1)
- Interval Run Test (2)
- Other (3) ________________
Q8 Which lifestyle variables do you track?
- Nutrition (1)
- Body Weight (2)
- Injuries (3)
- Sleep (4)
- Other: ____________________

Q9 How do you track nutrition, body weight, injuries, and sleep?
- Computer or Smartphone App (which one?) (1) ____________________
- Manual Log (2)
- Other: (3) ____________________

Q10 Do you change your strength and conditioning plan based on the results of your monitoring?
- Yes (1)
- No (2)

Q11 Under what basis will you alter your training plan?

Q12 Do you change your training plan on the fly or is the change pre-programmed?
- On the fly (1)
- Pre-programmed (2)

Q13 What are the reasons you do not currently monitor recovery?
- I do not have the budget or resources (1)
- I do not have enough time (2)
- I think monitoring recovery is up to the head coach or athletic training staff (3)
- I am not sure of the best methods to monitor recovery (4)
- Other: ____________________
Answer If Do you currently monitor recovery with your athletes between training sessions? No Is Selected

Q14 Are you interested in monitoring recovery in the future?
- Yes (1)
- No (2)

Q15 Recovery resources are services provided within a performance center that assist directly in the recovery of athletes between training sessions. For this survey recovery resources include but are not limited to nutrition/food stations, nutritional information, compression garment, and athletic training service (ice, heat, electric stimulation etc.). Do you provide recovery resources for your athletes?
- Yes (1)
- No (2)

Answer If Do you provide recovery resources for your athletes? Yes Is Selected

Q16 What recovery resources do you provide?
- Nutrition/Food Station (1)
- Educational Information (2)
- Compression Garments (3)
- Athletic Training Services(ice, heat, electric stimulation etc.) (4)
- Other: (5) ____________________
Q22 What sports do you work with?
- Football (1)
- Men's Basketball (2)
- Men's Ice Hockey (3)
- Men's Lacrosse (4)
- Baseball (5)
- Men's Track and Field (6)
- Men's Soccer (7)
- Men's Rugby (8)
- Men's Volleyball (9)
- Men's Crew (10)
- Men's Tennis (11)
- Men's Golf (12)
- Men's Swim and Diving (13)
- Field Hockey (14)
- Softball (15)
- Women's Soccer (16)
- Women's Basketball (17)
- Women's Track and Field (18)
- Women's Rugby (19)
- Women's Ice Hockey (20)
- Women's Volleyball (21)
- Women's Crew (22)
- Women's Tennis (23)
- Women's Golf (24)
- Women's Swim and Diving (25)
- Other (26) ________________

Q28 Please provide the following demographic information:

Q27 Gender:
- Male (1)
- Female (2)

Q29 Age:

Q30 Number of years experience as a Collegiate Strength and Conditioning Coach:
Q31 Highest level of education achieved:
☑ High School Degree/GED (1)
☑ Bachelors Degree (B.A./B.S) (2)
☑ Masters Degree (M.A./M.S.) (3)
☑ Doctoral Degree (PhD) (4)

Q32 What NCAA Division 1 conference are you a member of? (Optional)
Email Sent for Survey:

Dear Coach,

I am writing to ask for your help with a survey investigating how collegiate strength and conditioning coaches monitor recovery. You are part of a random sample of NCAA Division I collegiate strength and conditioning coaches, who’s conference was selected to complete a brief questionnaire about recovery monitoring strategies. The goal of this survey is to understand whether strength and conditioning coaches are monitoring recovery and, if so, what tools they are using.

The questionnaire is short and should only take about 3-5 minutes to complete. To begin the survey, simply click the link below:

(Insert link to survey once it is activated for the two-week collection time)

The survey is confidential. Your participation is voluntary, and if you come to any question you prefer not to answer please skip it and go onto the next. Should you have any questions or comments please contact Alice Read at alice.read@umontana.edu.

Your input is greatly appreciated. The results from this survey will help strength and conditioning coaches increase their knowledge about monitoring recovery in the pursuit of peak performance. You will be given the opportunity to receive a summary of our results and conclusions at the end of the survey if you chose.

Thank you,

Alice Read

Graduate Student
Health and Human Performance Department
University of Montana