Training Periodisation: an Obsolete Methodology?

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GENERAL CONCEPT
Periodisation is probably the most important and fundamental concept in sports training. Typically, it consists of a 'training cycle' divided into different training phases (Figure 1) – with distinct physical and physiological objectives – to enable the best performance from athletes in a competition (i.e. peak performance). Theoretically, using the periodisation concept, peak performance occurs in a controlled way, as a result of the summation of the particular adaptations provided by each training phase (mesocycles)\(^1\-^4\). In fact, several studies have reported that different periodisation regimens are superior to non-periodised models for improving performance in elite athletes\(^5\-^6\). However, from a practical point of view, this research is limited by the fact that the authors – throughout the experimental period – only investigated the changes in physical capacities (i.e. muscle strength and power), but not in actual sports performance (competition results). Therefore, it is accepted that programmed training interventions produce greater enhancements in athletes' fitness scores than unplanned (non-periodised) exercise regimens. However, when examining the role of the periodisation concept in achieving the maximum specific performance in selected sports events (season's best result), an important drawback emerges: very low rates of effectiveness. In a unique study published in New Studies in Athletics, Bartonietz and Larsen\(^7\) presented these low rates statistically, after comparing the results obtained in the 'peak oriented phase' with all other results attained by the athletes throughout the competitive season (Table 1). More specifically, the number of athletes achieving their personal season's best during the target competition of the year (World Championship) varied between 17 and 25%. In addition, a further dissimilarity has been identified between peak performance and performance variation obtained by high-level sprinters (who train following an identical periodised training regimen), targeting the same main events in the same competitive season (unpublished data) (Figure 2). Taken together, this evidence brings into question the role of periodisation in optimising actual performance during the planned peaking phase and reinforces the need to identify better strategies to control and improve the athletes' sporting capability.

THE PHYSIOLOGICAL PARADOXES: BASIC OR CONCURRENT CAPACITIES?
The traditional periodisation model assumes that a relatively prolonged period
of basic training (general preparation) is a prerequisite to a more specific phase (special preparation). During general preparation, strength and conditioning coaches aim to improve cardiorespiratory endurance and strength-endurance, even in athletes competing in power-speed sports disciplines (sprint and long jump events). This is surprising, as it has been known since the early 1980s that high volumes of endurance training are capable of attenuating the chronic gains in muscle strength and power, principally in highly trained subjects. Although the molecular aspects of this interference effect have been extensively debated in sport sciences and still need to be fully elucidated, it seems that the multiple signaling responses induced by endurance training are capable of inhibiting protein synthesis and muscle hypertrophy, which is possibly related to the antagonism between the adenosine monophosphate activated protein kinase (AMPK) and mammalian target of rapamycin complex 1 or mechanistic target of rapamycin complex 1 (mTORC1) signaling cascades.

Another common belief related to strength-power development, is that the so-called ‘strength foundation phase’ will provide positive transfer of maximum strength to the ability to produce muscle power in the subsequent training phases. To date, there is no strong evidence supporting this belief, mostly held in traditional literature written at best on the basis of authors’ personal experiences and not supported by research work. Conversely, there are extensive studies showing that training using heavy-loads (i.e. maximum strength training) results in improvements only in the high-force/low-velocity portion of the force-velocity curve, without necessarily affecting the ability to produce higher amounts of force at high velocities (muscle power). In effect, it appears that the parametric relationship between force and velocity (i.e. the higher the load, the lower the velocity) plays a key role in modulating chronic neuromechanical adaptations. Some studies have even reported significant decreases in power-speed related motor tasks (i.e. short sprints, agility tests and peak velocity in vertical jumps) after periods of heavy strength training.

**Figure 1:** Classical periodisation model, shifting from high-volume/low-intensity training to low-volume/high-intensity training. Theoretically, sport form is gradually enhanced through the successive training cycles, until the target competition (▲performance peak). Adapted from Matveyev.

**Table 1:** Effectiveness of the preparation for the World Track and Field Championships, 1995 in specific events: Championship results versus the best performance in the season. WC = World Championships result. PB = Personal best. EFF = Effectiveness.

<table>
<thead>
<tr>
<th>Event</th>
<th>Number of athletes</th>
<th>WC better than season PB</th>
<th>% EFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>All throws (finalists)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>48</td>
<td>8</td>
<td>17</td>
</tr>
<tr>
<td>Women</td>
<td>36</td>
<td>9</td>
<td>25</td>
</tr>
<tr>
<td>High jump</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>33</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>Women</td>
<td>35</td>
<td>9</td>
<td>26</td>
</tr>
<tr>
<td>Triple jump</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>43</td>
<td>7</td>
<td>16</td>
</tr>
<tr>
<td>Women</td>
<td>32</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>110m and 100m hurdles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>47</td>
<td>13</td>
<td>28</td>
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<tr>
<td>Women</td>
<td>32</td>
<td>8</td>
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</tr>
</tbody>
</table>
Importantly, the theoretical and speculative ‘delayed training effect’ concept assumes that training basic capacities at earlier phases of the periodisation cycle has positive effects on actual performance long after this period of general overloading. The question that remains to be answered, is whether these unwanted adaptations (i.e. decreases in power-speed abilities) are really able to boost future (and targeted) neuromuscular training responses. The same holds true for specific endurance adaptations. The research does not support the existence of some physiological posterior (and also enhanced) positive effect, by showing that the ‘fatigue valley’ induced by high-intensity training sessions is not effective at increasing VO₂max or inducing peak performance in high-level endurance athletes. Surprisingly, for this selected group of non-elite but highly-trained athletes, the management of levels of fatigue at non-detrimental levels was more effective in provoking performance improvements. Furthermore, physical capacities gained in ‘shock microcycles’ were moderately to largely reduced only a few days after the last exposure to high-intensity training sessions. Therefore, the delayed training effect is not completely supported by the scientific literature and its use as a tool to improve actual results is highly controversial, as its outcomes are very unpredictable. To be more succinct, there is no physiological basis to sustain the idea that the body is ‘compartmentalised’ into basic and specific capacities and that the overloading of a given basic capacity will suddenly ‘supercompensate’ later in the training cycle. Essentially, we can state that so-called basic training may potentially be a period of concurrent training stimulus. The predicted effects (high endurance level and impaired strength-power characteristics) are detrimental to the desired training targets in the subsequent seasonal phases, especially due to the absence of solid scientific evidence regarding the delayed training effect and its purported benefits. Strength and conditioning coaches should ask themselves whether basic training is a real basis for competitive performance in their respective sports disciplines, or whether it is a loss of precious time to athletes, sometimes causing malfunction of the systems mobilised during actual performance. For instance, in endurance sports, athletes appear to benefit from performing high volumes of low-intensity training (i.e. below lactate thresholds) during their basic/specific periods of preparation. Furthermore, the role played by prolonged periods of basic training on muscle-tendon tissues and injury prevention cannot be ignored. However, it is likely that these positive adaptations in muscles and tendons may also be obtained by typical strength power exercises, which can be directly implemented during the course of the season. On the other hand, the counterproductive effects of prolonged basic preparation phases in team sports were recently evidenced by the impairments in the speed capacity presented by elite athletes during their pre-season training, with faster players (at baseline) presenting higher levels of deterioration in the maximum sprinting performance in comparison with their slower peers. In this regard, it is important to note that sprinting speed is a key component of match performance in many team sports. More importantly, the accumulated effects of several years of heavy and long-lasting concurrent training each season might have a role in the performance ceiling effect experienced by most athletes during their careers. It is possible that the ability to sustain progress in sporting capability over years will benefit from training strategies that are less aggressive and targeted i.e. concurrent, making the sports training process more economical, simple and focused on the specific physical capabilities that really matter to actual competitive outcomes.

A COMPLICATED METHOD VERSUS A COMPLEX PHENOMENON

The periodisation structure is quite complicated and is centred on a series of rigid and inflexible concepts which emphasise the necessity to progress (within the same training cycle) from basic to particular aspects of the specific sports performance. Indeed, for most sports disciplines, the current congested competition (and training) schedules make it extremely difficult for strength and conditioning coaches to adopt this classic and theoretical method. Even recent ‘undulated periodisation training regimens’ are difficult to implement in high-level sports, where the preparatory events are qualifiers for the main competitions (e.g. competitions during an Olympic training cycle) and/or tournaments where all matches have the
same importance (e.g. a national soccer championship). To meet the needs generated by this increased competitive demand, some authors have proposed the use of the ‘block periodisation model’ – a periodisation regime based on the original idea of exclusively concentrating a specific training target during a block (e.g. a maximum strength block), in order to reduce the possible concurrence between two or more physical capacities. In fact, this training model showed to be more effective than the traditional periodisation in achieving positive adaptations in certain aspects related to specific sports performance. Nevertheless, this ‘specialised training system’ usually requires considerable amounts of time to be implemented (4 to 5 weeks per block), which highly compromises its usefulness in top-level sports. In addition to the ‘periodisation puzzle’, actual competitive performance in elite sports is somewhat complex and depends on a wide range of unpredictable and changeable factors. Therefore, considering the technical hitches that arise from the problematic combination of managing training schedules and controlling peak performance, seeking simpler and more effective methods than the segmented programmes of periodisation is highly recommended to train professional athletes, who frequently have to maintain their peak or optimal performance.

**Training to the Point**

Identifying practical measures which best correlate to actual sports performance in elite athletes may assist strength and conditioning coaches in selecting appropriate tests to monitor variations in peak performance and choose the best methods/exercises to enhance athletes’ competitiveness. For instance, Loturco et al. found that simple and timesaving vertical and horizontal jump tests are strongly associated with competitive performance in the 100 metre sprint. When combined in a multiple regression linear equation, squat jump height and lower limb muscle power (assessed in the squat jump exercise) could be good predictors of Paralympic sprinters’ competitive results, besides being directly related to their performance peaks. Furthermore, loaded and unloaded jump tests have been extensively associated with sport-specific motor skills such as punching acceleration in karate, punching impact in boxing, swimming speed in sprint swimmers and change-of-direction ability in rugby players. From an applied perspective, coaches could use these rapid field measurements to increase or decrease training volume and intensity, in individual or team sports according to the performance presented by a given subject during a particular test. Moreover, since actual athlete performance may be directly related to a determined capability (e.g. vertical jumping ability), coaches could simplify their training regimes, by adopting methods/exercises able to improve this specific capacity. Certainly, further studies should be carried out to identify other functional assessments or simple physiological measures to predict sports performance in a wide range of sports disciplines. It is suggested that sports practitioners should interpret these training outcomes in the context of the loads applied to the athletes. Since large inter-subject variability in ‘internal training load’ can be observed within a squad submitted to similar external training loads, the quantification of individual physiological and perceptual demands is highly advisable. In this sense, heart-rate-derived training impulses and session rating of perceived exertion methods have been spread among athletes and teams. The observation of these useful concepts may contribute greatly to the development of better and more applied strategies for training elite athletes.

**Looking for the Optimum Training Zones**

In traditional modes of strength training, loading intensity is commonly based on different percentages of one repetition maximum (1RM). For instance, at the start of a training cycle, the athlete usually performs resistance exercises...
using lower percentages of 1RM (40 to 60% 1RM), gradually increasing these ratios as the macrocycle advances and the competition gets closer (70 to 95% 1RM). Although this sequence of loading has been recognised as a classic ‘periodisation methodology’ for more than 5 decades, little is known about the exact importance/role of this temporal training pattern in the subsequent fitness improvements. In fact, previous studies have already reported that distinct temporal organisations of the strength-power exercises promote equivalent enhancements in numerous neuromechanical capacities such as maximum strength, muscle power and sprinting speed. In addition and perhaps more importantly, the determination of 1RM values is very time consuming and it has been suggested that this measurement may expose those being assessed to increased risk of injury. With these limitations in mind, coaches and sport scientists have been trying to find more practical and effective methods to train and optimise the neuromuscular abilities of their athletes. In this regard, it was reported that training at the ‘optimum power zone’ produces similar performance improvements to traditional strength training in moderately trained subjects and can reduce the decrements in speed and power capacities that commonly occur in elite soccer players during the short pre-seasons. Importantly, in a recent study, it was observed that this training regime is superior to a classic strength training model in increasing the neuromuscular performance of top-level soccer players throughout an in-season training period. Of note, for training at this optimum zone (i.e. range of loads capable of maximising muscle power production) the athlete does not have to perform any 1RM tests, which greatly simplifies strength-power training prescription and control. Importantly, it seems that this training regime may provoke positive adaptations at both ends of the force-velocity curve (high-velocity/low-force portion and low-velocity/high-force portion), without compromising the athletes’ ability to apply force at any velocity. In addition, it has been reported that the power outputs collected at these zones – and even the magnitude of the optimum power loads – are highly associated with performance in a wide range of sport-specific movements, which possibly increases the importance of training in these zones. However, since this load varies according to the exercise performed (e.g. squat or bench-press), it is essential to carry out further analysis to identify the best training zones for each specific movement. Moreover, detection of optimal loads depends on the specific kinematic devices (accelerometers or linear encoders), which could be a problem for practical field measurements. Indeed, it is clear that the optimum power zone method calls for effectiveness trials to further confirm its usefulness in various sports settings, especially application in the long-term and in athletes of different ages and competition levels. Even with these limitations, the optimum power zone may be an applied and efficient alternative to traditional modes of strength training periodisation.

TAPERING STRATEGIES

Tapering is probably one of the few constructs in the periodisation methodology which is widely supported in the literature. Periodisation theorists state that ‘performance supercompensation’ is the final outcome of this method, purporting that it is accumulated across different training phases, through the summation of expected and predictable delayed effects. In fact, there is strong evidence demonstrating...
physiological and performance enhancements after planned reductions in training volume and increases in training intensity\textsuperscript{15,81,82} and this strategy is commonly used by coaches as a ‘pre-contest’ approach. Importantly, similar effects are also observed both during active and complete training cessation during the transition phases (i.e. the off-season periods\textsuperscript{84,85}). Therefore, it appears that improvements in athletes’ performance can be observed independent of the strategy adopted to diminish the training loads, occurring even after short periods of ‘detraining’. It is very plausible that improved sport form after periods of reduced training take place because the concurrent (and sometimes detrimental) effects of general (non-specific) and specific (fatiguing) training are partially withdrawn. Thereafter, athletes are able to present greater improvements in their competitiveness, since it is expected that this ‘unloading training strategy’ potentially allows full expression of their non-fatigued physical, technical and tactical capabilities.

CONCLUSION AND PRACTICAL APPLICATIONS

It is evident that this article will not resolve the controversies and debates which surround the conceptual basis of training periodisation. However, it highlights a clear need to develop more applied, effective and realistic methods of training (and developing) professional athletes, who compete several times per year and need to maintain near peak performance throughout the macrocycle. Even for athletes and teams with a low number of competitions/matches during a given period, the periodisation concept should be revisited, since its rate of effectiveness to control and attain the athletes’ peak performance is very low. From a practical standpoint, monitoring athletes using tests which best correlate to actual sports performance is much more important than following theoretical concepts, which subjectively state that form might be predictable and controlled. With this simple and applied thought, strength and conditioning coaches may select better ways to control fluctuations in the competitiveness of individuals and teams, besides the already well-established variations in traditional training components (i.e. volume and intensity). It will help coaches to detect unexpected adaptations in the athletes’ fitness traits and adjust training loads according to these measured responses. In this regard, the use of validated methods for daily assessment of the internal training loads might be a useful strategy to quantify/modulate training intensity and its respective dose-response relationship with the specific changes in physical qualities\textsuperscript{64,86}. Further studies are necessary to develop more effective and applied methods to train and develop high-level athletes for long-term success, in order to better enhance their form, according to their specific athletic requirements. Finally, coaches are strongly encouraged to seek more accurate and practical methods to control peak performance on a daily basis, guided by feedback from simple measures, since the subjective and empirical concepts of training periodisation are not able to predict this crucial ‘point’ of athletes’ training cycles.

References

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