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Recovery practices in Division 1 collegiate athletes in North America

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Abstract

Objectives: Establish current practice and attitudes towards recovery in a group of Division-1 Collegiate athletes from North America.

Design: A 16-item questionnaire was administered via custom software via an electronic format.

Participants: 152 student athletes from a Division-1 Collegiate school across 3 sports (Basketball, American Football, Soccer).

Main Outcome Measures: The approaches and attitudes to recovery in both training and competition.

Results: Sleep, cold water immersion (CWI) and nutrition were perceived to be the most effective modalities (88, 84 and 80% of the sample believed them to have a benefit respectively). Over half the sample did not believe in using compression for recovery. With regard to actual usage, CWI was the most used recovery modality and matched by athletes believing in, and using, the approach (65%). Only 24% of student athletes believed in, and used, sleep as a recovery modality despite it being rated and perceived as the most effective.

Conclusions: Collectively, there is a discrepancy between perception and use of recovery modalities in Collegiate athletes.

Highlights

- Use of recovery modalities at the collegiate level is not fully supported by evidence
- Only a quarter of athletes both believed in, and used sleep for recovery
- The most used modality in both training and competition was cold water immersion
- Two thirds of the participants relied on ‘feel’ to know they had recovered

Key Words: Belief; Cold Water Immersion; Sleep; College

Introduction

North American Division 1 (D1) Collegiate athletes compete in unique circumstances; with a requirement to perform at a high sporting level (Singer, 2008) and show their prowess on the field to potentially further their professional career upon leaving college (e.g. NFL). In addition to peak performance for competitive fixtures on the sporting field they are typically required to do the same in academic studies to maintain their eligibility (Aquilina, 2013). Student athletes must balance the effects of training and the subsequent adaptation or recovery periods to optimize physical condition, alongside the associated mental pressures of academic studies (Romo, 2016). For instance, athletes must ensure that adequate training (intensity and type) is being performed to induce positive (e.g. muscular) adaption. Conversely, athletes must also allow adequate recovery between these sessions to both allow this supercompensation process to occur and minimize the potential for injury.

While the use of recovery practices are commonplace in diverse athletic populations, recovery remains an under-researched area relative to training and competition, with many practices currently used in applied settings not fully supported by peer-reviewed evidence

(Simjanovic, Hooper, Leveritt, Kellmann, & Rynne, 2009). This is somewhat understandable given the multi-dimensional components of recovery and that practitioners are typically early adopters of new technology and training methods with the aim of gaining a competitive advantage (Coutts, 2016). Indeed, despite numerous post-exercise recovery options currently available for athletes (Crowther, Sealey, Crowe, Edwards, & Halson, 2017), there remains no clear definition of the most ‘appropriate’ modality, protocol and timing according to the level of the athlete and their training goals (Barnett, 2006; Kellmann et al., 2018). Interestingly, there has been little investigation into the attitudes and beliefs associated with the choice and use of these practices – particularly within a collegiate setting. For instance, many coaches/practitioners implement recovery strategies without truly assessing the cost-benefit of such an approach (Murray, Turner, Sproule, & Cardinale, 2017). They may implement strategies based on personal experience rather than research evidence (Simjanovic et al., 2009).

Recent work has shown that athletes may not be aware of the intended effects of a specific recovery modality on their physical status though around two-thirds perform some type of recovery after sport

(Crowther et al., 2017). Anecdotal evidence suggests that it is typical for D1 student-athletes to follow the direction of their technical and/or strength coach, rather than display autonomous thought, around the choice of recovery practice, which may reflect the coach-athlete relationship (Murray et al., 2017). It is clear that negative subjective impressions of a recovery intervention have been shown to impact its effectiveness (Higgins, Heazlewood, & Climstein, 2011). Spanish basketball players were shown to have varying perception of recovery strategies and so individual approaches were recommended (Moreno, Ramos-Castro, Rodas, Tarragó, & Capdevila, 2015). Knowledge of athletes' perceptions, regarding recovery strategies, within a collegiate setting, would be useful in maximising athlete compliance with and belief in particular modalities and help create better education practices around recovery for optimal performance.

Integrating athletes' belief systems into their recovery, or developing education programs around a chosen method, may contribute to planning more effective interventions and aid selection strategies for implementation (Van Wilgen & Verhagen, 2012). For instance, while athletes in one sport or group may have a tendency to act homogeneously in regards to recovery practices, the reasons for this may be affected by the immediate environment and climatic conditions, which in turn affects their beliefs (Institute of Medicine & National Research Council, 2011). Given the limitations on current knowledge around the interaction of these factors, the purpose of this study was to establish current practice around and attitudes towards recovery in a group of D1 Collegiate athletes from North America.

Methods

Participants

A convenience sample of 152 athletes from a D1 college across 3 sports (Men's Basketball *n*=10, Men's Football *n*=116, Women's Soccer *n*=26) participated in this study. A total of 161 athletes were invited across the 3 team rosters (9 declined to complete the survey; response rate of 94%). There was no penalty for not completing the survey. Participants were invited to complete the study over a 2-month period (September & October 2016) with a requirement for it to be completed only once. The support staff for each team differed and so there were no common influencers on the student athletes across sports. The age range of the participants was between 18 and 24 years (20.5±1.5 years). The study had ethical approval from the

Moray House School of Education, University of Edinburgh, Ethics Committee and the rights of the participants were protected.

Experimental Protocol and Procedures

Research Instrument

Utilising an online questionnaire and the same approach that was taken previously in an adolescent population (Murray et al., 2017) the purpose of the study was to establish current practice and attitudes towards recovery in collegiate athletes. Additional questions not present in the original instrument were added within the *beliefs* section prior to data collection on the effectiveness of foam rolling and compressive massage as these are routinely used in the D1 population (Behara & Jacobson, 2017; Zwerling, 2014). The questionnaire comprised of 17 questions in four sections: *demographic information*; *current practice; beliefs;* and *evidence* (Supplementary File 1). Questions utilised six open, and eleven closed, answers. Subjects could return to prior questions until the survey was completed.

A combination of open and closed questions was used to maximize the response rate, yet enable more detail from the answers (Thomas, Nelson, & Silverman, 2011). The open ended questions enabled athletes to express opinions and elaborate on beliefs (Portney & Watkins, 2009).

Demographics

In the first three questions the participant's name, gender and experience level within their chosen sport were assessed. In terms of experience, the participants chose the appropriate option from less than 18 months to more than 10 years.

Open Questions

The first of the open-ended questions asked the participant which sport they competed in (question 4). The next concerned the participant's current practice of recovery post-training and competition (questions 5 & 6). The fourth was an optional expansion on the limited response of *experience*, *evidence* or *both* outlining why the participant undertook the specified recovery strategy (question 8). In the final evidence section, participants were asked to state how they knew they had recovered (question 17).

Closed questions

The first closed question asked participants why they currently undertook the specified recovery strategy, from a choice of *evidence, experience or both* (question 7). Subsequently they were asked to rate their opinion on a range of common recovery methods' effectiveness (questions 9 – 16). Belief of effectiveness was assessed via closed questions assessing the athlete's perceived benefit of a technique. A 5-point scale of *no effect, minor, neutral, moderate* or *major* was used to reflect the participants' beliefs. The answers were assigned a numerical value (5 = most benefit, 1 = least). If the athlete rated the effectiveness as 4 or 5 then this was coded as a *benefit* otherwise it was coded as *no benefit*. Answers coded as 3 remained *neutral*. This reduction to nominal levels (Lavrakas & Battaglia, 2008) was taken to avoid any bias from central tendency, acquiescence or social desirability.

Statistical Analyses

The absolute values of responses were calculated from the information contained in the returned questionnaires. For the open questions, the answers were subsequently coded on completion of all questionnaires by the lead author into subcategories for subsequent analysis of the frequency of occurrence. Coding accounted for all answers given across the sample groups. Closed questions were assigned a numerical value based on their response and assessed as continuous data. Analysis occurred using Minitab 17.0 (Pennsylvania, USA). Differences between groups were assessed between frequency of responses using the chi-square test (χ^2), one-way ANOVA or t-tests of the proportional data as appropriate. A multivariate analysis was made to cluster the type of recovery groups. Alpha was set at $p<0.05$.

Results

Demographics

Across the cohort 35% had more than 10 years' experience in their chosen sport. The other groups had: 3-5 years' experience (22%); 5-10 years (19%); <18 months (14%); and 18 months to 3 years (10%). This shows a significant greater than even split with more 10+ year athletes and less athletes with <18-months (35% v 14%; $p<0.001$).

Effectiveness

There was a significant difference in the level of belief across different modalities ($p<0.01$; table 1). There was a belief that sleep, and CWI immersion could benefit recovery while the participants did not believe that compression could benefit recovery (table 1).

*** Table 1 near here ***

Use

There were no significant differences between training and competition for the use of any of the recovery modalities in terms of frequency (p>0.05; table 2). Across all athletes 12 (8%) and 21 (14%) reported that they did not undertake a recovery strategy.

*** Table 2 near here ***

Belief

Almost a quarter of the participants (24%) believed in and used sleep as a recovery strategy (table 3). Around two-thirds of the sample (63%) did not use sleep as a recovery strategy, despite believing in it as an appropriate recovery strategy. Conversely, the belief and use of cold water immersion (CWI) aligned with two-thirds of the sample (65%) using and believing in CWI. Nutrition practices did not mirror beliefs as 65% didn’t list it as a recovery practice despite believing in it. Belief in, and use of, contrast therapy did match with 62% neither using nor believing in it.

*** Table 3 near here ***

Assessment of recovery

There was no difference in the number of recovery modalities used after training or competition (Training: 2.3±0.1 v Competition: 2.3±0.1). The majority of athletes relied on subjective feel to determine if they had recovered (59%), whereas 25% listed their subsequent performance as how they determined if they had recovered.

Reasons

Most athletes indicated that they chose their method of recovery based on both evidence and experience (74%); a fifth of athletes cited their own experience as the main reason with only 5% using an evidence base. Cluster analysis for post-training recovery responses showed 3 main groups in terms of their responses: a *traditional* group who favour sleep, nutrition and hydration; a *manual therapy* group who favoured active recovery, massage and rest, and a *mixed-modality* group who favoured hot, cold, contrast and the input of technologies such as neuromuscular electrical stimulation or sequential compressive massage. These groups were slightly different in post-competition strategies with one group choosing active recovery, sleep, nutrition, and hydration; a second group favouring massage, heat and further training; and a third group using all of the intervention modalities.

Discussion

This study aimed to establish current practice and attitudes towards recovery in D1 Collegiate athletes. As reported in previous research with older athlete populations (Crowther et al., 2017; Tavares, Healey, Smith, & Driller, 2017), there are a wide range of recovery modalities used by D1 collegiate athletes. The use of some of the recovery modalities is not fully supported by the current evidence base, for example CWI was used widely despite mixed support in the literature (Tipton, Collier, Massey, Corbett, & Harper, 2017). In contrast, active recovery was hardly utilised reflecting the lack of evidence that active recovery enhances recovery between training sessions (Barnett, 2006). There was no difference in the recovery approaches used post-training and post-competition.

Importantly, we have identified some clear discrepancies between the beliefs and practices of the athletes in terms of recovery, especially in relation to sleep and nutrition. This data presents several interesting challenges and opportunities for researchers and practitioners. In this cohort of student-athletes the highest rated recovery intervention by participants was sleep; however, in contrast the most used intervention was cold water immersion. Furthermore, although sleep was rated the most important, it was only the fourth most used modality by student athletes. Two-thirds of the sample believed in sleep but didn't mention it as a modality that they used to recover, with only 24% of athletes believed in, and used, sleep.

Within the literature the recommendation for young adults (18-25 yrs) is to get 7 to 9 hours of sleep per night (Hirshkowitz et al., 2015). Recent work has suggested that due to training schedules and life constraints, some athletes sleep far less than this recommendation (Sargent, Halson, & Roach, 2014) and collegiate student-athletes are possibly the most at-risk (healthy) population for sleep disruption (Carney, Edinger, Meyer, Lindman, & Istre, 2006).

Athletes have rated sleep as critical to optimal performance (Venter, 2012) and recovery (Tavares et al., 2017) and in this population that belief seemed to hold true. In stark contrast to this, however, only a quarter of athletes both believed in, and used, sleep as a recovery modality. It is possible that extraneous factors exist which may compromise athletes' ability to obtain sleep. More than 70% of college students have been reported to obtain less than 8 hours of sleep per night during the week (Lund, Reider, Whiting, & Prichard, 2010). Furthermore, the commencement of university classes (Hershner & Chervin, 2014) within the sportingseason could pose a risk to sleep quality with early morning training starts (Fullagar, Govus, Hanisch, & Murray, 2016). This threat may be accentuated at times of high stress and anxiety (for example exams or end of school year) (Mann, Bryant, Johnstone, Ivey, & Sayers, 2015). Other possibilities could include the increase in technology use and blue light providing general brain activation later in the evening (Cajochen et al., 2011). However, these theories remain speculative and further research is required to assess the mechanisms behind the discrepancy between the belief and usage of sleep in collegiate student athletes.

There may also exist a possibility in which student-athletes misinterpreted the language surrounding timing of sleep as a recovery strategy. The language used in definition of activities has been shown to be important in education of athletes (Banna, Richards, & Brown, 2016). For instance, whilst participants reported they were less likely to use sleep compared to its perceived importance, they may have been referring to purely sleep at night rather than the combination of naps (for instance in the afternoon following an early training session), or vice versa. Future analyses which depicts sleep in greater detail with regards to recovery use and perceived importance would aid such understanding. Athletes should understand their sleep needs and should be educated regarding aspects such as sleep hygiene and potential positive effects of sleep extension (Fullagar et al., 2014).

The most used modality in this population in both training and competition was CWI. This is similar to international team sport athletes in previous studies (Crowther et al., 2017; Venter, 2012). The reported reason for using CWI in other populations was to reduce swelling and inflammation (Crowther et al., 2017), although previous research studies have shown that this is not the case (Ingram, Dawson, Goodman, Wallman, & Beilby, 2009) and any positive effects of CWI are small and more applicable to single sprints rather than endurance or team sport performance (Poppendieck & Faude, 2013). Hence the choice to use CWI as an intervention may be more influenced by the perceived outcome; for example being perceived in a positive light as has been shown in track athletes (Omoniyi et al., 2017), rather than the actual physiological effect (Murray & Cardinale, 2015).

A quarter of athletes (27%) believed in, and used, foam rolling. Other questionnaire based studies did not assess this modality specifically, but soccer athletes have mentioned massage (Venter, 2012) to be important for recovery, as did a high percentage of international team sport athletes (Crowther et al., 2017). In contrast 44% of athletes believed in the modality but did not use it. Foam rolling is believed to have similar effects to massage which include relief of muscle tension, increased flexibility and range of motion (ROM) (Cheatham, Kolber, Cain, & Lee, 2015). The associated discomfort with the modality may contribute to why it was not more widely used (Behara & Jacobson, 2017). Changing the perception of this discomfort may help with the implementation. (Leknes et al., 2013)

Within an adolescent population in the UK 36-38% used foam rolling, in contrast to under 5% in Asia (Murray et al., 2017). Interestingly, there is limited evidence on the physiological benefits of foam rolling, however some studies have shown that ROM is improved by foam rolling (MacDonald et al., 2013; Macdonald, Button, Drinkwater, &

Behm, 2014). Longer application of foam rolling has been shown to positively affect both range of motion and perceived soreness in the short-term (Jay et al., 2014), although this was not in trained participants. In contrast, it has been shown that a single bout of foam rolling had no statistically significant effect on muscle contractility markers or temperature in adolescent athletes (Murray, Jones, Horobeanu, Turner, & Sproule, 2016).

Most athletes in the current sample did not use compression as a recovery method. Their belief was split evenly in terms of in favour or not. This concurs with previous research into the efficacy of compression garments used post-exercise. Compression has produced equivocal results on performance when tested on well-trained athletes (Ali, Caine, & Snow, 2007; Davies, Thompson, & Cooper, 2009). This though may be affected by belief status as it was found that 'believers' found a positive effect on performance when wearing compression compared to 'non-believers', despite no significant difference in muscle soreness or fatigue (Brophy-Williams, Driller, Kitic, Fell, & Halson, 2016). As previously mentioned, the placebo effect in sport may be present with the use of any recovery modality (Beedie & Foad, 2009) and strongly influences perception of recovery

(Halson & Martin, 2013). This placebo effect is likely as expectancy plays a major role in the success of interventions in the field of high-performance sport (McClung & Collins, 2007).

While sleep is one of the few modalities that is free of cost, the provision of recovery modalities at the D1 collegiate level means that almost all the mentioned interventions were available, so feasibility is likely less of an explanation. Within this study nutrition and hydration were not noted as high use modalities, indeed 65% of athletes believed in nutrition but did not utilise it in recovery. This may well be as athletes viewed nutrition and hydration as part of their routine, rather than a specific recovery component (for example there was no conscious choice made around nutritional intake to reflect that they were recovering or refuelling). This may have been due to the terminology employed in the survey failing to differentiate the multiple benefits for both performance and recovery. Alternatively this could simply be a lack of understanding as it has been shown previously that student athletes' knowledge around sport-nutrition is less than adequate (Andrews, Wojcik, Boyd, & Bowers, 2016).

The choice of recovery modality in team sport players may be influenced by what coaches and support staff prefer (Wyk & Lambert, 2009). For instance, it has been shown that a high degree of confidence in a coach’s capabilities predicted enhanced commitment for the athlete (Rey, Lago-Peñas, Lago-Ballesteros, & Casáis, 2012). Therefore, the athlete may take what the coach says as the truth, for example telling them that a particular modality is effective so the athlete believes in it, hence having a positive effect on the athlete’s attitude during subsequent training sessions (Rey et al., 2012). This may be a self-perpetuating phenomenon with coaches ‘doing what they have always done’. This is highlighted by the majority of coaches’ self-directed learning occurring with other coaches and colleagues and a typically negative experience from formal learning (~98%) (Stoszkowski & Collins, 2015). Thus, our finding that over two thirds of athletes believe in sleep, nutrition and active recovery but do not utilise it, could potentially impact practice of coaches and support staff at the D1 level.

Choices around recovery strategy may also be influenced by what athletes have observed at higher (professional) levels, as previous work has shown that athletes replicate the behaviours of the elite

(Crowther et al., 2017). In previous work in adolescent populations this was not the case, as Asian and UK populations only utilised cold as a recovery modality 13% and 23% of the time respectively in training, and within Asia less than 10% used it in competition (Murray et al., 2017). While speculative, this may reflect some cultural difference as Asian athletes do not see this practice at a more senior level and hence don't replicate it. Though this could also be perceptual as there is no difference in the perception of the importance of recovery between amateur and elite rugby players but there was a difference in the number of modalities used in a week (*24 v* 6) (Tavares et al., 2017).

Perceptual recovery after games has been shown to take longer than 96 hours to return to pre-competition levels within collegiate athletes (Fullagar et al., 2016). It has also been shown that individuals are able to closely predict full recovery without the need for external validation (Glaister, Pattison, Dancy, & McInnes, 2012). This raises important questions around monitoring of recovery as this process may affect the variable itself and its efficacy (for example a push to monitor sleep may affect the actual quality and quantity achieved; (Van-den-Bulck, 2015)). Within this population 59% relied on how they felt to know they had recovered, supporting further exploration of subjectivity within recovery as has shown to be effective in athlete monitoring (Saw, Main, & Gastin, 2015). Future research should establish if these self-perceptions are accurate in the educated athlete and remove the need for continual objective monitoring and intervention.

The differences between belief and practice highlight that the education of athletes across their life cycle within the collegiate setting is important. Developing a curriculum of knowledge ensures that senior athletes set the social norms and impact positively on the younger athletes. Education around these topics may not be needed whereas emphasis on other chosen modalities may provide a better return on investment of time. However, further work is required to demonstrate a similar pattern in other D1 schools to highlight potential differences between sub-cultures, sports, investment in facilities and teaching/coaching practices. Further research should focus on replicating these findings following an educational intervention for both athletes and support staff that focuses on developing knowledge around recovery practice. Effective approaches to enhance coach education and continued professional development, may increase the use of evidence-based, or at least evidence-informed, approaches through enhanced belief of coaches transferring to increased belief and use in athletes.

Limitations

Given the responses of this study were subjective in nature, further studies which investigate objective use of recovery modalities, and the subsequent effect of these modalities on either upcoming exercise sessions or cognitive performance, would strengthen future applied practice. Indeed, investigating the combination of perceived and objective effectiveness of recovery in combination would be the most robust approach and may allow a minimal clinically important difference (Atkinson, 2003) to be established for modalities for both perceptual and objective measures.

This study focused on a subset of recovery techniques while others are available and used by athletes. Indeed, future investigations could investigate other, less popular, recovery techniques such as photobiomodulation (de Oliveira et al., 2017), sensory deprivation (Morgan, Salacinski, & Stults-Kolehmainen, 2013) or blood flow restriction (Borne, Hausswirth, & Bieuzen, 2016). Taking the participants' age into further account may help assessment directly related to age and stage of development. In this study, we simply recruited within an age bracket. Future research from a large sample across differing schools and sports may benefit from insights into the differing responses – here we did not find differences in beliefs across sports, but a bigger sample size is needed to individualise sports. This approach may also lend itself to a more structured interview style of collection to avoid any potential misunderstandings around the questions posed and this may also allow exploration in more detail as who the key influencers are of practice (for example individual, captain or coach). This approach though would need to consider both potential sport and culture differences and may need a prohibitively large sample size across Colleges and levels.

Conclusion

This study describes athletes' recovery practices within a Division 1 collegiate setting and highlights the discrepancies between their beliefs and their implementation. Collectively, there is a discrepancy between perception and use of recovery modalities in Collegiate athletes. It appears that the primary variances are around the belief and use of sleep and CWI for recovery. The results of this study suggest that there is a need to educate athletes on the benefits of different facets of recovery.

As these athletes operate at the highest level within the NCAA, practitioners now have an initial source of data describing recovery practice within elite level student athletes. Strength & Conditioning staff, sports scientists and coaches who work with collegiate athletes at all levels may use this summary as a resource to inform and improve their practice. Information presented in this article may also influence the design of athlete education curriculums within NCAA institutions around recovery modalities.

References

Ali, A., Caine, M., & Snow, B. (2007). Graduated compression stockings: physiological and perceptual responses during and after exercise. *Journal of Sports Sciences*, *25*(4), 413–419. http://doi.org/10.1080/02640410600718376

Andrews, A., Wojcik, J. R., Boyd, J. M., & Bowers, C. J. (2016). Sports Nutrition Knowledge among Mid-Major Division I University Student-Athletes. *Journal of Nutrition and Metabolism*, *2016*, 1–5. http://doi.org/10.1155/2016/3172460

Aquilina, D. (2013). A Study of the Relationship Between Elite Athletes' Educational Development and Sporting Performance. *The International Journal of the History of Sport*, *30*(4), 374–392. http://doi.org/10.1080/09523367.2013.765723

Atkinson, G. (2003). Does size matter for sports performance researchers? *Journal of Sports Sciences*, *21*(2), 73–74. http://doi.org/10.1080/0264041031000071038

Banna, J., Richards, R., & Brown, L. B. (2016). College Students' Perceived Differences Between the Terms Real Meal, Meal, and Snack. *Journal of Nutrition Education and Behavior*, *49*(3), 228–235.e1. http://doi.org/10.1016/j.jneb.2016.11.001

Barnett, A. (2006). Using recovery modalities between training sessions in elite athletes: does it help? *Sports Medicine (Auckland, N.Z.)*, *36*(9), 781–96.

Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/16937953

Beedie, C. J., & Foad, A. J. (2009). The placebo effect in sports performance: a brief review. *Sports Medicine (Auckland, N.Z.)*, *39*, 313–329. http://doi.org/10.2165/00007256-200939040-00004

Behara, B., & Jacobson, B. H. (2017). Acute Effects of Deep Tissue Foam Rolling and Dynamic Stretching on Muscular Strength, Power, and Flexibility in Division I Linemen. *Journal of Strength and Conditioning Research*, *31*(4), 888–892. http://doi.org/10.1519/JSC.0000000000001051

Borne, R., Hausswirth, C., & Bieuzen, F. (2016). Relationship Between Blood Flow and Performance Recovery: A Randomized, Placebo-Controlled Study. *International Journal of Sports Physiology and Performance*, 1–27. http://doi.org/10.1123/ijspp.2015-0779

Brophy-Williams, N., Driller, M. W., Kitic, C. M., Fell, J. W., & Halson, S. (2016). Effect of Compression Socks Worn Between Repeated Maximal Running Bouts. *International Journal of Sports Physiology and Performance*, *0*(0), 1–22. http://doi.org/http://dx.doi.org/10.1123/ijspp.2016-0162

Cajochen, C., Frey, S., Anders, D., Späti, J., Bues, M., Pross, A., … Stefani, O. (2011). Evening exposure to a light-emitting diodes (LED)-backlit computer screen affects circadian physiology and cognitive performance. *Journal of Applied Physiology (Bethesda, Md. : 1985)*, *110*(5), 1432–8.

http://doi.org/10.1152/japplphysiol.00165.2011

Carney, C. E., Edinger, J. D., Meyer, B., Lindman, L., & Istre, T. (2006). Daily activities and sleep quality in college students. *Chronobiology International*, *23*(3), 623–637. http://doi.org/10.1080/07420520600650695

Cheatham, S. W., Kolber, M. J., Cain, M., & Lee, M. (2015). The effects of self-myofascial release using a foam roll or roller massager on joint range of motion, muscle recovery, and performance: *International Journal of Sports Physical Therapy*, *10*(6), 827–838.

Coutts, A. J. (2016). Working Fast and Working Slow: The Benefits of Embedding Research in High-Performance Sport. *International Journal of Sports Physiology and Performance*, *11*, 1–2. http://doi.org/10.1123/IJSPP.2015-0781

Crowther, F., Sealey, R., Crowe, M., Edwards, A., & Halson, S. (2017). Team sport athletes' perceptions and use of recovery strategies: a mixed-methods survey study. *BMC Sports Science, Medicine and Rehabilitation*, *9*(1), 6. http://doi.org/10.1186/s13102-017-0071-3

Davies, V., Thompson, K. G., & Cooper, S.-M. (2009). The effects of compression garments on recovery. *Journal of Strength and Conditioning Research / National Strength & Conditioning Association*, *23*, 1786–1794. http://doi.org/10.1519/JSC.0b013e3181b42589

de Oliveira, A. R., Vanin, A. A., Tomazoni, S. S., Miranda, E. F., Albuquerque-

Pontes, G. M., De Marchi, T., … Leal-Junior, E. C. P. (2017). Pre-Exercise Infrared Photobiomodulation Therapy (810 nm) in Skeletal Muscle Performance and Postexercise Recovery in Humans: What Is the Optimal Power Output? *Photomedicine and Laser Surgery*, *35*(11), 595–603. http://doi.org/10.1089/pho.2017.4343

Fullagar, H., Govus, A., Hanisch, J., & Murray, A. M. (2016). The Time Course of Perceptual Recovery Markers Following Match Play in Division I-A Collegiate American Footballers. *International Journal of Sports Physiology and Performance*, 1–11. http://doi.org/10.1123/ijspp.2016-0550

Fullagar, H., Skorski, S., Duffield, R., Hammes, D., Coutts, A. J., & Meyer, T. (2014). Sleep and Athletic Performance: The Effects of Sleep Loss on Exercise Performance, and Physiological and Cognitive Responses to Exercise. *Sports Medicine (Auckland, N.Z.)*. http://doi.org/10.1007/s40279-014-0260-0

Glaister, M., Pattison, J. R., Dancy, B., & McInnes, G. (2012). Perceptual and physiological responses to recovery from a maximal 30-second sprint. *Journal of Strength and Conditioning Research*, *26*(10), 2850–7. http://doi.org/10.1519/JSC.0b013e3182430198

Halson, S., & Martin, D. T. (2013). Lying to Win — Placebos and Sport Science, 597–599.

Hershner, S., & Chervin, R. (2014). Causes and consequences of sleepiness among college students. *Nature and Science of Sleep*, 73. http://doi.org/10.2147/NSS.S62907

Higgins, T., Heazlewood, I. T., & Climstein, M. (2011). A random control trial of contrast baths and ice baths for recovery during competition in U-20 rugby union. *Journal of Strength and Conditioning Research / National Strength & Conditioning Association*, *25*, 1046–1051. http://doi.org/10.1519/JSC.0b013e3181cc269f

Hirshkowitz, M., Whiton, K., Albert, S. M., Alessi, C., Bruni, O., DonCarlos, L., … Adams Hillard, P. J. (2015). National sleep foundation's sleep time duration recommendations: Methodology and results summary. *Sleep Health*, *1*(1), 40–43. http://doi.org/10.1016/j.sleh.2014.12.010

Ingram, J., Dawson, B., Goodman, C., Wallman, K., & Beilby, J. (2009). Effect of water immersion methods on post-exercise recovery from simulated team sport exercise. *Journal of Science and Medicine in Sport*, *12*(3), 417–421. http://doi.org/10.1016/j.jsams.2007.12.011

Institute of Medicine, & National Research Council. (2011). *The Science of Adolescent Risk-Taking Worskshop Report*. *Committee on the Science of Adolescent*. http://doi.org/10.1006/jado.2000.0327

Jay, K., Sundstrup, E., Søndergaard, S. D., Behm, D., Brandt, M., Særvoll, C. A., … Andersen, L. L. (2014). Specific and Cross Over Effects of Massage for Muscle Soreness: Randomized Controlled Trial. *International Journal of*

Sports Physical Therapy, *9*(1), 82–91.

Kellmann, M., Bertollo, M., Bosquet, L., Brink, M., Coutts, A. J., Duffield, R., … Beckmann, J. (2018). Recovery and Performance in Sport: Consensus Statement. *International Journal of Sports Physiology and Performance*, 1–6. http://doi.org/10.1123/ijspp.2017-0759

Lavrakas, P. J., & Battaglia, M. (2008). Encyclopedia of Survey Research Methods. In *Encyclopedia of Survey Research Methods* (p. 429). http://doi.org/http://dx.doi.org.zorac.aub.aau.dk/10.4135/9781412963947.n322

Leknes, S., Berna, C., Lee, M. C., Snyder, G. D., Biele, G., & Tracey, I. (2013). The importance of context: When relative relief renders pain pleasant. *Pain*, *154*(3), 402–410. http://doi.org/10.1016/j.pain.2012.11.018

Lund, H. G., Reider, B. D., Whiting, A. B., & Prichard, J. R. (2010). Sleep Patterns and Predictors of Disturbed Sleep in a Large Population of College Students. *Journal of Adolescent Health*, *46*(2), 124–132. http://doi.org/10.1016/j.jadohealth.2009.06.016

Macdonald, G. Z., Button, D. C., Drinkwater, E. J., & Behm, D. G. (2014). Foam rolling as a recovery tool after an intense bout of physical activity. *Medicine and Science in Sports and Exercise*, *46*(1), 131–142. http://doi.org/10.1249/MSS.0b013e3182a123db

MacDonald, G. Z., Penney, M. D. H., Mullaley, M. E., Cuconato, A. L., Drake, C.

D. J., Behm, D. G., & Button, D. C. (2013). An acute bout of self-myofascial release increases range of motion without a subsequent decrease in muscle activation or force. *Journal of Strength and Conditioning Research*, *27*(3), 812–821. http://doi.org/10.1519/JSC.0b013e31825c2bc1

Mann, J. B., Bryant, K., Johnstone, B., Ivey, P., & Sayers, S. P. (2015). The effect of physical and academic stress on illness and injury in division 1 college football players. *Journal of Strength and Conditioning Research*, (MAY 2015), 1. http://doi.org/10.1519/JSC.0000000000001055

McClung, M., & Collins, D. (2007). " Because I know It will! " : Placebo Effects of an Ergogenic Aid on Athletic Performance. *Journal of Sport & Exercise Psychology*, *29*, 382–394. http://doi.org/10.1123/jsep.29.3.382

Moreno, J., Ramos-Castro, J., Rodas, G., Tarragó, J. R., & Capdevila, L. (2015). Individual Recovery Profiles in Basketball Players. *The Spanish Journal of Psychology*, *18*, E24. http://doi.org/10.1017/sjp.2015.23

Morgan, P. M., Salacinski, A. J., & Stults-Kolehmainen, M. A. (2013). The acute effects of flotation restricted environmental stimulation technique on recovery from maximal eccentric exercise. *Journal of Strength and Conditioning Research*, *27*(12), 3467–74. http://doi.org/10.1519/JSC.0b013e31828f277e

Murray, A. M., & Cardinale, M. (2015). Cold applications for recovery in adolescent athletes: a systematic review and meta analysis. *Extreme*

Physiology & Medicine, *4*(1), 17. http://doi.org/10.1186/s13728-015-0035-8

Murray, A. M., Jones, T., Horobeanu, C., Turner, A., & Sproule, J. (2016). Sixty seconds of foam rolling does not affect functional flexibility or change muscle temperature in adolescent athletes. *International Journal of Sports Physical Therapy*, *11*(5), 765.

Murray, A. M., Turner, A. P., Sproule, J., & Cardinale, M. (2017). Practices & attitudes towards recovery in elite Asian & UK adolescent athletes. *Physical Therapy in Sport*, *25*, 25–33. http://doi.org/10.1016/j.ptsp.2016.12.005

Omoniyi, M., Akwasi, P., Kwame, J., Appiah, J., Osei, F., & Gwendoline, Lady. (2017). Perception of Track and Field Athletes on the Use of Cryotherapy in Injury Management in Ashanti Region of Ghana, (March), 215–224.

Poppendieck, W., & Faude, O. (2013). Cooling and Performance Recovery of Trained Athletes-a Meta-Analytical Review. *… and Performance*, 227–242. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/23434565

Portney, L. G., & Watkins, M. P. (2009). *Foundations of Clinical Research: Application to Practice*. *Critical Care Medicine* (Vol. 36).

Rey, E., Lago-Peñas, C., Lago-Ballesteros, J., & Casáis, L. (2012). The effect of recovery strategies on contractile properties using tensiomyography and perceived muscle soreness in professional soccer players. *Journal of Strength & Conditioning Research*, *26*(11), 3081–3088. http://doi.org/10.1519/JSC.0b013e3182470d33

Romo, L. K. (2016). College Student- Athletes' Communicative Negotiation of Emotion Labor, 1–18. http://doi.org/10.1177/2167479516650591

Sargent, C., Halson, S. S., & Roach, G. D. (2014). Sleep or swim? Early-morning training severely restricts the amount of sleep obtained by elite swimmers. *European Journal of Sport Science*, *14*(sup1), S310–S315. http://doi.org/10.1080/17461391.2012.696711

Saw, A. E., Main, L. C., & Gastin, P. B. (2015). Monitoring the athlete training response : subjective self-reported measures trump commonly used objective measures : a systematic review. *British Journal of Sports Medicine*, *50*(5), 1–13. http://doi.org/10.1136/bjsports-2015-094758

Simjanovic, M., Hooper, S., Leveritt, M., Kellmann, M., & Rynne, S. (2009). The use and perceived effectiveness of recovery modalities and monitoring techniques in elite sport. *Journal of Science and Medicine in Sport*, *12*, S22. http://doi.org/10.1016/j.jsams.2008.12.057

Singer, J. N. (2008). Benefits and Detriments of African American Male Athletes' Participation in a Big-Time College Football Program. *International Review for the Sociology of Sport*, *43*(4), 399–408. http://doi.org/10.1177/1012690208099874

Stoszkowski, J., & Collins, D. (2015). Sources, topics and use of knowledge by coaches. *Journal of Sports Sciences*, (August), 1–9. http://doi.org/10.1080/02640414.2015.1072279

Tavares, F., Healey, P., Smith, T. B., & Driller, M. W. (2017). The usage and perceived effectiveness of different recovery modalities in amateur and elite Rugby athletes. *Performance Enhancement and Health*, *5*(4), 142–146. http://doi.org/10.1016/j.peh.2017.04.002

Thomas, J., Nelson, J., & Silverman, S. (2011). *Research methods in physical activity* (6th ed.). Champaign, IL: Human Kinetics.

Tipton, M. J., Collier, N., Massey, H., Corbett, J., & Harper, M. (2017). Cold water immersion: kill or cure? *Experimental Physiology*, *00*, 1–21. http://doi.org/10.1113/EP086283

Van-den-Bulck, J. (2015). Sleep apps and the quantified self: blessing or curse? *Journal of Sleep Research*, *24*(2), 121–123. http://doi.org/10.1111/jsr.12270

Van Wilgen, C. P., & Verhagen, E. A. L. M. (2012). A qualitative study on overuse injuries: The beliefs of athletes and coaches. *Journal of Science and Medicine in Sport*, *15*(2), 116–121. http://doi.org/10.1016/j.jsams.2011.11.253

Venter, R. E. (2012). Perceptions of team athletes on the importance of recovery modalities. *European Journal of Sport Science*, (April 2015), 1–8. http://doi.org/10.1080/17461391.2011.643924

Wyk, D. Van, & Lambert, M. I. (2009). Recovery strategies implemented by sport support staff of elite rugby players in South Africa. *South African Journal of Physiotherapy*, *65*(1), 1–6. http://doi.org/10.4102/sajp.v65i1.78

Zwerling, J. (2014). LeBron James, Kevin Durant Help Spearhead NBA Popularity of Legs Recovery System. Retrieved from http://bleacherreport.com/articles/1932257-lebron-james-kevin-durant-help-spearhead-nba-popularity-of-legs-recovery-system

Table Captions

Table 1: Belief in efficacy of treatments. Overall rating is a numerical value out of 5 based on 5=most benefit, 1=least). For belief groups the % of the overall sample and response count (in brackets) is given.

Table 2: Use of treatments. For each situation, the % of the overall sample who used the treatment and the response count (in brackets) is given.

Table 3: Belief of treatments relative to use. For each situation, the % of the overall sample is given.

Table 1

	Overall rating (/5)	*Benefit % (#)*	*Neutral % (#)*	*No Benefit % (#)*
Sleep	4.54^{A}	87.5 (133)	9.2 (14)	3.3 (5)
CWI	$4.23^{A,B}$	83.6 (127)	10.5 (16)	5.9 (9)
Nutrition	4.19^{B}	79.6 (121)	16.4 (25)	3.9 (6)
Contrast	$3.99^{B,C}$	75.0 (114)	19.1 (29)	5.9 (9)
Foam Roll	$3.84^{C,D}$	71.1 (108)	22.4 (34)	6.6 (10)
Compressive Massage	$3.78^{C,D}$	65.8 (100)	23.7 (36)	10.5 (16)
Active	$3.75^{C,D}$	65.1 (99)	28.3 (43)	6.6 (10)
Compression	3.61^{D}	7.2 (11)	38.8 (59)	53.9 (82)

*Values that do not share a letter are significantly different ($p<0.05$)

Table 2

	Training % (#)	*Competition* % (#)
CWI	55.9 (85)	65.8 (100)
Stretch	45.4 (69)	38.8 (59)
Foam Roll	30.9 (47)	23.7 (36)
Sleep	22.4 (34)	20.4 (31)
Nutrition	14.5 (22)	10.5 (16)
Compressive Massage	13.8 (21)	17.1 (26)
Professional (i.e. athletic trainer)	12.5 (19)	10.5 (16)
Hydration	11.8 (18)	10.5 (16)
Heat	8.6 (13)	13.2 (20)
Contrast	7.9 (12)	13.2 (20)
Rest	7.9 (12)	11.8 (18)
Massage	4.0 (6)	1.3 (2)
Compression	1.3 (2)	2.0 (3)
Neuromuscular Electrical Stimulation	1.3 (2)	2.0 (3)
Training	n/a	1.3 (2)
Active Recovery	0.7 (1)	3.3 (5)

Table 3

	Belief & use by athlete (+/+)	*No belief but use by athlete (-/+)*	*Belief but no use by athlete (+/-)*	*No belief or use by athlete (-/-)*
Sleep[a,b]	24.3	2.6	63.2	9.9
CWI[a]	65.1	7.9	18.4	8.6
Nutrition[a,b]	14.5	1.3	65.1	19.1
Contrast[a,b]	16.2	1.3	23.7	61.8
Foam Roll[a,b]	27.0	6.0	44.1	23.0
Compressive Massage[a,b]	19.1	2.6	46.7	31.6
Active[a,b]	2.0	1.3	63.2	33.6
Compression[a,b]	2.0	0.0	52.0	46.0

[a]Significant difference at $p<0.01$ between belief groups

[b]Significant difference at $p<0.01$ between non-belief groups

Supplementary File

<table>
<tr><td colspan="4">Demographics</td></tr>
<tr><td>1</td><td>Name</td><td></td><td>Open</td></tr>
<tr><td>2</td><td>Gender</td><td>Male | Female</td><td>Closed</td></tr>
<tr><td>3</td><td>Experience in current position (i.e. years as an athlete)?</td><td><18 mths | 18mths - 3 years | 3-5 years | 5-10 years | >10 years</td><td>Closed</td></tr>
<tr><td colspan="4">Current practice</td></tr>
<tr><td>4</td><td>Which sport & discipline do you primarily compete in?</td><td></td><td>Open</td></tr>
<tr><td>5</td><td>What do you currently do to recover from training?</td><td></td><td>Open</td></tr>
<tr><td>6</td><td>What do you currently do to recover from competition?</td><td></td><td>Open</td></tr>
<tr><td>7</td><td>Why do you do this?</td><td>Evidence | Experience | Both</td><td>Closed</td></tr>
<tr><td>8</td><td>Please expand on the answer above…</td><td></td><td>Open</td></tr>
<tr><td colspan="4">Beliefs</td></tr>
<tr><td>9</td><td>How would you rate the effectiveness of sleep on recovery?</td><td>No Effect | Minor Effect | Neutral | Moderate Effect | Major Effect</td><td>Closed</td></tr>
<tr><td>10</td><td>How would you rate the effectiveness of nutrition on recovery?</td><td>No Effect | Minor Effect | Neutral | Moderate Effect | Major Effect</td><td>Closed</td></tr>
<tr><td>11</td><td>How would you rate the effectiveness of compression on recovery?</td><td>No Effect | Minor Effect | Neutral | Moderate Effect | Major Effect</td><td>Closed</td></tr>
<tr><td>12</td><td>How would you rate the effectiveness of active recovery on recovery?</td><td>No Effect | Minor Effect | Neutral | Moderate Effect | Major Effect</td><td>Closed</td></tr>
<tr><td>13</td><td>How would you rate the effectiveness of contrast baths on recovery?</td><td>No Effect | Minor Effect | Neutral | Moderate Effect | Major Effect</td><td>Closed</td></tr>
<tr><td>14</td><td>How would you rate the effectiveness of ice baths on recovery?</td><td>No Effect | Minor Effect | Neutral | Moderate Effect | Major Effect</td><td>Closed</td></tr>
<tr><td>15</td><td>How would you rate the effectiveness of Normatec on recovery?</td><td>No Effect | Minor Effect | Neutral | Moderate Effect | Major Effect</td><td>Closed</td></tr>
<tr><td>16</td><td>How would you rate the effectiveness of Foam Rolling on recovery?</td><td>No Effect | Minor Effect | Neutral | Moderate Effect | Major Effect</td><td>Closed</td></tr>
<tr><td colspan="4">Evidence</td></tr>
<tr><td>17</td><td>How do you know you or your athletes have recovered?
Please list markers you use, performance, physiological, psychological etc</td><td></td><td>Open</td></tr>
</table>