The Perceived Effectiveness of Different Recovery Modalities for Elite NCAA Division I Baseball Players

By

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A Thesis Submitted in Partial Fulfillment

of the Requirements for the Degree of Master of Science

Middle Tennessee State University

May 2024

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ABSTRACT

The purpose of this study was to examine the perceived effectiveness and use of different recovery modalities among Division I NCAA baseball players. The recovery modalities studied included cupping, electrical stimulation, blood flow restriction, contrast therapy, hot water immersion, cold water immersion, pneumatic device, and manual therapy. Through an electronic survey, participants were asked questions regarding demographics, followed by questions for each recovery modality regarding perceived effectiveness (1 to 5 rating) and use during their collegiate career (yes/no). Based on reported use, questions were presented to capture reasons for not using the modality or frequency, timing, and reasons for using the modality. A total of 54 Division I baseball players (age: 20.5 ± 1.6 years) completed the survey. In terms of perceived effectiveness and use, respectively, the top three modalities were manual therapy (4.1 ± 0.9; 93%), cupping (3.8 ± 0.6; 85%), and electrical stimulation (3.7 ± 1; 76%). Among those who used the top 3 modalities, manual therapy was the most frequently used (56% daily or 2-3 times per week), followed by electrical stimulation (42% daily or 2-3 times per week) and cupping (92% using once per week or month). The top reason(s) for use were personal and/or athletic trainer belief that the recovery modality was effective. Among the most frequent contributors to not using a modality were personal belief that the recovery modality was ineffective, and that the modality was inconvenient or uncomfortable/unenjoyable. Overall, the results of perceived efficacy and use of each recovery modality showed consistency, which was supported by the reasons for use or no use of each modality.

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CHAPTER I

INTRODUCTION

Adequate recovery is a vital component in preventing injuries in athletes, leading to an increasing number of accessible recovery modalities. Athletes need recovery because of the high level of competition and play that occurs for months. Collegiate baseball players, for example, are notorious for their long, intense seasons, playing an average of 49 games with 53 practices in a three-month period with little time off between activities (Dick et al., 2007). This level of competition can push athletes beyond their physiological and psychological limits (Venter, 2014). As such, athletes and athletic trainers are challenged daily with the need to maximize recovery during lengthy seasons with little recovery time between events and activities (Venter, 2014).

Without proper recovery, athletes may not be able to meet the expected workload or performance level (Venter, 2014). Each recovery modality has a different effect on the body, but the goal of each is the same. The aim is to assist the athlete in recovering by reducing soreness, reduce swelling, increase relaxation, improve ROM, reduce tightness, and increase blood flow to active musculature (Crowther et al., 2017). In more elite athletes, recovery modalities are used more often during the week to relax the athletes and increase blood flow to get the creatine kinase and byproducts of exercise removed from the muscles (Tavares, 2017). The final purpose of recovery modalities is to increase muscular strength and recovery of power (Moore et al., 2022). There are a multitude of tools and modalities to choose from that continue to improve and evolve.

Commonly used recovery modalities athletes include blood flow restriction, cupping, neuromuscular electrical stimulation, hydrotherapy, and intermittent pneumatic compression. Hydrotherapy is used often following training or competition to decrease inflammation, reduce body temperatures, increase blood flow, decrease swelling, and decrease pain (Davis, 2022; Halson, 2013; Murray, 2014; Higgins, 2017). Intermittent compression or pneumatic compression are used to provide external pressure to the limbs. The pressure increases from the distal portion of the limb to the proximal to increase venous blood blow and lymphatic outflow, which removes the muscular metabolites to decrease inflammation, swelling, fatigue, and soreness (Davis, 2022; Halson, 2013). Electrical stimulation causes repeated muscular or nervous system contractions by stimulation the nerve endings to increase blood flow and reduce tightness in muscles (Finberg et al., 2013). Blood flow restriction is classified as a tourniquet that aids in reducing arterial and venous blood flow to assist in the removal of metabolites to increase the inflammatory response and swelling (Cognetti et al., 2022). Cupping therapy is classified as the drawing in of localized skin to assist in increasing the microcirculation, promote endothelial repair, and reduction of muscle tightness while increasing blood flow to the area (Al-Bedah, 2019; Furhad, 2023). Although there are many effective recovery modalities, it is important to consider the prevalence of use and perceived effectiveness of each by athletes.

According to Crowther et al. (2017) there is little research and knowledge as to why athletes partake in recovery strategies and if they believe they are effective or not. The available literature includes a mismatch between perceived effectiveness and use of recovery modalities among athletes, as well as sex-, sport-, and competition level-specific differences in use and perceived effectiveness of various recovery modalities (Crowther et al., 2017; Venter, 2014). Gaps in the literature have emerged because of the vast array of recovery modalities available, leaving the prevalence and perceived effectiveness of several modalities understudied. Additionally, while there appear to be sport-specific preferences for recovery modalities, there remains to be a thorough investigation into this topic with baseball players. Thus, there is a need to further investigate the prevalence of use and perceived effectiveness of varying recovery modalities with collegiate baseball players.

Purpose of the Study

One purpose of this study was to understand the prevalence of the use of recovery modalities Data were also collected to understand which recovery modalities athletes had access to and their perceived effectiveness of each modality. the research questions included:

1. Which recovery modalities do Division I baseball players use?
2. How do Division I baseball players rate the effectiveness of the recovery modalities they have used?
3. What are reasons for using or not using each modality?
4. Which recovery modalities do Division I baseball players think are most effective?

Significance of the Study

This study is significant because it is important to understand the perceived effectiveness of recovery modalities to ensure the best quality of care for baseball players via athletic trainers and other health care professionals. Every athlete is different, and they will each have a different perception of what helps their body the best and how their body recovers. With this information, athletic trainers and coaches will be able to understand what recovery modalities help different positions and players, to allow for a more streamlined approach to recovery.

CHAPTER II

REVIEW OF LITERATURE

This review begins with background information on recovery and presents information about baseball- and position-specific recovery. Next, several common recovery modalities represented, including the theory and measured effectiveness for each method of recovery. Finally, the literature review concludes with information about athlete-reported prevalence of use and ratings of perceived effectiveness for varying recovery modalities.

Recovery

Elite sport performance requires high-volume, high-intensity training. These stressful components in training create a need for effective recovery modalities for athletes. Recovery is vital to an athlete's physical work capacity and elite sports performance. The need for recovery is characterized by the destruction and breakdown of skeletal muscle fibers that creates an inflammatory response in the muscles, yielding a likely decrease in overall athletic performance (Bailey, 2017; Barnett, 2006; Malone, 2014). The aim of recovery after training and competition is to facilitate athletes returning to their normal physiological and psychological state as rapidly and effectively as possible (Barnett, 2006; Jentjens & Jeukendrup, 2003). It is important for athletes to achieve adequate recovery, especially in elite level sport where the margins between winning and losing are often extremely small. The development of modalities aimed at enhancing the recovery process for athletes has been at the forefront of much of the scientific research into training methods and technology over the years (Barnett, 2006; Malone, 2014). These artificial recovery modalities create a "short-cut" to allow elite athletes to continue their top-notch athletic performance while minimizing fatigue. Common therapeutic modalities typically include cupping, neuromuscular electrical stimulation, intermittent pneumatic compression, hydrotherapy, and blood flow restriction. Therapeutic interventions have shown a promising ability to improve ROM deficits, decrease soreness, minimize fatigue, prevent injury, increase blood flow, and increase the venous and lymphatic return to assist in the reduction of swelling following activity. However, there is little available evidence to guide clinicians in the selection of the best available recovery options (Bailey, 2017).

Position-Specific Importance of Recovery in Baseball Players

Although recovery is important for all athletes, the lengthy season, daily training, and multitude of games create a particularly high stress environment for baseball players. Additionally, baseball-specific recovery is unique because each position places a different strain on the body. One position that experiences notable strain, particularly on the throwing arm, is pitcher. Delayed onset muscle soreness (DOMS) and extreme fatigue increase the risk for elbow injuries in pitchers (Williams, 2017). The unique, unnatural angle and torque placed on the arm cause repeated stress, increasing the risk of injury (Williams, 2017). As a result, pitchers experience anatomical changes in the shoulder and elbow (Keller et al., 2014). Following an outing and throughout the season, the ulnar collateral ligament exhibits thickening potentially in relation to a protective response to the large amount of valgus stress in the elbow that occurs during throwing (Khalil et al., 2019). Furthermore, there are significant decreases in ROM that commonly occur, especially in the shoulder, towards the end of the season (Chalmers et al., 2021). To protect from injury or missing playing time and games because of these stresses, pitchers need to maintain optimal strength and ROM without adversely affecting performance or tissue quality. In general, pitchers need to be rested and ready to return to the mound either daily or within 5-7 days depending on if they are a starter, reliever, or closer. Recovery is vital in that time frame to get their arms and bodies feeling the best before their next outing (Mehta et al., 2022). Pitchers' recovery is specific to their throwing arm and the frequency and modality of recovery are partially determined by how much they throw (Mehta et al., 2022).

Catchers are different than other positions because they are the only position that is lower body dominant. These players experience lower body fatigue because of the constant squatting motion, as well as shoulder and elbow fatigue due to throwing a ball more than any other position on the field (Freeston et al., 2023). Although their arm fatigue is not as high as pitchers, the quantity of throws causes many issues that need to be addressed in their recovery following both practice and games (Freeston et al., 2023). Catchers must be ready for every pitch of every game and need to optimize recovery to compete at their highest level. Thus, their workload and recovery need to be managed to avoid injury and optimize performance (Drew et al., 2016). Getting adequate recovery allows catchers to catch multiple days in a row without the increased risk of injury due to muscle fatigue.

Position players, such as infielders and outfielders, have different workloads than that of pitchers and catchers. They perform different tasks at their positions and are required to complete more high-speed running. In a study of infielders, outfielders, and catchers, each position had similar baserunning and offensive metrics (Freeston et al., 2023). However, running demands were highest for outfielders, followed by infielders and catchers. Hard accelerations were most frequent with first basemen, followed by outfielders, remaining infielders, and catchers (Freeston et al., 2023). Middle infielders had the highest demand for total throws, followed by outfielders, third basemen, catchers, and first basemen. According to Okoroha et al. (2019), pitchers are at the highest risk for hamstring injury followed by outfielders, catchers, and infielders. Finally, Freeston et al. (2023) reported that hard throws were highest for second basemen and shortstops. The remaining position ranks for hard throws from highest to lowest were third basemen, outfields/catchers, and first basemen. Although position players are less consistently active, with bouts of high intensity movement and intermittent periods of little to no movement, position players often play multiple games a week and sometimes multiple times daily. Recovery will be used to decrease the risk of injury and allow these athletes to perform at their highest levels.

Recovery Techniques Used with Elite Baseball Athletes

Cupping

Cupping is an ancient Chinese medical treatment technique that has made a return to clinics in the previous years because of the ease of treatment and benefits for athletes. There are two forms of cupping, dry and wet. Wet cupping deals with perforating the skin in hopes to draw out blood and is mostly used for immune system diseases. Dry cupping is the main form of cupping that is used for recovery and in athletes, which is the drawing in of localized skin through negative pressure to promote therapeutic benefits (Al-Bedah, 2019). Furhad (2023) described cupping as a technique that creates negative pressure through a form of suction on the cup. Cupping is performed with cups made from a polycarbonate clear plastic material that vary in sizes for different treatment sites. The cups have an air valve on the top where a pump is connected, to pull air out. This type of common equipment shows no indication of the pressure level in the cup and the pressure is dependent on each clinician (Chiu, 2020). The negative pressure is caused by a vacuum suction via heat, flame, or handheld pump to draw the localized skin and soft tissue into the cup (Wood et al., 2020).

Although cupping has been used for centuries, there is limited research on its effects on the body, with even less literature regarding its efficacy as a recovery modality (Al-Bedah, 2019). Cupping is mostly used for tightness and soreness in athletes to increase the elasticity of the muscles and remove the byproducts of exercise by increasing blood flow (Al-Bedah, 2019; Hou et al., 2020; Lauche et al., 2013; Wang et al., 2020). The drawing of localized skin improves microcirculation, promotes capillary endothelial cell repair, and produces progressive muscle relaxation (Al-Bedah, 2019, Ghods, 2016; Hou, 2021; Lauche et al., 2013). It is notable that these benefits are attained without detriment to the muscle tissue (Lowe, 2017; Hou et al., 2020; Hou, 2021; Wang et al., 2020; Jan et al., 2021). As a result, cupping may be used to reduce musculoskeletal inflammation, ultimately optimizing performance by reducing pain and fatigue (Kemper, 2000; Mehta, 2015). It is important to note that benefits from cupping therapy are delayed. For example, Hou et al. (2021) did not observe significant improvements in muscle fatigue until 24 hours post-cupping therapy. However, because fatigue was only measured immediately after exercise and 24 hours later, the precise timeline of benefits remains to be fully understood.

It is important to consider that a lack of standard clinical practice guidelines yields inconsistency in the implementation of cupping therapy among healthcare professionals. These inconsistencies may contribute to equivocal findings regarding the efficacy of cupping (Hou et al., 2021). For example, each clinician varies in how long the cups are pressurized, how much pressure is in each pump, how many pumps are used to pressurize the cups, and the types of cups used. In addition to these variables, the time between muscle fatigue and cupping therapy may vary and could impact the timeliness of benefits. For example, augmented local inflammation may be an unintended consequence of using cupping therapy immediately following intense muscle fatigue (Al-Bedah, 2019; Hou et al.2021).

There are few studies that have specifically assessed the efficacy of cupping therapy with baseball players. Warren et al. (2020) found that dry cupping is an effective modality in treating and addressing limitations in hamstring flexibility in baseball players with tight hamstrings. The practitioners performed the cupping for 3 minutes with six cups in place statically, then for 20 repetitions of active mobilization with the cups still in place followed by a treatment of 10-mintes of heat and 90-seconds of foam rolling. There were no data on the pressure applied in each cup during the treatment. Another recent study provides evidence that cupping therapy for baseball players improved soft tissue compliance and functionality of the shoulder and the upper limbs, as well as reduced inflammation and pain after strenuous exercise (Chiu et al., 2020). Chiu's methodology included an effective measure of using a negative pressure of the cups at 400 mmHg for 15-minute sessions, completed eight times over 4 weeks. Similarly, Cage (2023) used a method of dry cupping where he used plastic cups with air drawn in via two pumps with the handheld pump and was used for one 15-minute session. The effective treatment of Cage (2023) creates the more known answers about cupping and their benefits to recover; unlike their recovery counterpart of intermittent pneumatic compression devices who are not vastly researched, and results vary widely.

Intermittent Pneumatic Compression Device

An intermittent pneumatic compression device (IPC) is used mostly for lower body compression to increase the rate of recovery after muscular exertion. The damage and inflammation caused by exercise can delay the onset of the healing process and in turn slow recovery and progression in athletes by days or weeks (Armstrong, 1984; Draper et al., 2020). Like manual therapy or massage, the purpose of IPC is to increase the venous and lymphatic return to assist in the reduction of swelling, soreness, and pain (Cochrane, 2013; Waller et al., 2006). The goals of this are to increase recovery and reduce tightness (Draper et al., 2020; Haun et al., 2017). When implementing IPC, the devices can work as a static compression unit where it is a fixed compression typically from 20-100 mmHg for a fixed timeframe or it can work in an inflating and deflating capacity that starts on the distal extremity and moves proximally (Haun et al., 2017).

There are few investigations of IPC efficacy with regards to recovery and decreasing muscular fatigue and soreness. However, the limited research has primarily targeted endurance training and has yielded contradictory findings for how effective IPC garments are (Draper et al., 2020; Heapy et al., 2018; Hoffman et al., 2016; Stedge, 2021). Comparing a control trial to an IPC trial, Draper et al. (2020) found that there was no difference in recovery (self-reported pain rating) and inflammation (serum C-reactive protein) following a 20-mile run at 70% of their maximal oxygen uptake (VO_2 max). In contrast, IPC used immediately after ultramarathon performance yielded similar acute improvements in muscular fatigue, pain, and soreness when compared to either massage (Hoffman et al., 2016) or compression based manual therapy (Heapy et al., 2018). However, beyond the acute subjective benefits, there were no measurable improvements in prolonged subjective measures or functional recovery as measured by 400-meter performance for any implemented treatments.

In an application beyond endurance exercise, Haun et al. (2017) found IPC implementation (compared to a sham treatment) following 3 consecutive days of high-volume squat training yielded maintenance of flexibility, reduced muscle soreness, and reduced markers of oxidative stress and protein breakdown. In contrast, Wiecha et al. (2021) observed that IPC did not attenuate delayed onset muscle soreness when compared to a sham treatment immediately, 24-hours, or 48-hours after a single bout of eccentric exercise (100 drop jumps). These two contrasting studies mirror the contradictory findings reported for endurance training, which may be due to trained athletes generally recovering faster, increased muscle damage, increased inflammatory mediators, and increases in creatine kinase levels (Cranston & Driller, 2022; Haun et al., 2017; Wiecha et al., 2021). At this point, only one group focused on using IPC as a recovery tool with elite athletes at the Olympic Training Centers (Sands et al., 2015). The participants completed morning training, did a pressure-to-pain test, completed 15 minutes of lower-extremity IPC or control treatment, immediate pain-to-pressure test, afternoon training, and finished with another pain-to-pressure test. The authors concluded that when compared to a control group, IPC devices expedite and intensify recovery for short-term benefits (Sands et al., 2015). Although the research date are inconsistent on effectiveness, athletes and rehabilitation specialists use IPC's daily to assist with soreness and DOMS. Although IPC devices are alone in their uses and variety, hydrotherapy has lots of variety with great benefits of perceived effectiveness.

Hydrotherapy

Hydrotherapy has been used as a recovery modality since the 18th century, likely due to its efficacy, versatility, and ease of use (Makinde, 2015). The goal of hydrotherapy is to reduce the proliferation of tissue disruption and pain, as well as optimize ROM and muscle relaxation, ultimately aiming for enhanced recovery and performance (Mullaney, 2021; Versey et al., 2013). According to Versey et al. (2013), the hydrostatic pressure that occurs in the water will act on the body to increase recovery by assisting in the movement of body fluids. When utilizing hydrotherapy for recovery, the three main methods are cold water immersion (CWI), hot water immersion (HWI), and contrast therapy.

Conflating the effects of hydrostatic pressure, CWI causes a decrease in skin and muscle temperature that stimulates vasoconstriction which increases venous return and decreases swelling by slowing the metabolism and the production of metabolites (Abramson et al., 1966; Enwemeka et al., 2002; Sauls, 1999; Washington et al., 2000; Wilcock et al., 2006). Ultimately, this reduces edema, pain, and metabolite accumulation (Leeder et al., 2012; Vaile et al., 2011). Immersion also yields a reduction in acetylcholine production, which reduces the ability of the muscles to spasm (Sauls, 1999; Washington et al., 2000). Further, inflammation may be reduced by the reduction of lymphatic and capillary permeability caused by immersion (Enwemeka et al., 2002; Eston & Peters, 1999). Typically for CWI, the water is at a temperature of 10-12.5

degrees Celsius and immersion typically lasts 10-25 minutes (Versey et al., 2013). Due to the decrease in internal body temperature, CWI is best implemented post-exercise.

One investigation indicated 15 minutes of CWI at 12 degrees Celsius following high intensity exercise was effective at reducing DOMS when compared to a control trial in soccer players (Rupp et al., 2012). Similarly, in comparison to passive recovery, Takeda et al. (2014) observed lesser fatigue and creatine kinase accumulation following 10 minutes of CWI at 15 degrees Celsius immediately after an 80-minute game simulation training session in collegiate rugby players. In addition to the efficacy of a single CWI exposure, there is evidence that repeated post-exercise immersion also enhances recovery from fatiguing exercise (Halson et al., 2008; Ingram et al., 2009). For example, lower ratings of muscle soreness and smaller declines in isometric leg extension and flexion strength were observed when 80 minutes of high-intensity team sport activity and a 20-minute shuttle run to exhaustion was followed by five sets of 2-minute CWI at 10 degrees Celsius (separated by 2.5 minutes of sitting upright at room temperature) compared to a passive recovery (Ingram et al., 2009). In accordance, Halson et al. (2008) implemented three, 1-minute sets of CWI at 11.5 degrees Celsius following 40-minute cycling time trials, reporting CWI lowers heart rate and core temperature, although CWI did not elicit any other metabolic or physiological changes.

In contrast, the intention of HWI is to increase the tissue temperature, enhance metabolite production and muscle elasticity, stimulate local blood flow, and reduce muscle spasm (Hing, 2008). Hot water immersion is typically completed in water that is greater than 36 degrees Celsius ranging from 10-24 minutes of immersion time (Kuligowski, 1998; Pournot, 2011; Vaile, 2008; Versey et al., 2013). Versey et al. (2013)

stated that multiple studies used HWI as a recovery technique post-exercise. According to Viitasalo et al. (1997), who studied elite Junior track runners during a strength and power assessment training period, three weekly post-exercise sessions of HWI in 37-degree Celsius water for 20-30 minutes; improved strength and neuromuscular control, while it decreased muscular soreness compared to a control recovery session with no water immersion therapy. Kuligowski et al. (1998) studied university students with soreness and loss of ROM after a 1RM test on the patients' non dominant elbow flexion. The exercised arm was immersed up to the deltoid for 24 minutes at 39 degrees Celsius. The results of the HWI immediately post exercise, 24, 48, and 72 hours showed that there was an increase in range of motion (ROM) after immersion but no change in muscular soreness.

Contrast therapy is a technique that requires a repetitive alternation between HWI and CWI. The overall theory of contrast therapy is the creation of a pumping action of the blood that alternates between vasoconstriction and vasodilation to increase blood flow; however, there is literature on both sides of the argument of whether contrast therapy accomplishes this (Cochrane, 2004). There are multiple procedures that can be completed for contrast therapy. According to Versey et al. (2013) there is no difference between ending with CWI or HWI. On average, the total amount of time in the water is 6-15 minutes with average rotations lasting 1-5 minutes, rotating 3-7 times (Versey et al., 2013). Contrast therapy is more likely to enhance athletic performance recovery when completed with equal time spent in hot and cold water with short immersion duration (about 1 minute) consisting of a total of 15 minutes (Versey et al., 2013). According to Hamlin (2007), contrast therapy was an effective way to reduce lactic acid accumulation and general recovery but had no effect on performance when compared to active recovery. Ingram et al. (2009) studied males in team sports following a simulated game and immersed the athletes in both hot and cold water for three sets of 2 minutes alternating between HWI and CWI. The authors concluded that contrast therapy was an effective modality for reducing DOMS, but not creatine kinase levels, in these athletes. In contrast, Elias et al. (2013) studied professional Australian football athletes and had them alternate between CWI and HWI for 7 sets of 1 minute each. The authors concluded that with the 60 athletes studied, they did not observe significant reduction of DOMS following contrast therapy. These differing findings can be attributed to differing protocols, differing temperature, and the amount of exercise completed pre-treatment.

In a comparison of CWI, HWI, and contrast therapy following a damage-inducing leg press protocol, Vaile et al. (2008) concluded that only CWI and contrast therapy were effective modalities in reducing the effects of DOMS while also increasing dynamic power and reducing edema in 38 strength-trained males. However, HWI was not an effective modality for recovering from strength training except isometric force production. Cold water immersion was completed in 15 degrees Celsius water for 14 minutes with a whole-body immersion, HWI used 38-degree water for 14 minutes, and contrast therapy was completed for seven cycles alternating 1 minute in each HWI and CWI. Each of these protocols was completed on one of three groups 1 time a day post-exercise for 3 days following the exercise bout.

While research has been conducted to determine the influence of different hydrotherapy techniques on recovery in a variety of settings, there is a paucity of information available regarding the effects on recovery in baseball players or on baseball-specific metrics. Examples of relevant scenarios and metrics would include observing the effect of hydrotherapy as a recovery tool with position players and pitchers throwing multiple outings in a week. Although hydrotherapy has lots of uses, electrical stimulation is widely used for a numerous number of reasons for recovery with various brand names and great benefits of perceived effectiveness.

Electrical Stimulation (NMES)

Electrical stimulation, also known as neuromuscular electrical stimulation (NMES), is a diverse recovery modality purported to enhance performance and recovery. Neuromuscular electrical stimulation is categorized as a superficial electrical stimulation delivered by electrodes, the electrodes are typically placed over the muscular motor, trigger points, or on large nerves (Babault, 2011; Lattier et al., 2004; Martin et al., 2004). The main use of NMES for recovery is to increase the blood flow in the muscle to accelerate the removal of the muscle metabolites and creatine kinase (Neric et al., 2009) The other benefit and use of NMES is for pain reduction (Butterfield, 1997; DeSantana et al., 2009). There are multiple protocols and parameters that can be used depending on the specific type of recovery that is sought after, with each parameter having a different outcome (Malone, 2014). These modifiable parameters include wavelength, frequency, and target body part. With the focus of this literature review being on recovery, other protocols will not be discussed in detail.

Malone et al. (2014) conducted a systematic review of 13 different studies to determine the effect of NMES on recovery. The frequency fluctuated from 1-8 Hz with an average of 4.7 to induce recovery via muscle contractions at a low frequency (Babault et al., 2011; Baker et al., 1988; Doucet et al., 2012; Kroon et al., 2005). Pulse duration ranged from 125-500 microseconds with an average being 320 microseconds, which is how long a NMES pulse takes to travel from electrode to electrode (Douce et al., 2012; McLoda & Carmack, 2000). The electrodes will induce the intensity of the stimulation. If the intensity is too high it can cause a depolarizing effect on the muscle, whereas lower intensities can cause a decrease in fatigue; however, there is no optimal intensity researched (Mesin et al., 2010). Once the frequency and intensity are noted, a gradation of stimulation called ramp will be initiated until the desired frequency is obtained. A typical ramp is 1-3 seconds but can be longer depending on the intended intensity and amount of contraction (Bijak et al., 2005; Doucet et al., 2012).

There is little evidence on the efficacy of NMES for baseball players. In two separate studies comparing NMES, active recovery, and passive recovery between innings of pitching, NMES yielded the lowest post-recovery blood lactate concentration compared to active and passive recovery (Warren et al., 2011; Warren et al., 2015). Further, both studies demonstrated that perceived recovery/exertion was similarly enhanced by NEMS and passive recovery. The findings of these studies indicate a distinct benefit of NMES in that it can facilitate similar increases in blood flow to the muscle as active recovery without the cardiovascular strain, yielding lower perceived exertion and/or higher perceived recovery status (Warren et al., 2011; Warren et al., 2015). Electrical stimulation has been widely used for many years for recovery, however, a newer modality called blood flow restriction has begun gaining traction and beginning to break its way into recovery purposes.

Blood Flow Restriction (BFR)

Blood flow restriction (BFR), also known as Kaatsu training, is classified as an expanding recovery and rehabilitation device to reduce arterial inflow and occlude venous outflow (Cognetti, 2022). The main purpose of this technique is to stimulate adaptations at lower, less damaging intensities and reduce atrophy following an operation or fatiguing exercise (Lambert, 2023). Blood flow restriction works on the body by adapting to the hypoxic stimulus created by the tourniquet to create a greater accumulation of metabolites as an aerobic response in the muscles. These metabolites create a greater inflammatory response and increase of swelling in the muscle and recruits muscle fibers to increase activation to create greater hypertrophy and bring an increase of blood flow to the area (Saraf et al., 2022).

Blood flow restriction therapy utilizes a specialized cuff applied around the proximal thigh or humerus for the purpose of partially occluding blood flow, typically compressing to 40% to 80% arterial limb occlusion pressure (LOP; Abe et al., 2006; Lambert, 2023; Lambert, et al., 2015; Park et al., 2010). The cuffs are available in a variety of sizes, including 5, 8, 12, 13.5, and 18 cm (Weatherhol et al., 2019). The purpose of this array of sizes is to account for different body parts, as well as bigger cuffs being necessary for larger individuals on either the upper or lower extremity to get the correct amount of occlusion. A common cuff that is used is an automated unit, which calculates the occlusion percentage and allows for scheduling breaks, whereas handheld cuffs need to be monitored closely and are not as accurate. Delfi medical is a common brand that is automated and tests the blood pressure to get the correct occlusion percentage. This company and cuff are reliable and used widely in sports (Lambert et al., 2023). Suji is another common BFR brand that produces a different kind of cuff, which are moderated via phone and are less automated than that of the Delfi unit. The different brands and cuffs all complete the same end task.

Blood flow restriction can be completed in three ways: (a) passively, paired with electronic stimulation; (b) during aerobic exercise; (c) during low-intensity resistance training (Cognetti, 2022; Patterson et al., 2019; Pearson, 2015). In recent guidelines for BRF implementation, Patterson et al. (2019) recommend 3-5 cycles of 5 minutes passive BFR at 70-100% arterial occlusion pressure followed by a 3-minute break one to two times per day. When being incorporated with aerobic exercise, the recommendation is 5-20 minutes of exercise at less than 50% VO_2 max or heart rate reserve at 40-80% arterial occlusion pressure with frequency depending on the duration of implementation (two to three times per week for programs longer than three weeks; one to two times per day for programs of only one to three weeks; Patterson et al., 2019). Finally, incorporation with resistance training is recommended with 75 total repetitions (one set of 30 followed by three sets of 15 or sets to failure) at 20-40% 1 repetition maxiumum (1RM) with an occlusion level of 40-80% arterial occlusion pressure and 30-60 seconds of rest between sets (Patterson et al., 2019).

The American College of Sports Medicine (ACSM) indicates strength improvements will follow consistent training at 75-80% of 1RM (ACSM, 2009; Schoenfeld et al., 2019). In contrast, resistance training with BFR can yield significant muscular strength gain and an increase in muscular hypertrophy with exercises at intensities as low as 25% 1RM (Cognetti, 2022; Lambert, 2023; Manini, 2009; Takarda, 2000). The changes in the muscles observed with BFR occur due to accumulation of metabolites, creation of a hypoxic environment, and an increase in muscular protein synthesis stemming from a decreasing muscular protein breakdown (Jesse et al., 2018; Takarda et al., 2000). The low oxygen environment that is created by the restriction helps to stimulate angiogenesis that is like the environment seen in athletes that complete traditional resistance training programs (Rossi et al., 2018; Schoenfield, 2010). Additionally, metabolic stress is increased during low-intensity resistance training with BFR compared to without BFR, which is attributed to an increased recruitment of fast twitch muscle fibers (Suga et al., 2009). These fast-twitch fibers promote the release of lactate, which plays an important role in releasing chemicals and hormones, yielding the release of growth hormone (GH). Growth hormone is beneficial for tissue healing and recovery by promoting collagen synthesis, specifically in muscles, tendons, ligaments, and bone (Barraclough, 2020; Segal et al., 2015; Wilson et al., 2013). In accord, Hughes et al. (2017) reported in their meta-analysis that low-intensity BFR had a moderate effect on muscular strength, but a smaller effect than high-intensity resistance training. Additionally, while Hughes et al. (2017) lacked enough studies to calculate an effect size for hypertrophy in their meta-analysis, several studies indicate increases in muscle volume/cross-sectional area (Abe et al., 2005; Loenneke et al., 2012; Takarada et al., 2005; Takarada et al., 2000). It is also notable that there is evidence the BFR in combination with walking or cycling exercise can also yield improvements in strength and hypertrophy (Abe et al., 2006; Conceição et al., 2019).

Although BFR is most used as an intervention to increase strength while putting less strain on the body tissues, it can also be used as a recovery tool to increase blood flow and decrease fatigue following an outing and may also assist in the mitigation of strength loss. Blood flow restriction for recovery will only load irritated tendons at 10-

20% 1RM of force while perceiving the effect of doing 60-80% 1RM (Cognetti et al., 2022; Lixandrao, 2015; Patterson et al., 2019). These low forces will allow for minimal muscular/tissue damage, while increasing strength, endurance, and lean mass (Hedt, 2022; Lambert, et al., 2021). Mitigating strength loss and increasing blood flow will come from low load resistance training of BFR (Hughes et al., 2017). These results showthat low-intensity exercise combined with BFR can effectively yield improvements in strength and hypertrophy while also maintaining ROM and increasing the perception of recovery.

Blood flow restriction is beneficial for baseball players and overhead athletes because it allows them to maintain muscle strength and ROM without compromising tissue strength and health (Hedt et al., 2022; Lambert et al., 2021). According to Lambert (2021), BFR will be most beneficial for recovery with baseball players as a preventative measure to maintain strength, endurance, and lean muscle mass while reducing the fatigue in muscles post-exercise or pitching outing. Of all position players on a baseball team, pitchers are among those that particularly benefit from BFR because of the constant stress of their arms that occurs most often during the late cocking phase of the pitching mechanic (Safram, 2005; Triplet, 2023). Lambert et al. (2023) found that an 8-week program combining 50% occlusion BFR with exercise allowed pitchers to have a greater workload during their outing post-treatment. The exercises completed, with resistance of 20% isometric max applied, were elbow flexion, shoulder external rotation, shoulder horizontal abduction, shoulder abduction, and forward trunk tilt. The authors concluded that the athletes gained a larger amount of lean mass, increased strength, increased and maintained ROM, and finally a greater workload in scaption exercises. These results were compared to a non-BFR group who experienced a decrease in ROM. Blood flow restriction allows baseball pitchers to do recovery exercises at a low load to maintain and increase strength and endurance while allowing for less fatigue after treatment.

Manual Therapy

Manual therapy is classified as a passive movement and manipulation of tissue to decrease pain, tightness, and inflammation by directly targeting specific anatomical structures (Bishop et al., 2015). Manual therapy can include different forms of massage (myofascial release, trigger point, active release, and strain counter-strain), scraping, foam rolling, and other soft tissue work. These manual therapies create biomechanical and neurophysiological effects on the body. The biomechanical effects created include increased movement in targeted tissues, structural changes in targeted tissues, decreased muscular tightness, and increased ROM. Neurophysiological effects that can occur include a reduction in inflammation, an increase in blood flow, decreased spinal excitability, decreased pain sensitivity and perception, cortical modifications, and an excitation of the sympathetic nervous system (Bishop et al., 2015).

Manual therapy is an effective recovery modality because it can be completed by oneself with everyday items or can be completed by another person. There are many outcomes of manual therapy. For sports, the two main outcomes are to reduce fatigue (soreness) and DOMS (Davis et al., 2020). According to a study completed by Nunes et al. (2016) who looked at athletes following a triathlon found that manual therapy caused a decrease in pain and fatigue following the recovery treatment. Manual therapy has been shown to yield a significant decrease in muscle fatigue and fatigue ratings when compared to control and a pneumatic compression device (Hoffman et al., 2016;

Mancinelli et al., 2006; Ogai et al., 2008). In athletes that suffer from DOMS, manual therapy assists in reducing the fatigue and soreness following exercise at the 24, 48, and 72 hour marks (Hoffman et al., 2016). Similarly, Delextrat et al. (2013) found that following a high intensity basketball game a 30-minute massage created a reduction of DOMS and muscular fatigue and soreness, especially in female basketball players.

Manual therapy is commonly used in sports, however, there is little research that shows its effectiveness for baseball players and if it encourages better recovery. A study completed by Bailey et al. (2017) looked at the effectiveness of manual therapy combined with a stretching routine and its effect for increasing ROM after deficits have occurred. According to Bailey et al. (2017), using recovery to return ROM to resting state is particularly important for baseball pitchers. Thus, manual therapy elicits various recovery benefits, with previous investigations supporting its use to aid in recovering ROM for pitchers. Although there are many different types of manual therapy, there is an overwhelming majority opinion that it is an effective modality that creates proper recovery for athletes. Athletes being able to recovery properly with assist with its use and perception.

Athlete Use and Perceptions of Recovery Modalities

Although the use and perceptions of recovery can be influenced by coaches, healthcare professionals (athletic trainers), and other athletes, ultimately athletes will decide the method that assists their performance the greatest (Murray et al., 2018; Wyk & Lambert, 2009). There is only one study that provides findings from a sample with NCAA Division I athletes. Murray et al. (2018) surveyed 152 NCAA Division I athletes from (men's basketball, football, and women's soccer. The participants perceived CWI, sleep, and nutrition as the most effective recovery modalities based on their prior experience, expertise, and results they have achieved using those recovery methods. The authors noted a discrepancy between athlete perception and use of recovery modalities. Cold water immersion had the most alignment, with 84% perceiving it as effective and 65% using this as a recovery modality. In contrast, while 88% of athletes perceived sleep as effective, only 24% used this as a recovery modality. The largest discrepancies were active recovery and compression where 65.3% and 54% of the athletes believed them to be beneficial, respectively, while only 2% used either recovery method. In another study about recovery modality implementation, 43% of male athletes (rugby, basketball, soccer, and netball) did not use any post-exercise recovery and cited laziness and time constraints as the main reasons (Crowther et al., 2017).

In addition to the mismatch between perceived effectiveness and use, the literature supports variation in the perceived effectiveness and/or use of various recovery modalities based on competition level, sport, and sex (Crowther et al., 2017; Venter, 2014). For example, Crowther et al. (2017) surveyed 331 male Australian athletes and identified that more international and national level athletes used massage for recovery than state, regional, and local levels, which was attributed to access. However, competition level did not influence perceived effectiveness or use of stretching (rated among the most effective and most prevalently used) or active land-based recovery (rated among the least effective and least prevalently used). In regard to sport- and sex-specific variations, Venter (2014) assessed athlete ratings of importance of recovery modalities. The sample included 890 athletes (57% male) that participated in the highest level of competitions and tournaments in their sport, which included rugby, soccer, netball, and field hockey (Venter, 2014). Males and females rated sleep, fluid replacement, and socializing with friends as equally important recovery modalities. However, males reported ice baths, supplements, massage as more important than females. In contrast, females ranked prayer, music, and discussions with teammates and coaches as more important components of recovery than males (Venter, 2014).

Regarding sport-specific ratings of recovery modality importance, Venter (2014) found that sleep and fluid replacement were rated as equally important among hockey, netball, rugby, and soccer players. However, it is notable that hockey was the only sport where players did not rate prayer among the top three recovery modalities. Additionally, an active cool-down was only among the most important modalities for netball and soccer players and ice baths were only considered a top modality for hockey and rugby players (Venter, 2014). Further, only rugby athletes rated supplements as the most important modality and only hockey players rated snacks after a match as important. Finally, only soccer players rated a massage and progressive muscle relaxation as important (Venter, 2014). The authors noted that the source of athlete perceptions and use of different modalities remains unclear, as it could be a result of advice from coaches and training staff, availability, and/or their personal knowledge and perceptions about each modality. As such, it is important to further our understanding of diverse athlete population perceptions and use of various recovery modalities. In the only study of athlete perceptions of recovery modalities, Williams (2017) stated that intermittent compression, scraping, manual massage, and electrical stimulation were the most popular and perceived as the most effective modalities by NCAA Division I baseball players. Further research is needed to establish the perceived efficacy of other recovery modalities with this population, as well as understanding the prevalence of use and access to each of the modalities being ranked.

CHAPTER III

METHODOLOGY

Participants

The sample for this study included 54 Division I baseball athletes from various institutions. Participants were recruited by contacting the athletic trainer for the collegiate baseball team and asking them to distribute the survey to their athletes. All participants were between 18 and 24 years old and were required to be on the active roster for a Division I baseball team. Injured athletes were permitted to participate, while red shirts were excluded from this study. The local Institutional Review Board approved the study prior to data collection (see Appendix A). All participants were volunteers and provided electronic informed consent prior to beginning the survey.

Instrumentation

The survey was conducted electronically and managed using Qualtrics Electronic Software. The questionnaire included 27 questions, with an estimated completion time of 5 to 15 minutes. The survey was divided into two parts: demographics and information regarding use, access, and perceived effectiveness of recovery modalities. In the demographics section, participants provided confirmation of being on the active roster of a Division I baseball team along with their age, year in collegiate baseball career, position(s) played, injury history, and access to/use of an athletic trainer. In the second section, participants were asked to provide information about perceived effectiveness and use of the following recovery modalities: cupping, hydrotherapy, intermittent pneumatic compression, neuromuscular electrical stimulation, and blood flow restriction. For each modality used, follow-up questions about prevalence, timing, and reasons for use were included. For each modality not used, a follow-up question regarding the reasoning was included. See Appendix B.

Procedures

Participants were recruited through various schools' athletic trainers. The athletic trainers were emailed personally and were then requested to distribute the survey to their division 1 baseball players. The baseball athletes were given a 3-week window to complete the online questionnaire. The athletic trainers were sent email reminders to forward to their players 7 and 14 days after the initial email was received.

Statistical Analysis

Descriptive statistics were performed to determine the use and perceived effectiveness of each recovery modality compared against each other. The data collected from all surveys were analyzed using Microsoft Excel (Version 2402; Microsoft Corp., Redmond, WA, U.S.A.). Statistical significance was set at a p value of $< .05$.

CHAPTER IV

RESULTS

There was a total of 54 Division I baseball players who completed the survey (age: 20.5 ± 1.6 years). Of those athletes, 13 were in their first year (24%), 10 in their second year (19%), 15 in their third year (28%), 7 in their 4th year (13%), 8 in their fifth year (15%), and 1 in their sixth year (2%). A total of 15 participants reported playing two or more positions. The frequencies for each position included 5 catchers, 4 first baseman, 8 second baseman, 5 third baseman, 8 shortstops, 4 right fielders, 6 center fielders, 7 left fielders, and 26 pitchers. Of the 26 pitchers, 5 were starters (19%), 18 were relievers (69%), and 3 were closers (12%). All participants in the sample reported having direct access to an athletic trainer. Of those, 40 (74%) reported frequently seeing their athletic trainer for recovery purposes. It is notable that 43 of the survey respondents (80%) said they are not currently injured or rehabilitating from an injury.

The results for perceived effectiveness of the studied recovery modalities are displayed in Figure 1. In response to being asked to provide which recovery modality they perceived as most effective, manual therapy was the most frequent response (33%), followed by electrical stimulation (19%). The third most frequent response was tied between contrast therapy (16%) and cupping (16%). When asked about which recovery modalities they have used during their collegiate career, 46 (85%) have used cupping, 43 (80%) have used electrical stimulation, 22 (41%) have used blood flow restriction, 29 (54%) have used contrast water therapy, 23 (43%) have used HWI, 29 (54%) have used CWI, 33 (61%) have used IPC, and 50 (93%) have used manual therapy. Using data from those who reported using a given modality, the frequency of use and perceptions of most effective timing are in Table 1 and reasons for use are located in Table 2.

For instances where a modality was not used, Table 3 displays reported reasons for not using each modality. The common responses for the "other" answers included that the athlete did not believe they were in need of recovery, they did not think the modality met their recovery needs, or that they had not tried the modality before.

Figure 1

Perceived Effectiveness of Recovery Modalities

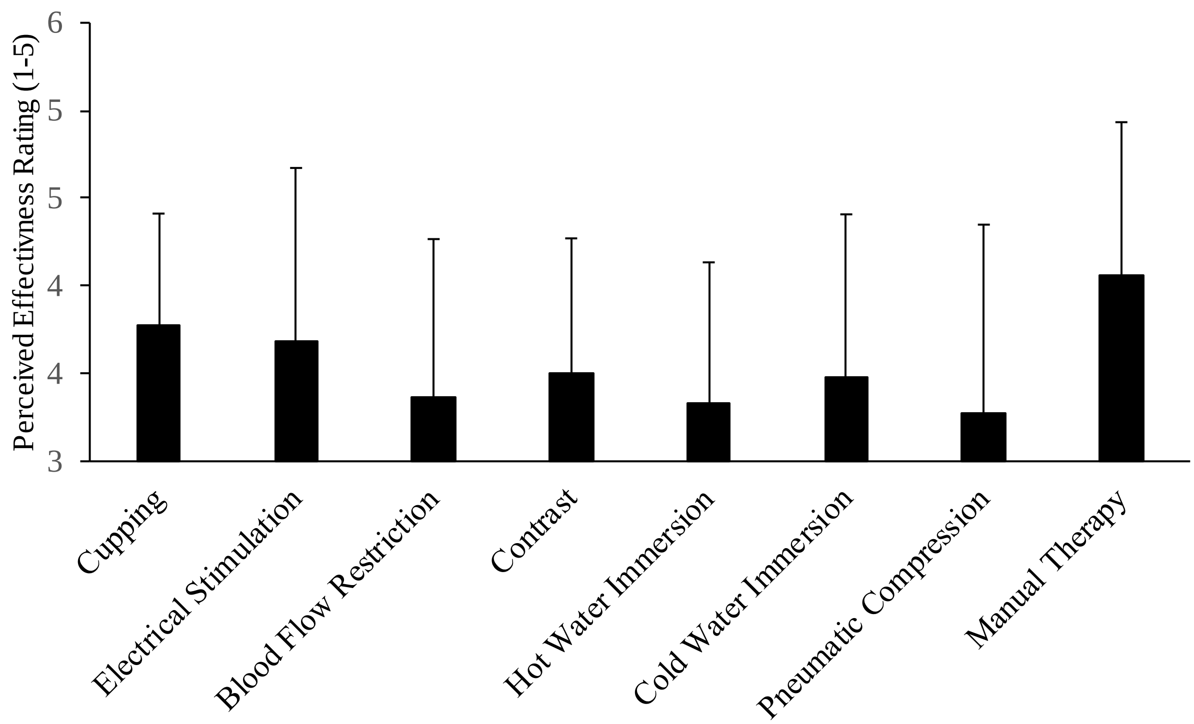

Table 1

Frequency of Use and Perceived Effective Timing for Participants Who Reported Using Each Recovery Modality

	Recovery Modality (*n*[%])							
	Cupping (*n* = 46)	E-Stim (*n* =41)	BFR (*n* =22)	Contrast (*n* =29)	HWI (*n* =22)	CWI (*n* =27)	Pneumatic Device (*n* =30)	Manual Therapy (*n* =50)
Frequency of Use	*n* = 45	*n* = 41	*n* = 18	*n* = 27	*n* = 22	*n* = 27	*n* = 30	*n* = 50
Daily	0 [0]	4 [10]	3 [17]	0 [0]	0 [0]	1 [4]	2 [7]	6 [12]
2-3 times per week	3 [7]	13 [32]	1 [6]	6 [23]	5 [23]	3 [11]	2 [7]	22 [44]
4-6 times per week	0 [0]	5 [12]	1 [6]	0 [0]	1 [5]	1 [4]	1 [3]	5 [10]
Once per week	22 [48]	7 [17]	5 [28]	5 [19]	5 [23]	9 [33]	8 [27]	8 [16]
Once per month	20 [44]	12 [29]	8 [44]	16 [59]	11 [50]	13 [48]	17 [57]	9 [18]
Most Effective Timing of Use	*n* = 44	*n* = 40	*n* = 17	*n* = 27	*n* = 22	*n* = 27	*n* = 30	*n* = 50
Less than 2 hours after activity	25 [57]	20 [50]	6 [35]	14 [52]	8 [36]	11 [41]	9 [30]	19 [38]
2 to 5 hours after activity	15 [34]	3 [8]	0 [0]	4 [15]	4 [18]	6 [22]	2 [7]	3 [6]
1 day after activity	3 [7]	16 [40]	8 [47]	6 [22]	9 [41]	8 [30]	16 [53]	27 [54]
2 days after activity	1 [2]	1 [3]	3 [18]	3 [11]	1 [5]	2 [7]	3 [10]	1 [2]

Note. Sample sizes within a given modality may vary per variable due to missing responses. E-Stim = electrical stimulation; BFR = blood flow restriction; Contrast = contrast water therapy; HWI = hot water immersion; CWI = cold water immersion.

Table 2

Reasons for Using of Each Recovery Modality

	Recovery Modality (*n*[%])							
	Cupping (*n* = 46)	E-Stim (*n* =41)	BFR (*n* =22)	Contrast (*n* =29)	HWI (*n* =22)	CWI (*n* =27)	Pneumatic Device (*n* =30)	Manual Therapy (*n* =50)
Reason(s) for Use								
Athletic trainer believes it is effective	29 [63]	29 [67]	11 [50]	13 [45]	11 [50]	13 [48]	13 [43]	32 [64]
I believe it is effective and advocate for using it.	36 [78]	29 [67]	12 [55]	22 [76]	18 [82]	7 [26]	20 [67]	43 [86]
Coaches think it is effective.	0 [0]	0 [0]	0 [0]	0 [0]	1 [5]	1 [4]	2 [7]	10 [20]
A teammate told me it is effective.	17 [37]	5 [12]	6 [27]	9 [31]	2 [9]	1 [4]	6 [20]	12 [24]
It is convenient.	20 [43]	23 [53]	3 [14]	5 [17]	8 [36]	1 [4]	14 [47]	25 [50]
It is time efficient.	15 [33]	9 [21]	3 [14]	3 [10]	4 [18]	1 [4]	9 [30]	18 [36]
Other	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]

Note. Participants could select more than one response. E-Stim = electrical stimulation; BFR = blood flow restriction; Contrast = contrast water therapy; HWI = hot water immersion; CWI = cold water immersion.

Table 3

Reasons for Not Using Specific Recovery Modalities

	Recovery Modality (*n*[%])							
	Cupping (*n* = 8)	E-Stim (*n* =11)	BFR (*n* =32)	Contrast (*n* =25)	HWI (*n* =31)	CWI (*n* =25)	Pneumatic Device (*n* =21)	Manual Therapy (*n* =4)
Reason(s) for Not Using								
Do not have access to this modality.	0 [0]	1 [9]	4 [13]	5 [20]	3 [10]	4 [16]	3 [14]	0 [0]
Coach does not think it is effective.	0 [0]	0 [0]	0 [0]	0 [0]	1 [3]	0 [0]	0 [0]	0 [0]
Athletic trainer does not think it is effective.	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]
I do not think it is effective and avoid using it for recovery.	1 [13]	1 [9]	5 [16]	2 [8]	5 [16]	2 [8]	6 [29]	0 [0]
It takes too much time.	0 [0]	0 [0]	1 [3]	1 [4]	0 [0]	1 [4]	2 [10]	0 [0]
It is inconvenient	0 [0]	2 [18]	1 [3]	5 [20]	14 [45]	5 [20]	1 [5]	0 [0]
It is uncomfortable/ unenjoyable.	2 [25]	1 [9]	8 [25]	5 [20]	0 [0]	9 [36]	7 [33]	1 [33]
Teammate(s) say it is not effective.	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]	0 [0]
Other	4 [50]	5 [45]	14 [44]	6 [24]	6 [19]	5 [20]	4 [19]	2 [67]

Note. Participants could select more than one response. E-Stim = electrical stimulation; BFR = blood flow restriction; Contrast = contrast water therapy; HWI = hot water immersion; CWI = cold water immersion.

CHAPTER V

DISCUSSION

The aim of this study was to assess the perceived efficacy, prevalence of use, and reasons for using or not using recovery modalities among Division I NCAA baseball players. The findings indicated manual therapy was perceived as the most effective recovery modality (see Figure 1). The ratings of perceived efficacy and prevalence of use were highest for manual therapy, cupping, and electrical stimulation (see Figure 1 and Table 1). Among those who used these modalities, manual therapy was the most frequently used, cupping was the least frequently used, and electrical stimulation had a more dispersed range of reported frequency (see Table 1). Generally, the top responses for timing of use for each recovery modality were within 2 hours of activity or 1 day after activity (see Table 1). Among the most common responses for using a recovery modality were the athlete's perception of its efficacy, the athletic trainer's perception of efficacy, and convenience (see Table 2). In contrast, the most reported reasons for not using a modality included discomfort or inconvenience (see Table 3).

Among the recovery modalities in the current study, the top three for perceived efficacy and prevalence of use were manual therapy, cupping, and electrical stimulation, in that order (see Figure 1 and Table 1). In listing all modalities in order of perceived effectiveness and prevalence of use for the current study, the lists align almost perfectly. The only exception is that pneumatic devices were perceived to be the least effective by the athletes yet were the fourth most common modality used. The reasons for using or not using pneumatic devices seem to be consistent with those of other recovery modalities. The perceived effectiveness data were likely a result of a higher number of participants ($n = 5$) who indicated perceived effectiveness was a "1" or "not effective at all" for pneumatic devices. The maximum frequency of responses of "1" for perceived effectiveness of all other modalities was 2.

The match between perceived effectiveness and use of recovery modalities differs from that identified by Murray et al. (2018), who found that in a sample of 152 Division I basketball, American football, and soccer players, athletes perceived sleep, CWI, and nutrition as the most effective recovery modalities. However, CWI, stretching, and foam rolling were among the most frequently used recovery modalities. In contemplating why CWI was among the top three for perceived effectiveness and use by Murray et al. (2018) but not in the current study, there are two important considerations. The first is that the list of modalities differed, where Murray et al. (2018) had separate categories for manual therapy (foam rolling and compressive massage) and did not include HWI, BFR, or pneumatic devices. Additionally, there is a chance that the difference in sport demands may lead to different preferences and use of recovery modalities, where those in more contact heavy sports (such as basketball, American football, and soccer) may perceive CWI as more beneficial and use it as a recovery tool more frequently.

Although the use and perceived effectiveness of CWI for the current participants was moderate, there is potential that icing may be a more frequently utilized modality with higher perceptions of effectiveness. For example, Williams (2017) found that 7 out of 10 pitchers reported icing after pitching as helping a lot or a great deal in the recovery of their pitching arm. Perhaps icing is a more commonly utilized recovery modality than CWI in this population. Additionally, the practice of icing may disproportionately be utilized by pitchers, as this position notoriously deals with management and prevention of overuse injuries. Unfortunately, this modality was not included in the survey for the current study and further research is warranted on the topic. Additionally, although icing has been a controversial topic in the realm of athletic training recently, if athletes perceive it as an effective modality, more research should be conducted to further understand its efficacy.

Although the match between perceived effectiveness and prevalence of use varied between the current study and that of Murray et al. (2018), Williams (2017) also identified consistency in the most frequently utilized modalities and the perceived effectiveness of each. The modalities with the highest effectiveness ratings and most prevalent use among Division I baseball pitchers were stretching, rolling, and band work. Although both the current study and Williams (2017) identified a match between perceived effectiveness and use of each modality, there are notable differences in the top modalities, which is likely partially attributable to the modalities included in each survey. The only repeated modality in both studies was electrical stimulation, which was third for perceived effectiveness and prevalence of use in the current study and among the least frequently utilized and lower perceived effectiveness among the pitchers assessed by Williams (2017). Additionally, there was a wide variety of manual therapies included separately in the list of modalities included by Williams (2017). There was also a differentiation between perceived effectiveness of each recovery modality before and after pitching in the study by Williams (2017), which was not included in either the current study or that conducted by Murray et al. (2018). Researchers are currently limited in their capacity to draw evidence-informed conclusions about recovery modality use and perceived effectiveness due to variation in the composition of the sample pools, the recovery modalities included in each study, and differences in collecting information about perceived effectiveness and timing of use.

It is also important to consider that both the current study and that conducted by Williams (2017) focused on recovery modalities directly applied by athletic trainers rather than including modalities that are considered more habitual lifestyle choices, such as sleep and nutrition. This may be an explanation for the differential findings for matches in perceived efficacy and use. For example, Murray et al. (2018) observed that CWI had a good match between perceived efficacy and use, while the more habitual recovery modalities of sleep and nutrition were perceived to be effective but were not used by the athletes. This suggests that athletic trainers may need to provide intentional support and resources to help athletes take advantage of recovery strategies that rely on daily commitment and diligence. Further research is warranted to gather data regarding the gap between perceived effectiveness and use for certain recovery strategies among athletes, including sleep and nutrition. This may be particularly relevant for student athletes, who have a unique set of demands and constraints.

In alignment with the idea that the most convenient recovery modalities may have better agreement between perceived efficacy and use, participants in the current study reported inconvenience or uncomfortable/unenjoyable as the top reasons for not using a given modality. Considering the potential discomfort and inconvenience of making consistent and effective lifestyle choices regarding sleep and nutrition, this could explain the mismatch between perceived efficacy and use by Murray et al. (2018). In the current study, there were also several responses for "other" with common themes including that the recovery modality was not relevant to their recovery needs, that they did not perceive a need for recovery treatment overall, or that they simply had not tried the modality before. Notably, the respondents reported zero influence of coach, athletic trainer, or teammates as reasons for not using a modality. Personal belief in efficacy and access to the modality had generally small but existent influence on the decision not to use a modality. Based on these results, athletic trainers can learn from the perspective of the athletes by teaching the athletes that discomfort can be beneficial for recovery and helping them to understand that not all treatment and recovery will be convenient, comfortable, or enjoyable. Every facility for athletic trainers will be different in their ability to have each modality, but athletic trainers being able to assist in making as many of the modalities more convenient and comfortable will assist in athlete recovery. These results emphasize how much influence athletic trainers have, as they are able to positively or negatively influence an athlete's recovery based on the recovery environment created.

When assessing the top reasons for use among all modalities, personal belief in efficacy, athletic trainer belief in efficacy, convenience, and time efficiency were the most reported. For most modalities, personal belief in the efficacy of each recovery modality was the top reason for use. The only modality this was not true for was CWI, where the athletic trainer's opinion of the modality was used to a higher proportion than their own personal experience. The recovery modalities that were most used because of convenience and/or time efficiency were manual therapy, electrical stimulation, cupping, and pneumatic device, which aligns closely with the top modalities for perceived efficacy and prevalence of use Finally, it is notable that the responses indicated athletes give low consideration to their teammates' opinions about the efficacy of a given modality, with even less consideration given to coaches' perceptions of effectiveness. These results show that athletic trainers can apply this into their clinics by understanding the importance of personal preference and the influence athletic trainers have on the recovery process.

According to the data in Table 1, participants most frequently reported use of recovery modalities within 2 hours of activity or the day following. Many of the athletes studied did not view recovery as being effective beyond day 1, hence the importance of getting it completed quickly after activity. One modality that did not follow this trend was cupping, where 91% of those who used the modality perceived it to be most effective if used within 5 hours of activity. Regarding frequency of use, manual therapy was reported as the most frequently implemented, with 56% of those who reported using manual therapy indicating they used it at least 2-3 times per week. This may be due to the ease of manual therapy, the different ways it can be applied, and general accessibility to this modality. Electrical stimulation had a more dispersed range of reported frequency, where about 30% noted use 2-3 times per week and another 30% reported use only once per month. In contrast, 92% of participants who used cupping reported frequency of use as once per week (48%) or month (44%; see Table 1). The trends seemed to show that the modalities that were said to be uncomfortable in Table 2 were generally completed no more than once per month, indicating that getting modalities that are comfortable may encourage more recovery sessions.

Limitations

One limitation of this study is that the survey questions did not allow the researchers to differentiate responses by team. With a sample size of 54 participants, there is a chance that those from a few teams were the primary contributors of information, potentially limiting the generalizability of the findings. Additionally, although there was a text entry box for the "other" option regarding reasons participants used or did not use each modality, not all participants provided further information. Finally, the single category of manual therapy may have limited the conclusions that can be drawn from this study, as there may be certain categories that are perceived as more effective or are more prevalently used. Separating this category into several specific modalities would benefit future studies.

Conclusions

According to the results of the study, athletes perceive each recovery modality differently and provide insight into how athletic trainers can enhance their recovery experience. Overall, manual therapy was perceived to be the most effective recovery modality among Division I NCAA baseball players with cupping and electrical stimulation coming in second and third. The respondents stated that being able to do recovery within 2 hours or the day after produces the best results. These results based on timing show that athletic trainers can try to enhance recovery by doing it shortly after activity or the next day based on the modality, balancing the evidence-informed best practices and the athlete's preferences. Based on the current study, there is evidence that Division I baseball players are influenced in using recovery modalities based on comfort and convenience. The participants in this study reported relying most on their own perceptions of effectiveness for each modality, followed by strong consideration to the opinions of the athletic trainer(s). In contrast, the perceptions of coaches and teammates seem to be less influential in making decisions about which recovery modalities to use. The athletes studied here provide insight into showing that athletic trainers have a large impact on the use of recovery and encouraging athletes to listen to what their athletic trainers have to say can assist in optimizing the recovery process. Athletic trainers can implement and learn from the results that state that athletes prefer cupping and manual therapy. They can understand their influence on what recovery is completed and how much the athletes listen to them and can understand timing as to when athletes believe the best time for recovery is for them. Further research is warranted regarding recovery practices of Division I baseball players, including a larger sample and expanding the modality list.

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Appendix A

[EXTERNAL] IRB-FY2024-138 - Initial: Initial Exempt Protocol Approval Letter

do-not-reply@cayuse.com <do-not-reply@cayuse.com>
Fri 2/9/2024 11:40 AM
To:Quinn MacDonald <qm2f@mtmail.mtsu.edu>;Samantha L. Johnson <Samantha.Johnson@mtsu.edu>

Office of Research Compliance
2269 Middle Tennessee Blvd.
Sam H. Ingram Bldg (ING) Room 010A
Box 124
Murfreesboro, TN 37132
www.mtsu.edu/irb

Date: February 9, 2024
PI: Quinn MacDonald
Department: Middle Tennessee State University, Health and Human Performance
Re: Initial - IRB-FY2024-138
Collegiate Baseball Player Use and Ratings of Received Effectiveness for Various Recovery Modalities

The Middle Tennessee State University Institutional Review Board has rendered the decision below for the above referenced study.

Decision: Exempt
Category: Category 2.(i). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met:
The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects;

Findings:
Research Notes:

Please note that even though your proposed study is deemed exempt from further IRB review, the following apply to your approved study:

1. In accordance with 45 CFR 46.110, expiration dates do not apply to research eligible for Exempt Review under the Common Rule, and continuing review is not required by the IRB.
2. Any unanticipated harm to participants or adverse events must be reported to the Office of Compliance.
3. All modifications to the approved study must be submitted for review through Cayuse IRB for approval before their implementation. Adding new researchers constitutes a modification to the protocol. Per MTSU Policy, a researcher is defined as anyone who handles the data or interacts with participants. Everyone meeting this definition for this project must have completed the required CITI training and received IRB approval prior to becoming actively involved in the project.
4. Closure of the study must be submitted within Cayuse when the study ends or when personal identifiers are removed from the data and all codes and keys are destroyed.

5. All research materials must be retained by the PI for at least three (3) years after study completion and then destroyed in a manner that maintains confidentiality and anonymity.

Sincerely,

The Middle Tennessee State University Institutional Review Board

Appendix B

The Perceived Effectiveness of Different Recovery Modalities

Start of Block: Informed Consent

Informed Consent **INFORMED CONSENT**
Study Title: Collegiate Baseball Player Use and Perceived Effectiveness for Various Recovery Modalities
Protocol Number: IRB-FY2024-138
Approval Date: 2/8/2024
Principal Investigator: Quinn MacDonald
Institution: Middle Tennessee State University
You are being asked to participate in a research project. The following information is provided to inform you about the research project and your participation in it.

1. Purpose of the study: The purpose of this study is to collect information regarding the prevalence and perceived effectiveness of various recovery modalities from Division I baseball players.
2. Description of procedures to be followed and approximate duration of the study: Complete each question accordingly. Approximately 5-10 minutes to full completion
3. Compensation for participation: No compensation

Here are your rights as a participant:
a) Your participation in this research is voluntary.
b) You may skip any item that you don't want to answer, and you may stop the research at any time. Note that if you leave an item blank, you will be warned that you missed one, just in case it was an accident. You can still click that you don't want to answer. Some items may be required in order to accurately present the study.
c) There are no risks associated with your participation besides possible discomfort with some of the questions.
d) There are no real benefits to you from participating besides possibly learning something about the research.
e) You will NOT be asked to provide any identifiable personal information.
f) All efforts, within reason, will be made to keep the personal information in your research record private, but total privacy cannot be promised. Your information may be shared with people at MTSU (such as the MTSU Institutional Review Board) or other agencies (such as the Federal Government Office for Human Research Protection) if you or someone else is in danger

or if we are required to do so by law.

Contact Information:
If you should have any questions about this research study please contact:
Principal Investigator: Quinn MacDonald
Contact Information: qm2f@mtmail.mtsu.edu
Faculty Advisor: Samantha Johnson
Contact Information: samantha.johnson@mtsu.edu

For additional information about giving consent or your rights as a participant in this study, please contact the Middle Tennessee State University (MTSU) Office of Compliance at 615-494-8918 or via email at irb_information@mtsu.edu (http://www.mtsu.edu/irb).

If you're ready to get started, please make your choice below before clicking the arrow button. Thanks again for volunteering your time to this project!

I have read the information above. I am at least 18 years old. I believe I understand the purpose, risks, and benefits of the research, and I know what I will be expected to do as a study participant.

○ I consent to participate (1)

○ I decline to participate (2)

End of Block: Informed Consent

Start of Block: Inclusion Criteria

Q2 Are you currently on the active roster of a Division I baseball team?

○ Yes (1)

○ No (2)

End of Block: Inclusion Criteria

Start of Block: Demographics

Q3 What is your age?

____

Q4 What year are you in your collegiate playing career?

- ◯ 1st (1)
- ◯ 2nd (2)
- ◯ 3rd (3)
- ◯ 4th (4)
- ◯ 5th (5)
- ◯ 6th (6)

Q5 What position(s) do you play? [Please select all that apply.]

▢ Ist base (1)

▢ 2nd base (2)

▢ 3rd base (3)

▢ Short Stop (4)

▢ Right field (5)

▢ Center field (6)

▢ Left field (7)

▢ Pitcher (8)

▢ Catcher (9)

Q6 Do you have direct access to an athletic trainer?

○ Yes (1)

○ No (2)

Q7 Do you frequently use your athletic trainer for recovery purposes?

○ Yes (1)

○ No (2)

Q8 Are you currently injured or rehabilitating from an injury?

- ○ Yes (1)
- ○ No (2)

End of Block: Demographics

Start of Block: Pitchers

Q9 You indicated you are a pitcher. Please select which of the following best describes your role.

- ○ Starter (1)
- ○ Reliever (2)
- ○ Closer (3)

End of Block: Pitchers

Start of Block: Recovery Modalities

Q10 How would you rate the effectiveness of each of the listed recovery modalities?

	1 - Not effective at all (1)	2 - Slightly effective (2)	3 - Neutral (3)	4 - Moderate Effect (4)	5 - Major effect (5)
Cupping (1)	○	○	○	○	○
Electrical Stimulation (compex, firefly, e-stim) (2)	○	○	○	○	○
Blood flow restriction (3)	○	○	○	○	○
Contrast water therapy (4)	○	○	○	○	○
Hot water immersion (5)	○	○	○	○	○
Cold water immersion (6)	○	○	○	○	○
Normatech or other pneumatic compression device(s) (7)	○	○	○	○	○
Manual therapy (scraping, massage, foam roll) (8)	○	○	○	○	○

Q12 Indicate if you have used the following recovery techniques during your college career.

	Yes (1)	No (2)
Cupping (1)	○	○
Electrical stimulation (compex, firefly, marc pro) (2)	○	○
Blood flow restriction (3)	○	○
Contrast water therapy (alternating hot and cold water immersion) (4)	○	○
Hot water immersion (5)	○	○
Cold water immersion (ice bath) (6)	○	○
Normatech or other pneumatic compression device(s) (7)	○	○
Manual therapy (scraping, massage, foam roll) (8)	○	○

Q79 Are there any recovery modalities you have used during your college career that are not included in the previous list?

____

Q80 Based on your experience, which recovery modality do you think is most effective? (This can include modalities in the list provided or others you use.)

____

End of Block: Recovery Modalities

Start of Block: Does not use Manual Therapy

Q58 You indicated you have **NOT** used **manual therapy (scraping, massage, foam roll)** during your college career.

Please answer the following question.

Q59 Which of the following is/are reasons you have **NOT** used **manual therapy (scraping, massage, foam roll)?** [CHECK ALL THAT APPLY]

- ▢ Do not have access to this modality. (1)
- ▢ Coach does not think it is effective. (2)
- ▢ Athletic trainer does not think it is effective. (3)
- ▢ I do not think it is effective and avoid using it for recovery. (4)
- ▢ It takes too much time. (5)
- ▢ It is inconvenient to access/complete. (6)
- ▢ It is uncomfortable/unejoyable. (7)
- ▢ Teammate(s) say it is not effective. (8)
- ▢ Other (9) ____

End of Block: Does not use Manual Therapy

Start of Block: Uses Manual Therapy

Q56 You indicated you have used **manual therapy (scraping, massage, foam roll)** during your college career.

Please answer the following questions.

Q61 How frequently do you use **manual therapy**?

- Daily (1)
- 4-6 times a week (2)
- 2-3 times a week (3)
- Once a week (4)
- Once a month (5)

Q81 In relation to training or competition activities, when do you find **manual therapy** to be most effective?

- Less than 2 hours after activity (1)
- 2 to 5 hours after activity (2)
- 1 day after activity (3)
- 2 days after activity (4)

Q62 Which of the following is/are reasons you have used **manual therapy?** [CHECK ALL THAT APPLY]

- ☐ Athletic trainer thinks it is effective. (1)
- ☐ I believe it is effective and advocate for using it. (2)
- ☐ Coaches think it is effective. (3)
- ☐ A teammate told me it is effective. (4)
- ☐ It is convenient. (5)
- ☐ It is time efficient. (6)
- ☐ Other (7) ____

End of Block: Uses Manual Therapy

Start of Block: Uses Cupping Therapy

Q21 You indicated you have used **cupping therapy** during your college career.

Please answer the following questions.

Q15 How frequently do you use **cupping therapy**?

- ○ Daily (1)
- ○ 4-6 times a week (2)
- ○ 2-3 times a week (3)
- ○ Once a week (4)
- ○ Once a month (5)

Q16 In relation to training or competition activities, when do you find **cupping therapy** to be most effective?

- ○ Less than 2 hours after activity (1)
- ○ 2 to 5 hours after activity (2)
- ○ 1 day after activity (3)
- ○ 2 days after activity (4)

Q18 Which of the following is/are reasons you have used **cupping therapy**? [CHECK ALL THAT APPLY]

- ☐ Athletic trainer thinks it is effective. (1)
- ☐ I believe it is effective and advocate for using it. (2)
- ☐ Coaches think it is effective. (3)
- ☐ A teammate told me it is effective. (4)
- ☐ It is convenient. (5)
- ☐ It is time efficient. (6)
- ☐ Other (7) ____

End of Block: Uses Cupping Therapy

Start of Block: Does not use cupping therapy

Q20 You indicated you have **NOT** used **cupping therapy** during your college career.

Please answer the following questions.

Q19 Which of the following is/are reasons you have **NOT** used **cupping therapy?** [CHECK ALL THAT APPLY]

- ▢ Do not have access to this modality. (1)
- ▢ Coach does not think it is effective. (2)
- ▢ Athletic trainer does not think it is effective. (3)
- ▢ I do not think it is effective and avoid using it for recovery. (4)
- ▢ It takes too much time. (5)
- ▢ It is inconvenient to access/complete. (6)
- ▢ It is uncomfortable/unejoyable. (7)
- ▢ Teammate(s) say it is not effective. (8)
- ▢ Other (9) ____

End of Block: Does not use cupping therapy

Start of Block: Uses Electrical Stimulation

Q22 You indicated you have used **electrical stimulation** during your college career.

Please answer the following questions.

Q23 How frequently do you use electrical stimulatio**n**?

- Daily (1)
- 4-6 times a week (2)
- 2-3 times a week (3)
- Once a week (4)
- Once a month (5)

Q24 In relation to training or competition activities, when do you find **electrical stimulation** to be most effective?

- Less than 2 hours after activity (1)
- 2 to 5 hours after activity (2)
- 1 day after activity (3)
- 2 days after activity (4)

Q25 Which of the following is/are reasons you have used **electrical stimulation**? [CHECK ALL THAT APPLY]

- ☐ Athletic trainer thinks it is effective. (1)
- ☐ I believe it is effective and advocate for using it. (2)
- ☐ Coaches think it is effective. (3)
- ☐ A teammate told me it is effective. (4)
- ☐ It is convenient. (5)
- ☐ It is time efficient. (6)
- ☐ Other (7) ____

End of Block: Uses Electrical Stimulation

Start of Block: Does not use Electrical Stimulation

Q26 You indicated you have **NOT** used **electrical stimulation** during your college career.

Please answer the following question.

Q27 Which of the following is/are reasons you have **NOT** used **electrical stimulation?** [CHECK ALL THAT APPLY]

- ▢ Do not have access to this modality. (1)
- ▢ Coach does not think it is effective. (2)
- ▢ Athletic trainer does not think it is effective. (3)
- ▢ I do not think it is effective and avoid using it for recovery. (4)
- ▢ It takes too much time. (5)
- ▢ It is inconvenient to access/complete. (6)
- ▢ It is uncomfortable/unejoyable. (7)
- ▢ Teammate(s) say it is not effective. (8)
- ▢ Other (9) ____

End of Block: Does not use Electrical Stimulation

Start of Block: Uses BFR

Q46 You indicated you have used **blood flow restriction** during your college career.

Please answer the following questions.

Q47 How frequently do you use **blood flow restriction**?

- Daily (1)
- 4-6 times a week (2)
- 2-3 times a week (3)
- Once a week (4)
- Once a month (5)

Q48 In relation to training or competition activities, when do you find **blood flow restriction** to be most effective?

- Less than 2 hours after activity (1)
- 2 to 5 hours after activity (2)
- 1 day after activity (3)
- 2 days after activity (4)

Q49 Which of the following is/are reasons you have used **blood flow restriction**? [CHECK ALL THAT APPLY]

- ☐ Athletic trainer thinks it is effective. (1)
- ☐ I believe it is effective and advocate for using it. (2)
- ☐ Coaches think it is effective. (3)
- ☐ A teammate told me it is effective. (4)
- ☐ It is convenient. (5)
- ☐ It is time efficient. (6)
- ☐ Other (7) ____

End of Block: Uses BFR

Start of Block: Does not use BFR

Q50 You indicated you have **NOT** used **blood flow restriction** during your college career.

Please answer the following question.

Q51 Which of the following is/are reasons you have **NOT** used **blood flow restriction**? [CHECK ALL THAT APPLY]

- ▢ Do not have access to this modality. (1)
- ▢ Coach does not think it is effective. (2)
- ▢ Athletic trainer does not think it is effective. (3)
- ▢ I do not think it is effective and avoid using it for recovery. (4)
- ▢ It takes too much time. (5)
- ▢ It is inconvenient to access/complete. (6)
- ▢ It is uncomfortable/unejoyable. (7)
- ▢ Teammate(s) say it is not effective. (8)
- ▢ Other (9) ____

End of Block: Does not use BFR

Start of Block: Does not Use Contrast

Q32 You indicated you have **NOT** used **contrast therapy** during your college career.

Please answer the following question.

Q33 Which of the following is/are reasons you have **NOT** used **contrast therapy**? [CHECK ALL THAT APPLY]

- ▢ Do not have access to this modality. (1)
- ▢ Coach does not think it is effective. (2)
- ▢ Athletic trainer does not think it is effective. (3)
- ▢ I do not think it is effective and avoid using it for recovery. (4)
- ▢ It takes too much time. (5)
- ▢ It is inconvenient to access/complete. (6)
- ▢ It is uncomfortable/unejoyable. (7)
- ▢ Teammate(s) say it is not effective. (8)
- ▢ Other (9) ____

End of Block: Does not Use Contrast

Start of Block: Uses Contrast

Q28 You indicated you have used **contrast therapy** during your college career.

Please answer the following questions.

Q29 How frequently do you use **contrast therapy**?

- Daily (1)
- 4-6 times a week (2)
- 2-3 times a week (3)
- Once a week (4)
- Once a month (5)

Q30 In relation to training or competition activities, when do you find **contrast therapy** to be most effective?

- Less than 2 hours after activity (1)
- 2 to 5 hours after activity (2)
- 1 day after activity (3)
- 2 days after activity (4)

Q31 Which of the following is/are reasons you have used **contrast therapy**? [CHECK ALL THAT APPLY]

▢ Athletic trainer thinks it is effective. (1)

▢ I believe it is effective and advocate for using it. (2)

▢ Coaches think it is effective. (3)

▢ A teammate told me it is effective. (4)

▢ It is convenient. (5)

▢ It is time efficient. (6)

▢ Other (7) ____

End of Block: Uses Contrast

Start of Block: Does not use Hot water immersion

Q44 You indicated you have **NOT** used **hot water immersion** during your college career.

Please answer the following question.

Q45 Which of the following is/are reasons you have **NOT** used **hot water immersion**? [CHECK ALL THAT APPLY]

- ☐ Do not have access to this modality. (1)
- ☐ Coach does not think it is effective. (2)
- ☐ Athletic trainer does not think it is effective. (3)
- ☐ I do not think it is effective and avoid using it for recovery. (4)
- ☐ It takes too much time. (5)
- ☐ It is inconvenient to access/complete. (6)
- ☐ It is uncomfortable/unejoyable. (7)
- ☐ Teammate(s) say it is not effective. (8)
- ☐ Other (9) ____

End of Block: Does not use Hot water immersion

Start of Block: Uses Hot water immersion

Q40 You indicated you have used **hot water immersion** during your college career.

Please answer the following questions.

Q41 How frequently do you use **hot water immersion**?

- ○ Daily (1)
- ○ 4-6 times a week (2)
- ○ 2-3 times a week (3)
- ○ Once a week (4)
- ○ Once a month (5)

Q42 In relation to training or competition activities, when do you find **hot water immersion** to be most effective?

- ○ Less than 2 hours after activity (1)
- ○ 2 to 5 hours after activity (2)
- ○ 1 day after activity (3)
- ○ 2 days after activity (4)

Q43 Which of the following is/are reasons you have used **hot water immersion**? [CHECK ALL THAT APPLY]

- ☐ Athletic trainer thinks it is effective. (1)
- ☐ I believe it is effective and advocate for using it. (2)
- ☐ Coaches think it is effective. (3)
- ☐ A teammate told me it is effective. (4)
- ☐ It is convenient. (5)
- ☐ It is time efficient. (6)
- ☐ Other (7) ____

End of Block: Uses Hot water immersion

Start of Block: Does not use Cold Water Immersion

Q38 You indicated you have **NOT** used **cold water immersion** during your college career.

Please answer the following question.

Q39 Which of the following is/are reasons you have **NOT** used **cold water immersion**? [CHECK ALL THAT APPLY]

- ▢ Do not have access to this modality. (1)
- ▢ Coach does not think it is effective. (2)
- ▢ Athletic trainer does not think it is effective. (3)
- ▢ I do not think it is effective and avoid using it for recovery. (4)
- ▢ It takes too much time. (5)
- ▢ It is inconvenient to access/complete. (6)
- ▢ It is uncomfortable/unejoyable. (7)
- ▢ Teammate(s) say it is not effective. (8)
- ▢ Other (9) ____

End of Block: Does not use Cold Water Immersion

Start of Block: Uses Cold Water Immersion

Q34 You indicated you have used **cold water immersion** during your college career.

Please answer the following questions.

Q35 How frequently do you use **cold water immersion**?

- ○ Daily (1)
- ○ 4-6 times a week (2)
- ○ 2-3 times a week (3)
- ○ Once a week (4)
- ○ Once a month (5)

Q36 In relation to training or competition activities, when do you find **cold water immersion** to be most effective?

- ○ Less than 2 hours after activity (1)
- ○ 2 to 5 hours after activity (2)
- ○ 1 day after activity (3)
- ○ 2 days after activity (4)

Q37 Which of the following is/are reasons you have used **cold water immersion**? [CHECK ALL THAT APPLY]

- ☐ Athletic trainer thinks it is effective. (1)
- ☐ I believe it is effective and advocate for using it. (2)
- ☐ Coaches think it is effective. (3)
- ☐ A teammate told me it is effective. (4)
- ☐ It is convenient. (5)
- ☐ It is time efficient. (6)
- ☐ Other (7) ____

End of Block: Uses Cold Water Immersion

Start of Block: Does not use Normatech

Q56 You indicated you have **NOT** used **Normatech or another pneumatic device** during your college career.

Please answer the following question.

Q57 Which of the following is/are reasons you have **NOT** used **Normatech or another pneumatic device**? [CHECK ALL THAT APPLY]

- ▢ Do not have access to this modality. (1)
- ▢ Coach does not think it is effective. (2)
- ▢ Athletic trainer does not think it is effective. (3)
- ▢ I do not think it is effective and avoid using it for recovery. (4)
- ▢ It takes too much time. (5)
- ▢ It is inconvenient to access/complete. (6)
- ▢ It is uncomfortable/unejoyable. (7)
- ▢ Teammate(s) say it is not effective. (8)
- ▢ Other (9) ____

End of Block: Does not use Normatech

Start of Block: Uses Normatech

Q52 You indicated you have used **Normatech or another pneumatic device** during your college career.

Please answer the following questions.

Q53 How frequently do you use **Normatech or another pneumatic device**?

- ◯ Daily (1)
- ◯ 4-6 times a week (2)
- ◯ 2-3 times a week (3)
- ◯ Once a week (4)
- ◯ Once a month (5)

Q54 In relation to training or competition activities, when do you find **Normatech or another pneumatic device** to be most effective?

- ◯ Less than 2 hours after activity (1)
- ◯ 2 to 5 hours after activity (2)
- ◯ 1 day after activity (3)
- ◯ 2 days after activity (4)

Q55 Which of the following is/are reasons you have used **Normatech or another pneumatic device**? [CHECK ALL THAT APPLY]

- ☐ Athletic trainer thinks it is effective. (1)
- ☐ I believe it is effective and advocate for using it. (2)
- ☐ Coaches think it is effective. (3)
- ☐ A teammate told me it is effective. (4)
- ☐ It is convenient. (5)
- ☐ It is time efficient. (6)
- ☐ Other (7) ____

End of Block: Uses Normatech
