Module 1. Physical demands of competition

In this next course, we will study: "***what we are training for***". The first topic discussed is the physical demands of competition. Unless we understand the physical demands of competition, it is very difficult to develop game-specific training programs to meet those demands.

Coupled with the physical demands of competition is the "worst case scenario", which relates to the most demanding passages of play. In this respect, we will go through some examples showing the most demanding passages of the game that occur in football and in rugby (including collision elements).

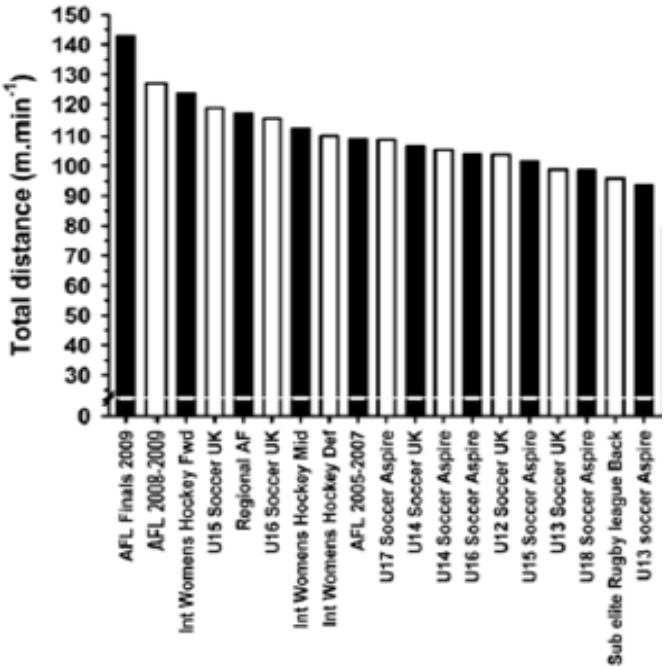
Finally, we will examine small-sided games and how effective they are in terms of replicating (or simulating) those most demanding passages of play, and for preparing players for those extreme competition demands.

So, let's focus on the demands of the game. Time-motion analysis is used to quantify the physical demands of competition. Some of the earliest time-motion studies used pencil and paper or voice recorders to "capture" the typical activities performed by athletes during their respective competitions. As technology evolved, single video cameras were used to track individual players. Semi-automated camera tracking systems have also been used for several years in major European football (soccer) competitions.

One of the ways that we can now measure the physical demands of different sports is by using Global Positioning System (GPS) technology. There are a number of ways that we can quantify the intensity of competition using this technology.

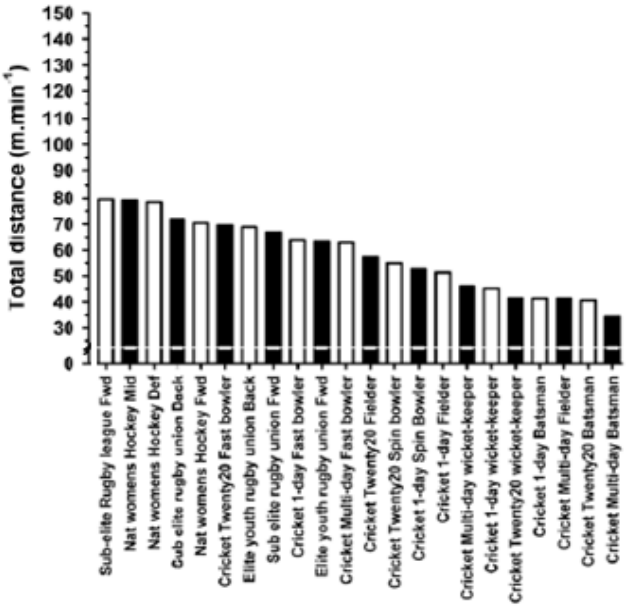
For instance, the *overall* intensity of competition can be estimated through the relative distance covered, which is reflected in the meters covered per minute. This is the most common variable used by most team sport researchers to assess the overall intensity of training and competition.

Figure 1: Intensity of the game determined by relative distance covered



Source: Aughey, 2011, p. 301.

Figure 2: Intensity of the game determined by relative distance covered



Source: Aughey, 2011, p. 301.

Figures 1 and 2 show the meters covered per minute as an estimate of overall intensity for different team sports. In terms of meters covered per minute of match-play, Australian football provides the greatest intensity, with players covering 120 m/min during fixture competition matches, with this intensity increasing during final matches (Aughey, 2011).

In football competition, players will typically cover ~100 to 110 meters per minute. Field hockey is a similar intensity. We can also examine sports such as the rugby codes (league and union). In the National Rugby League competition, players will cover ~100 meters per minute on average. In rugby union, the movement intensity is a little lower (approximately 60 to 70 meters per minute on average) (Aughey, 2011).

It is important to keep in mind that meters per minute only provide a "snapshot" of the intensity or training or competition. It gives us the average intensity across the course of the training session or game.

It is equally important to be mindful that different sports have different physical demands. This means there are sports in which it is not necessary to cover large distances in running, but intensity comes from other sources.

A football goalkeeper covers low meters per minute. However, during some passages of the game, the intensity of their tasks increases even though they are not covering a lot of distance.

Likewise, if we compare Australian football with Rugby, the intensity of the game depends on covering large distances for the first sport, and through the collision for the second. In Rugby, a player may have to make three tackles in close succession, which can generally occur in a small area. In this situation, there is not a lot of running involved. A player could be targeted on the same spot three times in a row. GPS data alone would not provide adequate information on the physical demands placed on the player. During these contests, a player might be involved in tackling, wrestling, and grappling and also drag their body off the ground after doing those three contact efforts. Although the GPS might indicate that very little movement (or activity) has occurred, the reality is that these tasks are extremely physically demanding. In fact, even in different levels or leagues of the same sport, physical demands may not be the same (Figure 3).

Figure 3: Physical demands of competition in National Rugby League and National Youth Competition

NYC			
Forwards	Adjustables	Outside Backs	Effect Size
52.3 ± 24.5	71.3 ± 14.0	75.5 ± 15.8	0.08–0.25
4866 ± 2383	6920 ± 1481	7172 ± 1377	0.13–0.49
93 ± 9	97 ± 10	96 ± 11	0.19–0.74
4641 ± 2315	6562 ± 1297	6767 ± 1262	0.12–0.54
89 ± 9	93 ± 9	91 ± 11	0.00–0.71
18 ± 6	27 ± 14	29 ± 8	0.07–0.53
0.4 ± 0.1	0.4 ± 0.1	0.4 ± 0.1	0.00–1.00
225 ± 90	358 ± 191	404 ± 125	0.20–0.40
4.6 ± 1.4	4.8 ± 1.8	5.3 ± 0.7	0.29–1.38
0.6 ± 0.8	0.3 ± 0.5	–	0.30–0.60
0.01 ± 0.01	0.01 ± 0.01	–	0.00–1.41
7.4 ± 6.3	8.3 ± 6.1	6.0 ± 3.3	0.36–0.56
0.13 ± 0.07	0.13 ± 0.11	0.08 ± 0.03	0.45–0.87
10.3 ± 4.7	10.7 ± 2.9	8.8 ± 8.2	0.34–0.60
0.21 ± 0.08	0.15 ± 0.04	0.11 ± 0.10	0.34–0.75
18.3 ± 10.5	19.3 ± 6.7	14.8 ± 9.1	0.21–0.55
0.35 ± 0.11	0.29 ± 0.14	0.19 ± 0.10	0.23–1.00
7.5 ± 3.5	11.3 ± 6.6	8.1 ± 1.4	0.50–1.62
3.8 ± 0.5	3.9 ± 0.4	3.7 ± 0.3	0.00–1.11
4.5 ± 0.6	6.1 ± 2.1	4.8 ± 0.6	0.20–1.13
1.2 ± 0.2	0.9 ± 0.1	1.0 ± 0.3	0.00–0.00
4.4 ± 1.0	4.5 ± 0.8	4.6 ± 1.3	0.37–0.75
4.9 ± 1.7	5.7 ± 2.4	6.2 ± 2.2	0.06–0.90
1 every 7.0 min	1 every 8.7 min	1 every 9.3 min	0.81–2.42

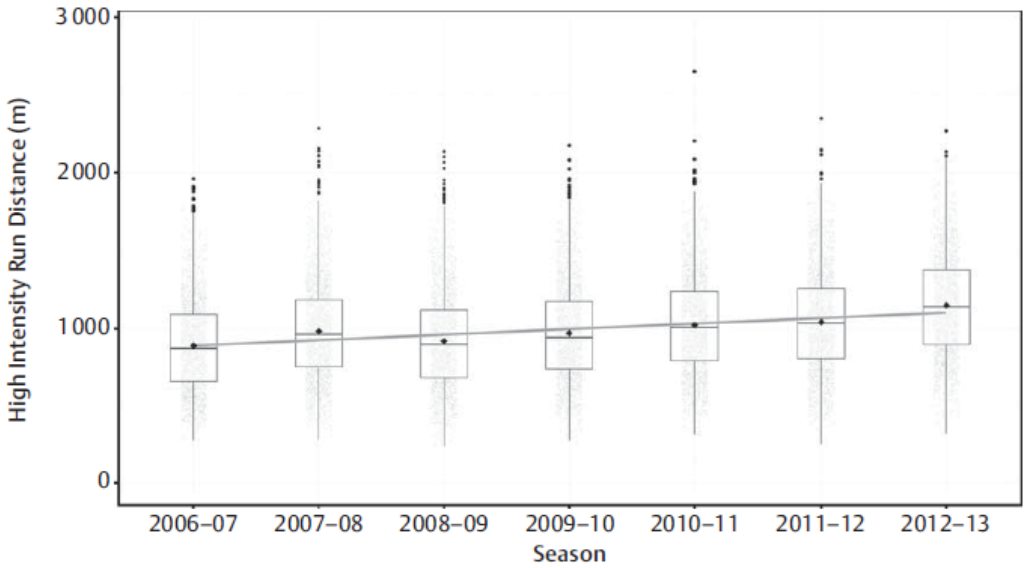
	NRL		
	Forwards	Adjustables	Outside Backs
Time (min)	50.7 ± 13.9	74.9 ± 14.6	77.8 ± 10.1
Distance (m)	5129 ± 1652	7834 ± 2207	7575 ± 850
Relative Distance ($m \cdot min^{-1}$)	105 ± 21	99 ± 8	94 ± 10
Low Speed			
Distance (m)	4878 ± 1541	7513 ± 2138	7123 ± 830
Relative Distance ($m \cdot min^{-1}$)	100 ± 20	93 ± 8	91 ± 10
High Speed			
Efforts (no.)	21 ± 14	28 ± 13	33 ± 7
Efforts ($no. \cdot min^{-1}$)	0.4 ± 0.2	0.5 ± 0.1	0.3 ± 0.1
Distance (m)	251 ± 157	320 ± 176	452 ± 113
Relative Distance ($m \cdot min^{-1}$)	5.2 ± 2.6	5.7 ± 1.7	3.6 ± 1.6
Collisions			
Mild (no.)	0.2 ± 0.5	0.5 ± 0.8	0.2 ± 0.6
Mild ($no. \cdot min^{-1}$)	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01
Moderate (no.)	10.1 ± 4.8	6.5 ± 3.5	4.3 ± 2.8
Moderate ($no. \cdot min^{-1}$)	0.20 ± 0.09†	0.09 ± 0.06	0.06 ± 0.04
Heavy (no.)	13.0 ± 4.3	9.4 ± 4.5	11.9 ± 4.3
Heavy ($no. \cdot min^{-1}$)	0.27 ± 0.08	0.13 ± 0.06	0.15 ± 0.05
Total (no.)	23.3 ± 7.6	16.4 ± 6.5	16.4 ± 6.1
Total ($no. \cdot min^{-1}$)	0.47 ± 0.13†	0.23 ± 0.10	0.21 ± 0.07
Repeated High-Intensity Efforts			
Bouts (no.)	11.9 ± 6.2	14.3 ± 5.4	14.5 ± 5.4
Mean Efforts per bout (no.)	4.1 ± 0.9	3.9 ± 0.5	4.3 ± 0.7
Maximum efforts per bout (no.)	6.0 ± 2.2	5.7 ± 2.0	7.4 ± 3.2
Mean effort duration (s)	1.2 ± 0.3	0.9 ± 0.2	1.0 ± 0.3
Maximum effort duration (s)	4.9 ± 0.9	3.9 ± 0.8	5.1 ± 1.4
Effort recovery (s)	6.3 ± 1.4†	7.0 ± 1.8	6.3 ± 1.3
Bout frequency	1 every 4.3 min	1 every 5.2 min	1 every 5.4 min

Source: adapted from Gabbett, 2013, p. 1130.

In handball, the intensity of matches increases through the contact that comes within the sport. As a consequence, it should be emphasized that GPS or running data alone will not provide a true understanding of the demands of that sport.

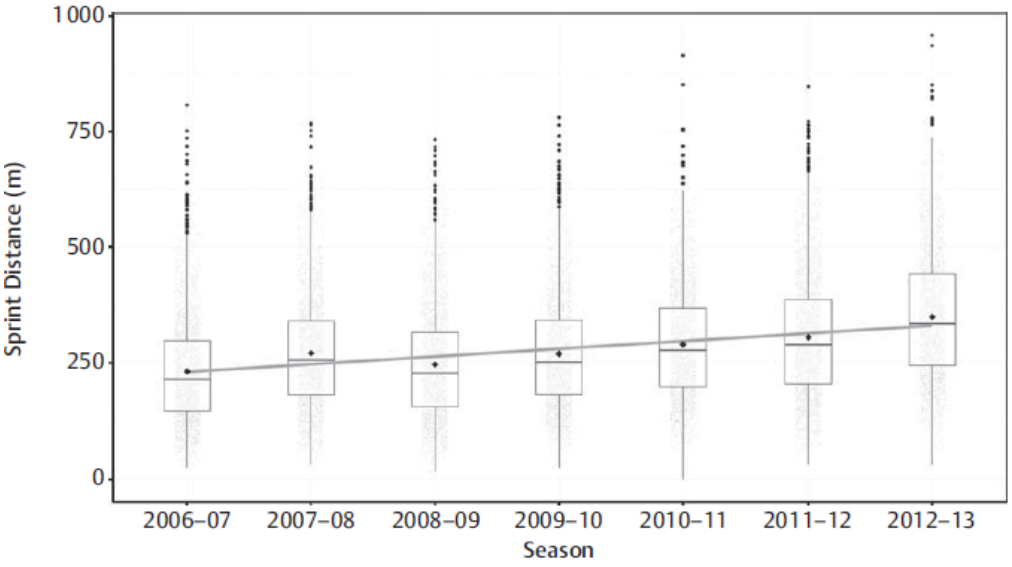
Below is some work that was performed in the English Premier League between 2006 and 2012 (Barnes, Archer, Hogg, Bush, & Bradley, 2014) (Figures 4 and 5).

Figure 4: High intensity running distances in different Premiere League seasons



Source: Barnes et al., 2014, p. 1097.

Figure 5: Sprinting distances in different Premiere League seasons



Source: Barnes et al., 2014, p. 1097.

As can be seen from Figures 4 and 5, the number of high intensity actions, and the amount of sprinting performed increased progressively over that period. It shows us that the physical demands of the Premier League are increasing. Another important aspect of this study is that from 2006/2007 to 2012/2013, there was a much greater number of passes, skills involvements, and game-specific actions. These results demonstrate that it's not only the physical demands that are increasing; the skills demands are increasing as well.

Figure 6: Technical indicators across the 2006–07 to 2012–13 seasons in Premiere League

Variables	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13
passes	25.3±13.4	27.0±13.7†	30.8±16.0†	29.0±14.6†	32.1±15.1†	35.5±18.2†	35.4±17.1†
successful passes (%)	76.3±12.7	78.0±12.1†	80.7±10.9†	78.2±11.8†	81.1±10.4†	84.0±9.6†	83.3 ±10.1†
short passes	6.1±4.3	7.0±4.7†	7.9±5.3†	7.5±5.2†	8.3±5.2†	9.6±6.4†	9.4±6.0†
medium passes	13.4±8.7	14.3±8.8*	16.7±10.3†	15.5±9.4†	17.7±10.0†	19.7±11.9†	19.8±11.3†
long passes	5.7±4.0	5.7±4.0	6.2±4.5#	5.9±4.3	6.2±4.3#	6.2±4.6†	6.2±4.5†
passes received	18.8±11.7	20.6±11.7†	24.3±14.0†	22.3±12.5†	25.5±13.2†	29.5±16.1†	29.2±14.9†
touches	1.9±0.6	2.0±0.5*	2.0±0.5†	1.9±0.5	2.0±0.5*	2.0±0.5†	2.1±0.5†
shots	1.2±1.4	1.2±1.4	1.2±1.5	1.2±1.5	1.2±1.5	1.3±1.6	1.2±1.5
clearances	3.0±2.9	3.4±3.2†	2.6±2.5†	2.8±2.6#	2.4±2.3†	2.1±2.2†	2.3±2.3†
dribbles	0.1±0.4	0.2±0.5	0.3±0.7†	0.5±1.0†	0.8±1.4†	1.2±1.7†	0.6±1.1†
tackles	3.2±2.2	2.6±2.0†	3.3±2.3	3.2±2.3	3.1±2.1	2.9±2.1#	3.0±2.2
tackled	2.8±2.7	2.3±2.3†	2.9±2.7	2.8±2.8	2.6±2.6	2.6±2.6	2.6±2.5*
final third entries	5.9±4.0	5.9±3.8	5.8±3.9†	5.9±3.8	5.7±3.7†	5.4±3.6†	5.2±3.6†
possessions won	19.6±9.4	19.7±9.4	18.1±8.9†	19.0±9.1	17.8±8.6†	16.4±8.0†	16.4±7.7†
possessions lost	22.8±6.9	22.7±7.0	21.0±6.6†	22.1±6.9#	20.5±6.7†	19.3±6.3†	19.3±6.3†

Source: Barnes et al., 2014, p. 1099.

When we are training players, it is important that we develop programs that prepare them for the most challenging parts of play. But we are not only training the physical components of play, we are actually trying to train them for high-intensity demands including decision making, and skill components of the game.

Regarding the physical demands of football, if we look at a ninety-minute match, on average players might cover 10 to 12 kilometers of distance. Not all of that distance will be covered at high-speed. It also involves lower intensity running, walking, and jogging. Players might cover 1 to 2 kilometers of high-speed running and 300 to 600 meters of sprinting (on average).

Across the course of a football game, the work-to-rest ratio is around 1:10. This means that for every 4 seconds of high-intensity activity (i.e. "work") players will have 40 seconds of lower intensity activity (i.e. standing, walking or jogging), which can be categorized as rest.

What is important to keep in mind, though, is that the game does not work in this perfect sequence of work-to-rest ratio. Playing team sports is not a laboratory experiment where we can place an athlete on a cycle ergometer and can control that person in an ordered fashion. Team sport competition is mostly erratic, or as we call it, stochastic. This means that the way and order actions occur during the game are chaotic. Therefore, across the course of the game

there might be an average work-to-rest ratio of 1 to 10. However, there are other game situations where the rest periods can be longer, or work periods can be more intense.

In football, during the most demanding passages of play, the work-to-rest ratio is closer to 1:3. This is typically called a "*repeated sprint bout*". In sports, where other actions are also critical (e.g. jumping and lateral movement in basketball and volleyball, or tackling in the rugby codes), these extreme passages of play are called *"repeated high intensity effort bouts*".

Many sport scientists refer to these bouts as "worst case scenarios". There are the average demands of competition, and then inside those average demands are the most demanding passages of play, the repeated sprint or repeated high-intensity effort bouts.

It is important to emphasize that if a team only trains for the average demands of competition, then by definition the players are only going to be prepared for 50% of the game, the lower half. It is likely that they will be underprepared for the most demanding passages of play.

References

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Barnes, C., Archer, D. T., Hogg, B., Bush, M., & Bradley, P. S. (2014). The Evolution of Physical and Technical Performance Parameters in the English Premier League. *International Journal of Sports Medicine, 35*(13), 1095-1100. doi: http://dx.doi.org/10.1055/s-0034-1375695

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