SPORT SCIENCE ON A BUDGET: A COST EFFECTIVE APPROACH FOR ATHLETE MONITORING

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INTRODUCTION: With the continuous ascent of human potential in sports, sports science advances the methods used for steady progress. According to Stone, Sands, & Stone (2004), sports science is "The tight interaction of sport scientists with the ongoing training and development of athletes at all levels, with the aim of improving all aspects of sports participation (9)." Athlete monitoring provides a means of determining whether training is creating the desired outcomes. Coaches must constantly balance the effects of training and fatigue caused by either training or competition. A primary concern in designing a training plan deals with "appropriate variation of training volume, intensity, and exercise selection such that fatigue is controlled and adaptation is optimized" (2). Mujika (2009) estimates that an enhancement of as little as 0.4% may mean the difference between 1st place and 8th place, implying that any improvement in performance is worthwhile (6). Obtaining measurements such as jump height, level of hydration, force production, and amount of training load can be very useful, but isn't always realistic for a coach due to cost. Many high schools and universities in the country have very limited budgets for strength and conditioning, let alone athlete monitoring. We propose an athlete monitoring program that costs less than $2000 and can be implemented quickly and efficiently by a strength and conditioning coach to allow them to effectively measure their athletes' preparedness.

FATIGUE: The fitness-fatigue paradigm states that an athlete's ability to perform (preparedness) is the sum of the effects of fitness and fatigue (10). The after effects of fatigue directly oppose the beneficial effects of fitness characteristics such as strength, explosiveness, endurance, and speed (10). Accumulative fatigue has been associated with decreased strength, power, explosiveness, motor control and technical ability (10). Additionally, the effects of accumulative fatigue may increase the risk of injury in athletes (12). In order to ensure optimal performance, coaches should aim to maximize fitness characteristics while minimizing the effects of fatigue.

An athlete monitoring program will provide coaches the tools to measure and understand the interplay between fitness and fatigue. Using tools such as force plates, session RPE, and volume load tracking can give coaches both objective and subjective measures of fatigue and fitness characteristics. Furthermore, frequent monitoring over the course of a competitive season allows coaches to identify trends in the effects of training and game loads on accumulative fatigue and fitness. This information can be used to alter training loads to ensure optimal performance in major competitions (peaking).

VOLUME LOAD AND QUESTIONNAIRES: Tracking volume load is an essential tool for coaches to utilize to better understand the progress of a program throughout the training year. Volume load can be described as summing the products of the load and number of reps for each set, session, and week (2). Understanding volume load can help a coach better manipulate training variables (volume and intensity) during important time periods such as overreaching, important competitions, and tapering. For an even more accurate calculation, a coach may use volume load displacement (VLd). VLd is calculated by multiplying the VL by the vertical distance the bar travels (2). VLd may be a more accurate measure seeing as athletes have

different limb lengths and can also account for partial movements (ex. ¼ squats). Coaches can easily use a tape measure to get an estimate of displacement for a lift such as back squat for each athlete. By ensuring the proper amount of work is accomplished, athletes will be better prepared to perform. Further, calculating VL (or VLd) is cost-free.

Questionnaires can be used to track subjective variables for each athlete. There are many forms of questionnaires available to coaches but for sport science, most will track measures of fatigue, soreness, recovery, diet habits, and mood states among others. Questionnaires give the coach the ability to understand the subjective feelings of their athletes. This can be useful in predicting overall fatigue and recovery of the athletes, and can provide early warning stages to the symptoms of overtraining. These can be easily shared using online tools such as Sportably.com or can easily be listed on training logs. Questionnaires are also completely cost-free.

RPE: Rate of perceived exertion (RPE) is a foundational instrument for coaches and strength coaches alike. Simply put, rate of perceived exertion aims to quantify subjective measures perceived by the athlete (3). With respect to monitoring, the coach can estimate effort, exertion, and fatigue (4). Too add, RPE is simple to understand from an athlete's perspective, and time effective for the coach. RPE can be tracked with cloud based services or simply pen and paper. Two scales that show high validity and reliability are the Borg RPE scale and the Borg CR10 scale (4). We recommend that coaches utilized RPE scales for useful feedback and cost efficiency.

SPORTABLY: Sportably is a monitoring and training tool which is available online for coaches, strength and conditioning coaches, and sport scientists to utilize daily. Sportably allows a coach to do both general and specific monitoring. Sportably provides the tools coaches need to do just that. Sportably tracks variables such as Volume Load (Load x Reps x Sets), distance, and duration, along with many monitoring variables including Body weight, heart rate, performance rating, fatigue, ratings of perceived exertion (RPE) and a battery of available mood questionnaires, to name a few (7). By tracking these variables, Sportably also gives coaches the ability to draw comparisons and correlations between different training and monitoring variables. Lastly, Sportably gives coaches the option of producing reports which can be easily and effectively shared with other coaches and athletes. Sportably is an extremely useful tool and is completely free of cost.

FORCE PLATE TESTING: A cornerstone tool for athlete monitoring is the use of force plates. Force plates can provide key information regarding jump height, explosiveness (rate of force development), and maximal strength. Vertical jumps provide beneficial information for performance and fatigue monitoring (8,10). Rate of force development is an important measurement for an athlete's acceleration, and maximal isometric strength provides good indications for dynamic strength (11). The values gathered from each of these variables can provide key trends for the strength coach to make necessary adjustments in programing, and to track progress over time. A reasonable force plate that can be implemented into an athlete monitoring program is Pasco Force plates (PASPORT 2-Axis Force Platform). This force plate is ideal for coaches, in that, this model is mobile and has wireless features that make it more functional. In addition, it's compatible with multiple devices. The total cost to implement this unit with 2 force plates, the interface, and the software is approximately $1300.

HYDRATION: Another tool a coach can implement as a part of their monitoring program is hydration testing. Judelson, et al., illustrated that dehydration can reduce maximal strength, maximal power, and strength endurance by -2%, -3%, and -10%, respectively (5). The gold standard for hydration testing is, measuring urine specific gravity (USG). Hydration is measured with a refractometer which measures the concentration of solutes in the urine. This method is useful especially if the coach wants more precise measurements. However, prices for a refractometer can range from $300 to $1,500. An alternative to USG is utilizing a urine color chart. Earlier work by Armstrong, et al., showed that testing urine color can be just as effective as plasma osmolality and USG (1). The cost to implement this method can range from $25 to $35 for sample cups. Monitoring hydration provides key educational views to the coach and player.

CONCLUSION: With the growing competition in today's sports world, sport science may be the difference between winning or losing. Sport science is no longer a far-off wish, but is a reality for coaches and can be implemented essentially cost-free.

REFERENCES

Armstrong, L. E., Soto, J. A., Hacker, F. T., Casa, D. J., Kavouras, S. A., & Maresh, C. M. (1998). Urinary Indices during Dehydration, Exercise, and Rehydration. *International Journal of Sport Nutrition, 8*(4), 345-355. doi:10.1123/ijsn.8.4.345

Deweese, B. H., Hornsby, G., Stone, M., & Stone, M. H. (2015). The training process: Planning for strength–power training in track and field. Part 1: Theoretical aspects. *Journal of Sport and Health Science, 4*(4), 308-317. doi:10.1016/j.jshs.2015.07.003

Foster, C. (1998). Monitoring training in athletes with reference to overtraining syndrome. *Medicine & Science in Sports & Exercise, 30*(7), 1164-1168. doi:10.1097/00005768-199807000-00023

Heath, E. M. (1998). Borg's Perceived Exertion and Pain Scales. *Medicine& Science in Sports & Exercise, 30*(9), 1461. doi:10.1097/00005768-199809000-0001

Judelson, D. A., Maresh, C. M., Anderson, J. M., Armstrong, L. E., Casa, D. J., Kraemer, W. J., & Volek, J. S. (2007). Hydration and muscular performance: Does fluid balance affect strength, power and high-intensity endurance? *Sports Medicine, 37*(10), 907-921.

Mujika, I., J. Santisteban, and C. Castagna, *In-season effect of short-term sprint and power training programs on elite junior soccer players.* J Strength Cond Res, 2009. **23**(9): p. 2581-7.

S. (n.d.). Sportably - Athlete Monitoring and Development System - Monitor Overtraining, Performance and Health. Retrieved November 08, 2016, from https://www.sportably.com/

Sams, M. L. (n.d.). Comparison of Static and Countermovement Jump Variables in Relation to Estimated Training Load and Subjective Measures of Fatigue [Abstract]. Retrieved from http://dc.etsu.edu/cgi/viewcontent.cgi?article=3781&context=etd

Stone, M. H., Sands, W. A., & Stone, M. E. (2004). The Downfall of Sports Science in the United States. *J Strength Cond Strength and Conditioning Journal, 26*(2), 72. doi:10.1519/1533-4295(2004)0262.0.co;2

Stone, M. H., Stone, M., & Sands, B. (2007). *Principles and practice of resistance training*. Champaign, IL: Human Kinetics.

Wang, R., Hoffman, H. R., Satoru, T., Amelia, M. A., La Monica, M. B., Beyer, K., . . . Stout, J. R. (2016, March 12). Isometric Mid-Thigh Pull Correlates with Strength, Sprint and Agility Performance in Collegiate Rugby Union Players. *Journal of Strength & Conditioning Research*. doi:10.1519/JSC.0000000000001416

Wilkerson, G. B., Gupta, A., Allen, J. R., Keith, C. M., & Colston, M. A. (2016). Utilization of Practice Session Average Inertial Load to Quantify College Football Injury Risk. *Journal of Strength and Conditioning Research, 30*(9), 2369-2374. doi:10.1519/jsc.0000000000001370