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Heart Rate Monitoring as a Supplemental Tool for Soccer Player Training Programs

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In high level soccer (i.e., NCAA, professional level), players may cover 8 – 12 kilometers in a given match, typically through a combination of walking, running, or sprinting (while often in possession of the ball) (1,6). Intensity levels frequently approach and sporadically exceed anaerobic threshold which places a high degree of stress on the cardiovascular system and metabolic (energy producing) pathways in the body. Therefore, in order to excel as a soccer player and withstand these demands on the cardiovascular system during a match (or training session), soccer players need not only sufficient anaerobic capacity, speed, power and strength, but also adequate (certainly higher than average) aerobic fitness and neurological facilitation (3). A fitter player will not only be able to cover more ground and thus respond to changes in ball possession and opposition plays, but they will also be able to recover more quickly from successive sprints and consecutive games often played within days of each other (2). Consequently, greater emphasis is now being placed on designing training programs for specific sports, in this case soccer, to reflect the metabolic and physiologic demands of the sport in a game or competitive setting (4,5,8).

However, the conundrum that often faces soccer players and their conditioning staff is not what intensity to work out at, but how to monitor the intensity so that optimal benefits can be achieved during the competitive season. In the college setting, coaches are faced with additional challenges:

1. Collegiate soccer has a short (often no more than 3 weeks) preseason
2. An early onset of in-season conference games
3. A complete team typically consists of approximately 25 players (a large group to monitor individually).

The purpose of this article is not to present a comprehensive training program. Excellent examples of soccer-specific training programs for the collegiate player have been presented elsewhere (8). The primary emphasis of this article is to describe how we used measures of heart rate to provide feedback during a soccer-specific summer conditioning program for players off-campus.

Different approaches have been used by coaches during training in an effort to stimulate variations in playing intensity experienced by players in typical match play, small group play, and dribbling drills. These have included heart rate and oxygen consumption monitoring, and self-perceived exertion. Heart rate is one of the most common ways in which intensity is prescribed and monitored (4,8). The inclusion of heart rate measures during metabolic conditioning sessions, skills training, drills and scrimmages, can help reproduce training intensity levels reflective of those experienced by the players on the soccer field. Training that includes heart rate monitoring, as opposed to several of the alternative approaches mentioned earlier, also allows for compensation or consideration for the individual needs of each player in his or her efforts to improve overall aerobic capacity and increase anaerobic threshold.

Heart Rate Data as a Training Tool

The potential for using heart rate monitors as a training tool is well established and implemented within soccer conditioning programs throughout the academic year (1,2,8). Heart rate monitoring has been used by numerous college level soccer players to assist with their conditioning to facilitate purposeful training goals, as well in team training sessions to evaluate effort put forth during fitness testing and game play. Traditionally, heart rate monitors

are worn and data is collected during training sessions, but the ability to download and analyze heart rate data after training or when the athlete is exercising independently, is an under-reported, yet highly beneficial application of this training tool.

Players from a Division I northeastern soccer program were provided heart rate monitors during their voluntary summer conditioning program to explore the utility and effectiveness of a heart rate driven training program designed to increase aerobic capacity prior to the fall in-season and the utility of heart rate as a feedback tool for a conditioning program in soccer players. In accordance with NCAA and IRB rules and regulations, this data was collected and heart rate and adherence data was fed back to an independent exercise physiologist, not the coaching staff, during the course of the summer. Players were instructed on correct use of both the heart rate apparatus and the accompanying software at this time, and assisted with downloading the necessary software onto their personal laptops. Following a workout wearing the heart rate watch and transmitter, each player was asked to download the heart rate onto their own computer. Players were then able to see if the downloaded exercise bouts adhered to the prescribed intensities within the summer training program, and were also able to email the downloaded files as an attachment for feedback.

A 2-week sample workout program (weeks 6 – 7 of a conditioning program beginning late May and ending with the start of pre-season at the beginning of August) is presented in table 1 for a player with a heart rate maximum (HRmax) of 195 bpm. As with many non-mandatory summer conditioning programs at the collegiate level, an emphasis was placed upon improving aerobic capacity in preparation for the fall “in-season” and anaerobic threshold through soccer-specific training. Each workout began with a dynamic warm-up and ended with an appropriate cool down. Training bouts were accompanied by agility and plyometric drills, but we found that using heart rate to monitor intensity with these drills

was not useful, as the drills did not allow for a sustained heart rate, given an all-out or close to maximal effort was prescribed. Therefore, these drills have not been included in table 1. Players were not asked to conduct interval training more than three times per week in order to optimize effort and allow for adequate recovery, and even less in the initial stages of the summer program in order to establish an aerobic (and anaerobic) base on which to build. The summer conditioning program was also designed under the assumption that each player would be playing games or scrimmaging at least twice a week. The sport zones (maximal training, onset of blood lactate/OBLA, steady state training, lactate threshold training, and moderate activity) are weighted for relative contribution to the overall exercise or training bout – this is reflected in the exertion score (see Figure 1). A higher exertion score typically reflects a longer time spent in a sport zone with a higher relative weighting—for soccer players these were zones of a higher intensity, specifically the “maximal intensity,” and “OBLA” zones. This presentation of the data was used to provide feedback to the players. Figure 2 illustrates another manner in which the data can be displayed, and it has been this presentation of the information recorded, which was used by the players during the summer conditioning program to compare their actual training data to the prescribed intensity presented in table 1. The heart rate curve displayed in Figure 2 was subsequently used as a visual feedback tool to players and coaches the following in-season to compare responses during progressive training bouts and illustrate improvements in aerobic fitness.

An analysis of fitness scores of players on this team collected in April (end of Spring post-season) and the following August (beginning of Fall pre-season) suggested that those who consistently emailed in for feedback had notable increases in aerobic fitness (as measured by the Yo-Yo Intermittent Endurance Test (7)) relative to those that were not in regular communication and did not use the heart rate apparatus on a regular basis throughout the summer. Irregular

or minimal use of the heart rate apparatus did not necessarily imply that no conditioning took place, just that either heart rate monitors were not used, data not obtained, or feedback not sought.

Program Application

The use of a heart rate training apparatus has allowed for the manipulation of training intensities to target a given training emphasis (i.e., improve aerobic capacity) or mimic soccer-specific game intensities. Once the heart rate training data has been downloaded, coaches and players can evaluate the workout via several perspectives and see a breakdown of the workout according to intensity levels, energy expenditure and distance. This allowed for feedback to be given to players in several ways using the visual presentations of the data to help guide player program manipulation and improvement. This proved to be an especially important component of the heart rate training apparatus given that the players were not on campus and the data was sent for feedback via email. Feedback to the player is not only instantaneous when heart rate watches are worn, but heart rate throughout the entire workout session can be recorded automatically and then downloaded for further analysis post-training bout at one’s own convenience.

This article outlines the application of an under-used training tool for soccer conditioning programs when coach-athlete interaction is restricted. However, throughout the season, coaches can still use these tools to manipulate time spent in heart rate training zones to suit training climate and goals that might vary throughout a given periodization cycle. The heart rate intensity that defines each sport zone can also be changed for the same reason. Figure 1 shows how this data was converted to help visualize time spent in the respective sport zones, total energy expenditure, average heart rate during the training bouts, and overall exertion score for players throughout the summer. This heart rate curve can show maximal and average heart rate, but also identify abnormal patterns not consistent with other players of the same posi-

tion during similar activities. We have since used heart rate measures in this manner with lacrosse teams. This type of analysis may help identify players experiencing unsafe stress responses to a given exercise or conditioning activity, as well as highlight players in need of more physical conditioning due to inadequate physical fitness or lack of sport-specific conditioning.

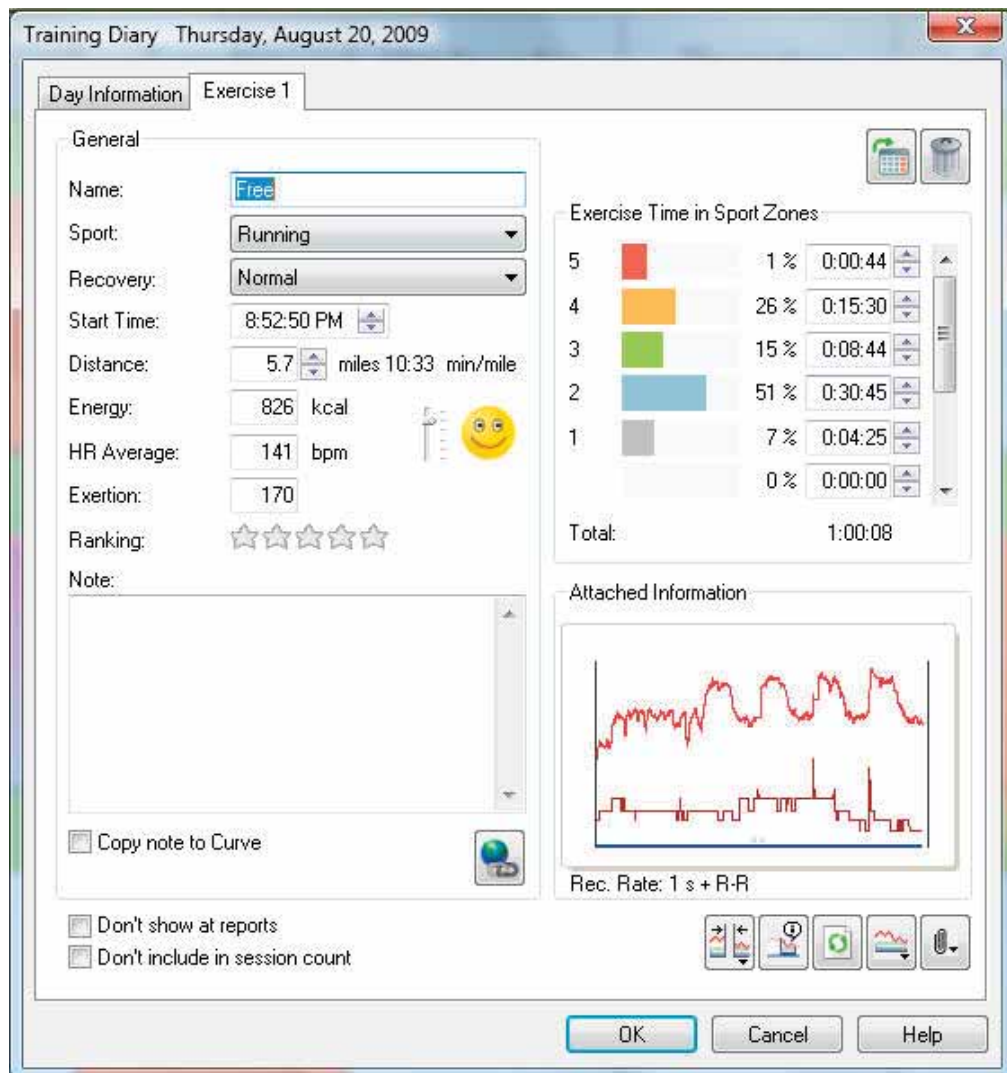
Feedback from the players suggested these visual tools provided motivation and encouraged adherence to a summer training program. This suggests they can be empowering for the player or athlete in that they can take ownership and responsibility for monitoring his or her own training program, especially in instances where NCAA rules and regulations prohibit coach (be it strength and conditioning or sport-specific) contact. Overall, including some form of heart rate based training program has advantages for coaching staff or conditioning professionals working with soccer players, or other athletes engaged in sports that necessitate sport-specific conditioning to meet both the aerobic and anaerobic demands of their given sport

The research shown in this study using technology to test and train in a program (table 1) was done as a trial and can be modified or substituted with a program that better addresses the conditioning goals of a given program. This was only intended for informational and educational purposes, to further educate teams, athletes and coaches on benefit of sports technology monitoring. In accordance with NSCA recommendations, always consult with your certified strength and conditioning specialist for specific testing and properly applied conditioning programs. ■

References

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Figure 1. Training diary displaying distance, energy expenditure, and heart rate data from exercise bout.



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Figure 2. Athlete's heart rate curve response to workout.



Table 1. Sample Summer Conditioning Program

Week (Day)	Workout	Intensity
6 (1)	4 x 800 m run; 3 min active rest between sets [#]	156-176 bpm (80-90 %HR _{max})
6 (2)	4 x 200 m; 1 min 30 s active rest between sets [#]	156-176 bpm (80-90 %HR _{max})
	6 x 100 m; 1 min active rest between sets [#]	165-185 bpm (85-95 %HR _{max})
6 (3)	4 x 4 min runs; 3 min active rest between sets [#]	165-185 bpm (85-95 %HR _{max})
7 (1)	3 x 1600 m runs; 3 min 30 s rest between sets	146-165 bpm (75-85 %HR _{max})
7 (2)	4 x 4 min runs; 3 min active rest between sets [#]	165-185 bpm (85-95 %HR _{max})
7 (3)	4 x 300 m shuttles [§] ; 3 min active rest between sets [#]	146-165 bpm (75-85 %HR _{max})
	3 x 100 m: 1 min 20 s active rest between sets [#]	156-176 bpm (80-90 %HR _{max})
	2 x 80 m; 1 min active rest between sets [#]	All-out effort
7 (4)	6400 m (4 mile) run	136-156 bpm (70-80 %HR _{max})

#Rest period – light jogging no lower than 108 bpm (55% HR_{max}).

§Shuttle: end-line to midfield and return twice and finish with end-line to midfield run.