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Human Kinetics
BRIEF REVIEW

The Optimum Power Load: A Simple and Powerful Tool for Testing and Training

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Purpose: The optimal power load is defined as the load that maximizes power output in a given exercise. This load can be determined through the use of various instruments, under different testing protocols. Specifically, the "optimum power load" (OPL) is derived from the load–velocity relationship, using only bar force and bar velocity in the power computation. The OPL is easily assessed using a simple incremental testing protocol, based on relative percentages of body mass. To date, several studies have examined the associations between the OPL and different sport-specific measures, as well as its acute and chronic effects on athletic performance. The aim of this brief review is to present and summarize the current evidence regarding the OPL, highlighting the main lines of research on this topic and discussing the potential applications of this novel approach for testing and training. ***Conclusions:*** The validity and simplicity of OPL-based schemes provide strong support for their use as an alternative to more traditional strength–power training strategies. The OPL method can be effectively used by coaches and sport scientists in different sports and populations, with different purposes and configurations.

Keywords: muscle strength, resistance training, muscle power, track and field, team sports, combat athletes

"Optimal power load" may be defined as the load that maximizes power output in a given exercise.[1] This load is determined from the load–power relationship through the use of various devices such as linear position transducers, linear velocity transducers, accelerometers, force plates, and mobile apps.[2–4] These instruments usually record and provide valid and reliable measures of muscle power production, considering either the "system power" (ie, using both bar-load and body mass [BM] in the power computation) or solely the "bar-power" (ie, calculated as the product of bar-force and bar-velocity).[5–7] Although distinct in their methodological basis, both measurements are widely used in practical and research settings, under different conditions and with different objectives.[5–7]

For example, for physical testing purposes, sprint coaches may be more interested in system power assessments and related outputs, as sprinters have to produce high levels of power against their own BM in order to achieve higher velocities.[5,7,8] In contrast, in sports that involve the application of power to external implements (eg, weightlifting, tennis, and shot-put) or to opponents (eg, contact situations in rugby and combat sports), coaches and practitioners may be more concerned with bar-power tests.[7,8] Therefore, the bar-power approach was not conceived to quantify the total power of the system, but rather, to calculate the external amount of power generated by the athlete when he/she is lifting a given load as fast as possible.[6,8,9] Different from system power—where power production in lower body exercises is generally optimized under unloaded conditions (ie, 0% BM)—bar-power output is usually maximized at moderate loads (ie, 30%–60% of the one-repetition maximum [1RM]), which appears to be independent of the exercise type (eg, bench-press or half-squat) and mode of execution (ie, ballistic or nonballistic).[6–8,10]

Recently, a comprehensive study was conducted on 109 elite athletes from 6 sport disciplines, verifying that bar-power output was constantly maximized at a narrow range of bar-velocities, regardless of individual strength–power level and training background.[11] To quickly determine this optimized loading range, the authors created and proposed a simple and straightforward incremental method, based on distinct fixed percentages of BM. This loading zone was thus described as the "optimum power zone" and its associated load as the "optimum power load" (OPL).[11] In this brief review, we present the current evidence on the OPL method, synthetizing and discussing the main findings and implications related to this novel testing and training approach, while clarifying some questions regarding its determination and use.

Determining the OPL for Testing and Training Purposes

The OPL can be easily and precisely determined using any device capable of measuring bar-velocity and automatically calculating

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bar-power.[2,4,11,12] The standard procedure for determining the OPL consists of two basic steps: (1) starting the power assessment with athletes performing 2–3 repetitions at maximal velocity at 30% BM (upper body exercises) or 40% BM (lower body exercises)[11,13] and (2) providing progressive increments of 5% BM (upper body exercises) or 10% BM (lower body exercises) in each set, until a clear decrease (at least 5%) in power production is consistently observed.[9,11,13] The rest interval allowed between exercise sets should be fixed at 3 to 5 minutes. The load corresponding to the maximum power output (obtained immediately before the power decrease, within the optimum power zone) should be considered as the OPL (Figure 1).[9,11,14] Since its first appearance in the scientific literature in 2014,[11] this methodological approach has been widely used by many researchers and practitioners in different sports and populations, with different training (ie, acute or chronic responses to the OPL), and testing (ie, correlational or descriptive studies) purposes.[15–23] The majority of these studies reported strong correlations between the bar-power output at the OPL and common sport-related measures, as well as confirming its positive acute and chronic effects on athletic performance.[16,18,21,24–26] Other investigations revealed that the bar-power production at the OPL is able to discriminate between athletes from different performance levels, sport disciplines, age categories, and sexes.[19,27,28] Some of these studies are presented and discussed in the subsequent sections.

Relationship Between the OPL and Sport Performance

Several studies have been conducted to examine the correlations between bar-power production at the OPL and different measures of athletic performance.[9,29–32] Elite sprinters and jumpers generating higher levels of bar-power at the OPL were equally able to sprint faster than their slower peers ($r = .64$–$.83$ for the association between 50- and 60-m sprint velocity and bar-power output at the OPL in both jump- and half-squat exercises).[30,31] Similar results were obtained for top-level combat athletes (ie, national karatekas and Olympic boxers), who presented correlations of .70 to .80 and .70 to .85 between punching acceleration and impact and bar-power output at the OPL in the jump-squat and bench-press exercises, respectively.[33,34] Professional players from various sports (ie, male and female soccer and handball players, male rugby players, and male futsal players) with higher levels of bar-power at the OPL were more likely to sprint faster and jump higher compared to their less powerful peers.[19] Moderate to very large ($r = .43$–$.86$) correlations between bar-power at the optimum power zone (in both jump-squat and Olympic push–press exercises) and sprint speed and vertical jump height were also observed in young soccer players from a first division soccer club.[32] A unique study on the relationships between bar-power output and performance in aquatic environments revealed that leg power (assessed in the jump-squat exercise) at the OPL was largely to very largely associated ($r = .65$–$.72$) with many tethered swimming force parameters (ie, peak force, average force, impulse, and rate of force development), and actual swimming velocity in well-trained male swimmers.[35]

From a general perspective, the close associations observed between bar-power at the OPL and performance in numerous sports may be explained by theoretical and mechanical factors. The opportunity to use a range of loads that simultaneously optimize the force and velocity applied to the barbell may better reflect the physical abilities and technical skills required in various sport tasks, where athletes are usually required to move submaximal loads at maximum speeds.[9] Although these strong correlations do not necessarily imply causality, they serve as a basis for the development of more detailed studies on the applications and effects of the OPL.

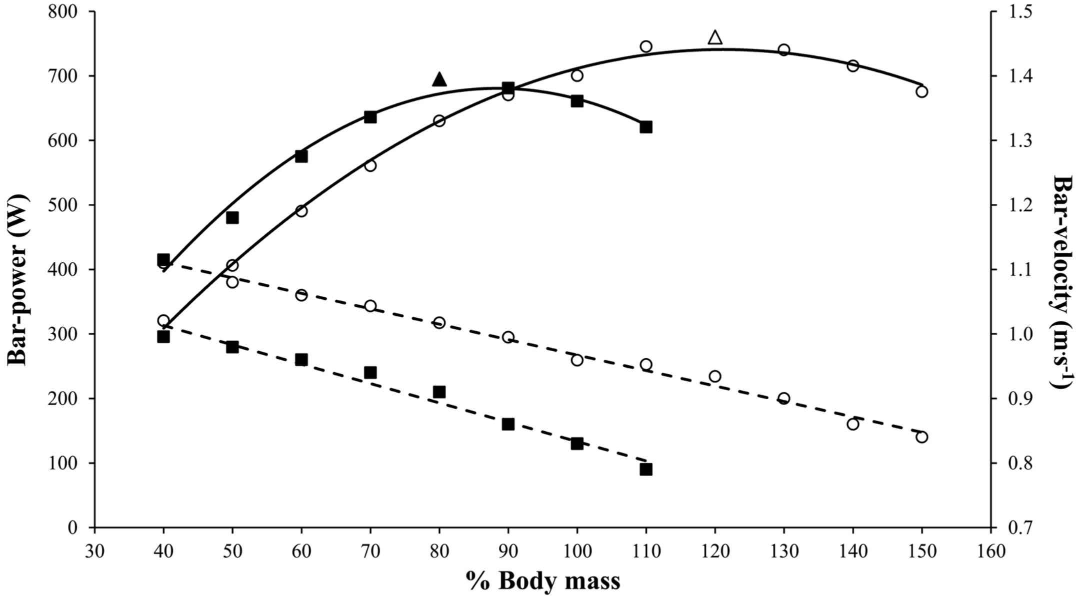

Figure 1 — The "optimum power load" (OPL): the load corresponding to the maximum power output obtained immediately before the bar-power decrease during an incremental loading test, based on relative percentages of body mass. Polynomial lines represent the bar-power and rectilinear lines represent the bar-velocity outputs (mean power and mean velocity values, collected during actual testing attempts, in the hip-thrust exercise). White symbols represent an elite track-and-field athlete and black symbols represent a rugby union player. For both athletes, triangles represent the OPL. Irrespective of the bar power values, they achieved the OPL at similar bar velocities.

Bar Power at the OPL as a Discriminating Factor Among Elite Athletes

The ability to generate high levels of bar-power output at the OPL has been shown to be a sensitive discriminator between sport disciplines and athletic performance levels.[11,27,28] In a multicenter study involving athletes from different countries, Valenzuela et al[28] reported mean values of ~32 and 19 W·kg^{-1} (peak power) and ~14 and 8 W·kg^{-1} (mean propulsive power) for male sprinters and endurance athletes in the jump squat at the OPL, respectively. Similar differences were also observed between female sprinters and endurance athletes, who produced, in the same exercise, mean values of ~ 27 and 16 W·kg^{-1} (peak power values) and ~12 and 6.5 W·kg^{-1} (mean propulsive power values) at the OPL, respectively. In that study, athletes from 16 sports were tested and split into 8 male and female subgroups (combat sports, endurance, power track and field, and team-sport players). It was observed that, in general, male athletes produced greater amounts of bar-power at the OPL than female athletes (ie, ~23 and 18 W·kg^{-1} and ~10 and 8 W·kg^{-1}, for peak and mean propulsive power values, respectively).[28] Another investigation comparing athletes from 4 team sports (soccer, futsal, handball, and rugby) demonstrated that rugby players had superior bar-power output at the OPL compared with the other 3 groups,[19] which is reasonably expected due to the characteristics of this contact sport that requires substantial levels of strength and power to overcome resistant forces applied by opposition players.[36] More importantly, it was also noted, that, even within each specific team sport, athletes with higher levels of bar-power in the jump-squat exercise were able to sprint faster and jump higher than their less powerful peers.[19] A similar trend was described in a recent study comparing jump-squat performance between sprinters and team-sport athletes, where sprinters achieved their OPL at greater relative loads (ie, % of BM) than rugby and soccer players (mean difference = +23.5%).[27] In summary, faster and more explosive athletes regularly exhibit higher levels of bar-power at the OPL, which is consistent with the close correlations frequently reported between these mechanical measures and both speed- and jump-related abilities.[11,28,30,31]

Besides its discriminative ability to differentiate between sport types and sexes, the bar-power output at the OPL seems to be a good indicator of performance level. Previous research comparing the physical performance of Olympic and Paralympic judokas showed that these athletes presented similar levels of maximal isometric strength, but bar-power at the OPL was superior in Olympic athletes in both ballistic and nonballistic exercises (ie, jump squat, bench-press, and standing barbell row).[37] Notably, two studies conducted with world-class combat athletes revealed that "outstanding athletes" (ie, a double world karate champion and an Olympic boxing champion) could produce, on average, 45% and 10% more bar-power at the OPL than their national team peers in the jump-squat and bench-press exercises, respectively.[38,39] Olympic female handball players also displayed higher bar-power values than their less specialized peers (ie, national college team players) in both jump squat and bench-press executed at the optimum power zone (ie, +15%, on average).[40] Nonetheless, greater levels of bar-power at the OPL do not always imply higher levels of specialization, especially when other physical and physiological factors may be directly or indirectly related to sport-specific performance.

Accordingly, studies on elite team-sport players have shown that, across age categories, significant increases in bar-power production are not consistently seen. For example, senior futsal players presented lower values (−13%, on average) of bar-power assessed in the jump squat than their under-20 counterparts.[41] Elite young soccer players also performed better than senior soccer players in the jump-squat testing by exhibiting higher values of relative bar-power (ie, 9.5 vs 9.0 W·kg^{-1}) at the OPL.[42] According to the authors, the progressive decrements in bar-power output observed across age categories might be partly associated with the negative impact of aging and the concurrent training phenomena on speed power–related adaptations, as team-sport players are increasingly exposed to extensive aerobic-based training methods (eg, technical–tactical training sessions, small-sided games) throughout their prospective development. Together these findings highlight and limit the discriminative ability of bar-power output at the OPL (and other power-related measures) on sport performance, especially at the top level.

Implementing the OPL in Postactivation Potentiation Enhancement Protocols

Postactivation performance enhancement (PAPE) refers to a short-term improvement in athletic tasks, such as jumping, sprinting, and throwing, induced by a previous conditioning activity (CA).[43,44] The time course and magnitude of PAPE effects are influenced by the interaction of many variables such as the type, volume, and intensity of the CA,[45] the rest interval between the CA, and the subsequent athletic task,[46] as well as the individual characteristics of the athlete, including sex, strength levels, and training background.[47,48] While PAPE mean effects are commonly observed at a group level following standardized protocols,[45,48] inconsistent findings and large variability for the time-course and magnitude of the PAPE effects are reported both within and between individuals, even when performing the same CAs.[49,50] Therefore, an individualized approach is reasonably required to optimize potentiation effects, by tailoring the PAPE factors and potential moderators on an individual basis.[51,52] In line with this conceptual rationale, the results of a few investigations have confirmed that the OPL approach is a valid and effective alternative when prescribing the intensity of conditioning activities in PAPE protocols aimed to enhance motor performances.[16,24,53] In fact, it is assumed that the OPL approach can affect the fatigue–potentiation relationship underpinning the PAPE time course by mitigating the accumulation of fatigue immediately upon completion of the PAPE protocol and optimizing the potentiation effects thereafter.[54] The available literature supports this hypothesis and highlights two main findings which can inform practical recommendations for the optimal implementation of OPL-based PAPE protocols among athletes. First, protocols implementing OPL likely induce superior potentiation effects compared with conditions in which the intensity of the CA is fixed and equivalent to heavy loads (ie, >85% of 1RM).[16,53,55] In the study by Dello Iacono and Seitz,[16] elite soccer players accelerated (ie, 5-m distance) and sprinted (ie, 10- and 20-m distances) faster across all post-PAPE time points following a hip-thrust PAPE protocol using OPL loads (ie, ~60% 1RM), compared with 85% of 1RM loads. This finding is not surprising as the OPL is accurately determined from individual load–power relationships and mechanical profiles. Importantly, the absolute loads equivalent to the corresponding OPLs across many resistance training exercises used in PAPE protocols are consistently lower (≥30% to ≤70% of 1RM)[56] than 85% of 1RM. In PAPE protocols 85% of 1RM loading, the heavy loads (associated with slower contraction velocities)[24] cause greater mechanical strain on the musculoskeletal system due to the considerable increase in the overall training volume (ie, absolute load × repetitions) and the time under tension.[57,58] Similarly, greater muscle damage and metabolic by-products (ie, lactate),[57,59] as well as higher acute perceptual responses of effort,[60] fatigue,[15] pain, and discomfort, are commonly observed during resistance training schemes with heavy loads (≥85 of 1RM) compared to OPL-based protocols. Altogether, the cumulative neuromuscular, mechanical, metabolic, and perceptual responses related to heavy loading conditions likely induce greater peripheral[58] and central[61] fatigue, whereby optimal PAPE effects are hindered. Indeed, using relatively lighter loads may avoid inducing excessive fatigue for some and under potentiate for others, with a greater likelihood of optimal individualized PAPE effects.

Second, the effectiveness of the OPL approach as a successful strategy to individualize the intensity variable of PAPE protocols can be supplemented with two other concurrent approaches, individualizing the volume and rest interval variables, respectively. Specifically, Dello Iacono et al[24] observed that elite basketball players jumped higher after self-selecting the number of repetitions to complete in a PAPE protocol compared to a fixed number of repetitions, with both conditions implementing the same CA consisting of jump squats loaded with OPL. The same authors also found that an OPL-based PAPE protocol designed as a cluster-set configuration (3 sets of 6 repetitions with 20-s rest every 2 repetitions) led the same cohort of elite athletes to jump consistently higher compared with a traditional-set configuration (3 sets of 6 repetitions without rest between repetitions) across all post-PAPE time points. Despite the limited number of studies,[15,16,24,53,62] their findings align with the same evidence showing that fatigue can be minimized, power outputs maintained, and potentiation optimized, by using OPL training configurations, with mediating benefits for acute PAPE effects that seem clear and meaningful.

Effects of Training at the OPL on Strength, Speed, and Power Performance

The prescription of resistance training is usually based on different percentages of maximum dynamic strength assessments such as the 1RM test.[9] However, the regular use of this measurement has been questioned by coaches and sport scientists because of its inherent risks, complexity, and time-demanding characteristics.[26,63,64] This is especially important at the elite level, where time constraints and large cohorts of athletes frequently preclude and limit the implementation of extensive testing and training procedures. In this regard, more recently, the practical and time-efficient velocity-based training (VBT) method has been proposed as an alternative strategy to prescribe and monitor resistance training intensity.[65,66] Interestingly, this approach builds upon the relationship between the velocities in distinct movements and the associated relative values of 1RM (ie, % 1RM), which highlights the inherent interconnection between the 2 methods.[9] In addition, some studies have raised concerns about the theoretical concepts behind the 1RM measure which, essentially, represents only the highest "mass" that an athlete can move during a maximum-effort lift.[8,9] The fact that this scalar variable does not reflect the force and velocity applied onto the barbell at the same time could hamper its utilization in high-performance sport settings, where time and velocity play a key role in determining the effectiveness of force application.[8,9] In turn, when training at the OPL, athletes can maximize the power applied against the external resistance, which seems to be much more connected to their sport-specific tasks.[8,9,29]

Indeed, previous research with 61 elite athletes (15 Olympians) from 4 different sports (ie, track and field, rugby sevens, bobsled, and soccer) confirmed that the bar-power outputs at the OPL (assessed in both half- and jump-squat exercises) were more strongly associated with sprint speed and vertical jump performance than 1RM.[9] Based on these mechanical principles and premises, several studies have been conducted to analyze the effects of training at the optimum power zone. Loturco et al[26] compared the effects of 2 different 6-week training interventions (traditional strength–power periodization vs training at the OPL) in elite soccer players and observed that, despite achieving similar improvements in maximum strength and jumping abilities, the "OPL group" exhibited greater increases than the "traditional periodization group" in both sprint speed and jump-squat power. Subsequently, Ribeiro et al[21] found that, compared to unloaded plyometrics, 7 weeks of combined squats and hip thrusts at the OPL led to greater gains in change-of-direction (COD) speed and linear sprint velocity. Accordingly, short- (1 wk) and medium-term (7 wk) investigations with Olympic boxers demonstrated the efficiency of training schemes based on the OPL, not only to enhance power-related capacities (eg, jump-squat and bench-press power), but also to increase punching impact.[38,67] More recently, Montalvo-Pérez et al[68] evaluated the effects of a 6-week training intervention at the OPL versus traditional resistance training in female competitive cyclists and reported similar gains in squat and split squat strength and power; however, superior increases in these mechanical variables were noted for the hip-thrust exercise in the OPL intervention. Moreover, OPL training resulted in an overall lower training intensity than the traditional resistance training program (~65% vs ~85% RM, respectively). Another recent study involved the ballistic bench-press to compare the effects of an 11-week individualized OPL training with a "traditional strength training program" where subjects were allowed to perform 50% of the maximal number of possible repetitions against different submaximal loads.[69] Although both methods were effective in improving power output, the OPL-based scheme minimized intrasession power decrements and generated less neuromuscular fatigue and less perceived exertion, which can be a great advantage for athletic and nonathletic populations.[69]

Other studies have reported comparable performance improvements between training regimes based on the OPL and different strength–power training methods. Rauch et al[20] investigated the effects of 2 different VBT approaches (ie, "progressive VBT" vs OPL) in female volleyball players using 3 different exercises: back squat, bench-press, and deadlift. Across 7 weeks, the progressive VBT group trained at velocity ranges of 0.55 to 1.0 $m \cdot s^{-1}$, whereas the OPL group always trained at the optimum power zone (at ~0.9 $m \cdot s^{-1}$). Overall, both training programs were equally effective for improving strength and power parameters, although a greater increase in deadlift 1RM strength was noticed in the OPL group.[20] Freitas et al[70] also found similar results when comparing the effects of a 6-week OPL training scheme with a modified complex training program (ie, combining loads of 80% 1RM and the OPL) on the physical performance of semi-professional basketball players during the competitive phase. The authors observed that the 2 training schemes induced moderate-to-large strength gains in both half-squat and hip-thrust exercises, with distinct but nonmeaningful improvements in COD, linear speed, and jump performances. Finally, an 8-week randomized controlled trial assessed the effects of OPL versus traditional resistance training (ie, 1RM-based loads) on the neuromuscular parameters of elite cyclists, and reported similar gains in squat, hip thrust, and lunge 1RM strength and power, although training intensity and "total weight lifted" were lower in the OPL group compared to traditional training for all exercises.[18]

Different exercises performed at the optimum power zone can potentially lead to different training adaptations. For instance, after testing the effects of training using the jump-squat or Olympic push–press exercises at the OPL over 6 weeks, Loturco et al[71] concluded that the jump squat was superior for improving speed- and power-related abilities (ie, 5-, 10-, and 20-m speed, COD speed, loaded and unloaded jumps) in elite young soccer players. Likewise, half- or jump-squat training under optimum loading conditions were able to partly counteract the speed and power decreases that commonly occur during short and congested preseasons in professional soccer players.[72] Nevertheless, these squat-based variations had different effects on players' performance: while the "traditional nonballistic half-squat" was more effective at improving jumping capacity, its "ballistic version" (ie, jump squat) seemed to be more effective in attenuating the potential decrements in short-sprint ability throughout the preseason phase.

Combinations of strength–power exercises executed at the OPL with other training strategies might also be used to induce more generalized performance adaptations. For example, mixed training approaches comprising jump- and half-squat exercises at the OPL and unloaded plyometrics or resisted sprints produced meaningful increases over different phases of sprint running (ie, acceleration and top-speed phases) in professional soccer players.[73] Finally, more recently, the OPL has been proposed as a reference value for determining a more comprehensive and effective range of "power loads," which can be selectively applied to elicit very specific adaptations to training.[74] For this purpose, coaches and sport scientists should define the specific "inferior and superior power-training zones," by increasing or decreasing the OPL magnitude at preestablished conditions (ie, using loads 20% higher or lower than the OPL). This simple loading adjustment may result in different training responses, with "heavier loads" (ie, OPL +20%) being possibly more effective for improving COD and jump performance and "lower loads" (ie, OPL -20%) for increasing short-sprint ability. Furthermore, the variation within these specific loading zones may be important to elicit progressive adaptation, as constant use of the same loading strategy could adversely affect performance gains across the competitive season.[75,76] Practitioners can easily implement these OPL-based training schemes either separately or combined, according to individual requirements and specific demands of the athletes and sports. It should be emphasized, however, that the load that maximizes power output changes over time and, thus, coaches are encouraged to frequently assess and adjust the OPL whenever possible and necessary (eg, on a weekly basis).

In summary, the available evidence indicates that the OPL approach may be used as an alternative and efficient training method, either in isolation or in combination with other training strategies (eg, as a "power-training block" after a maximum strength phase in long-term training interventions)[77] in athletes from different sports, with distinct training backgrounds. In general, the OPL approach leads to similar or slightly greater strength, speed, and power adaptations compared to more complex traditional resistance training methods, but with lower amounts of total weight lifted and lower levels of neuromuscular fatigue.

Effects of Training at the OPL on Body Composition Parameters

Apart from inducing strength, speed, and power adaptations, another common goal of resistance training programs is to enhance body composition (ie, promoting muscle mass gains or fat-mass loss). In this regard, recent evidence has investigated the effects of OPL training on body composition. Rauch et al[20] reported that a 7-week (3 sessions per week) OPL training program that mainly included the back squat, bench-press, and deadlift exercises was effective for increasing and reducing lean BM (+5.4%) and fat-mass (−8.5%), respectively, in female volleyball players, with these changes being similar to those induced by a progressive VBT program. More recently, different studies by the same research group assessed the effects of OPL training (2 sessions per week and including the hip thrust, squat, and lunge exercises) on cyclists. Gil-Cabrera et al[18] observed that training at the OPL for 8 weeks induced similar improvements in muscle mass (~ +1.5-2 kg) and decreased fat mass (approximately −0.5 kg) in professional male cyclists compared to those induced by a "traditional resistance training program" (ie, based on % 1RM). Valenzuela et al[78] reported that 7 weeks of OPL training (2 sessions per week) resulted in reduced fat mass (−0.5 kg) and increased bone mineral content (+0.04 g) in professional male cyclists, which was not observed when cyclists performed on-bike power training (ie, all-out 6-s sprints). Thus, although evidence is still scarce and mainly derived from studies in cyclists, OPL training appears as an effective intervention for improving body composition, being at least as effective as other traditional training regimes. It must be noted, however, that another study by the same research group[68] failed to find significant changes in any body composition-related parameters with either OPL or a traditional (ie, % 1RM) resistance training approach. Nonetheless, in this case, the study was shorter (6 wk), which might limit the comparison between the reported results.

Effects of Training at the OPL on Endurance-Related Outcomes

Given the potentially detrimental effects of increases in muscle mass and overall BM on endurance performance—particularly during uphill running or cycling—some concerns exist among endurance athletes about including resistance training.[79] However, resistance training programs have proven effective in improving not only strength, power, and body composition, but also endurance performance.[80–82] In this regard, although evidence is still scarce, recent studies conducted in cyclists also allow some preliminary conclusions to be drawn on the effects of OPL training on endurance-related outcomes. To date, all studies applying OPL training in endurance athletes have found beneficial effects on different performance indicators such as the power output (both in absolute and relative terms, ie, expressed relative to BM) attained during an 8-minute time trial or the power output associated with the respiratory compensation point,[18,68,78] with these benefits being similar to those induced by other training approaches such as "on-bike power training" or a "traditional resistance training program." Thus, OPL-based training appears as a useful strategy for endurance athletes, which is further supported by the positive influence of muscle power factors—which are improved with OPL training—on endurance performance.[12,62,83] It is important to note that the studies to date did not include a control group who maintained their usual endurance training regime without including resistance training. Therefore, the current results do not allow us to discern whether OPL training can provide additional benefits in endurance-related outcomes to those induced by endurance training alone. Moreover, further research is needed to determine whether OPL training could result in lower residual fatigue (eg, lower muscle soreness, neural fatigue, glycogen depletion) compared with other traditional resistance training programs, which would be of relevance so as to not to interfere with the athletes' endurance training.

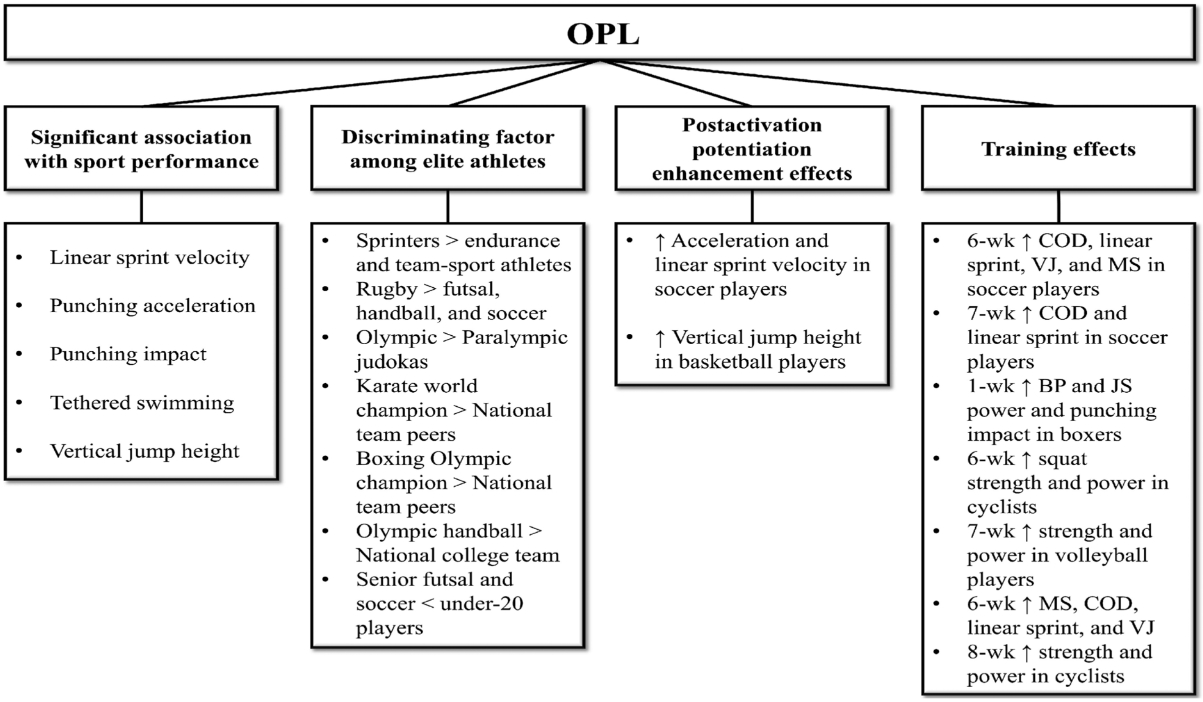

Figure 2 — Brief summary of the results and applications of the OPL approach. COD indicates change of direction; OPL, optimum power load; VJ, vertical jump; MS, maximum strength; BP, bench press; JS, jump squat.

Practical Applications

Overall, bar-power output at the OPL is strongly associated with athletic performance and is able to discriminate between athletes from different sport disciplines and performance levels. Coaches may implement OPL configurations to induce meaningful PAPE effects via distinct exercises (eg, hip thrust or loaded jump squats) and protocols (eg, cluster- or traditional-set conditions). Moreover, OPL training strategies can be used to increase strength, speed, and power performance in different athletic populations, with the possible advantage of generating lower levels of neuromuscular fatigue and perceived exertion (when compared with more traditional resistance training programs). Finally, practitioners from different sports may potentially employ OPL-based methods to improve endurance-related outcomes (eg, power output attained during a time-trial test) and body composition parameters. It should be acknowledged that there is a lack of long-term interventions based on the OPL, which is, in fact, a common limitation in studies that evaluate the effects of different resistance training strategies in top-level athletes. We also recognize that the occurrence of an acute mechanical phenomenon (ie, maximum power output at a given exercise) does not necessarily result in increased training responses—which is not the case here, since we are only synthetizing the evidence concerning OPL studies, while discussing their results and possible implications. Further studies are needed to investigate the long-term effects of training at the optimum power zone, as well as to compare the physiological and metabolic adaptations of OPL-based programs versus other strength training regimes.

Conclusions

The OPL-based schemes can be very useful for coaches and sport scientists interested in implementing simple and effective testing and training approaches. The OPL method can be effectively used in different sports and populations, with different purposes and configurations (Figure 2).

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