

Periodization for optimizing strength and hypertrophy; the forgotten variables

James P. Fisher, James Steele, Dave Smith, Paulo Gentil

Objectives: A growing area of discourse within sports medicine and resistance training is that of periodization. This has been represented as variation in load and subsequently repetitions as well as volume, with a view to maximize strength and hypertrophy adaptations. A number of recent review articles have attempted to draw overarching conclusions from the present body of literature in an effort to provide definitive guidelines. However, there are numerous variables within resistance training that are often overlooked, and in the context of periodization, might significantly impact adaptation.

Design & Methods: Narrative Review

Results: The present piece confers need for clarity in terminology of effort rather than intensity, as well as discussing how variety of load might impact volume-load, discomfort, muscle damage and recovery. Furthermore, this article discusses often overlooked variables such as variety in exercise selection, detraining periods, and supervision, which are all evidenced to impact strength and hypertrophy adaptations.

Conclusions: Our opinion is that without inclusion of these variables any guidelines surrounding periodization for strength or hypertrophy are limited in application. We conclude by highlighting areas for future research, as well as practical recommendations within this field.

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Key words: intensity ■ strength ■ hypertrophy ■ load ■ detraining ■ resistance training

INTRODUCTION

There has been a recent discussion about the use of periodization for resistance training adaptations (e.g. strength and hypertrophy).¹⁻³ Although many interesting points have been raised, there appears a failure to adequately discuss certain resistance training variables such as effort, detraining periods, variability in load and exercise selection, and supervision. These are all variables known to influence adaptations irrespective of periodized or non-periodized RT programs.⁴ In this commentary we elucidate these issues and discuss their importance in application to periodised resistance training as well as provide suggestions for future research.

It might first be worthwhile to discuss and differentiate between *periodization* and *programming*. Suchomel, et al.⁵ recently identified that whilst they appear similar, periodization “relates to the organization and timing of fitness adaptations” whilst “programming tactics ‘drive’ the appropriate adaptation during training phases in order to achieve the desired fitness characteristic” (page 769). The authors⁵ continue “Programming includes exercise selection, sets and repetitions, rest periods, and load selection”. However, from these descriptions it could be inferred that *periodization* is a reference to the desired specific adaptations, whilst *programming* is the manipulation of training variables by which these adaptations are incurred. The most recent review articles^{1,3} discuss periodization for maximizing strength and hypertrophy and

consider literature that has manipulated or considered the interaction between volume (sets), load (% 1-repetition maximum; RM), volume-load (VOL-L; load x repetitions x sets) frequency (number of days per week), and other such variables as a product of periodization models. We suggest that further review of these variables herein falls within the discussion of periodization and is worthwhile towards optimising desired adaptations.

Notably, periodization for the singular desirable adaptations of strength³ or hypertrophy¹ might be thought of as more one-dimensional than for other sporting populations where a more complex periodized model is necessary for the multiple physiological demands. For example, in preparing for a single event, a figure model or bodybuilder will look to optimise muscle hypertrophy and muscular definition,^{6,7} and a powerlifter/strongman will look to optimise strength⁸. However, their respective training demands do not include other key elements such as team cohesion or technical skill training as is common in sports performance. In this sense, even the seemingly gross motor skill of Olympic weightlifting might require more complex periodization strategies due to the technical elements of the Olympic lifts, compared to dominantly strength for a powerlifter or hypertrophy for a bodybuilder. Since the recent reviews focused solely on strength³ and hypertrophy,¹ the present discussion will also consider only these outcomes.

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From the Southampton Solent University, East Park Terrace, Southampton, UK (J.P.F., J.S.), Manchester Metropolitan University, Crewe, UK (D.S.), and Faculdade de Educação Física e Dança, Universidade Federal de Goiás, Goiânia, Brazil (P.G.)

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Correspondence to Dr. James Fisher, Southampton Solent University, East Park Terrace, Southampton, UK. Email: James.Fisher@solent.ac.uk

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EFFORT

A key aim of periodization is to manage or reduce the risk of overtraining through modification of variables over time². However, whilst fatigue and recovery are usually discussed, it is interesting that effort is not referred to. For example, Williams, et al.³ repeatedly discussed *training intensity* in reference to the load (% 1-repetition maximum; RM) being used. It has been suggested that intensity might best be thought of as the *effort* applied, rather than the *load* used⁹ and further that intensity actually refers to a measure of something and as such requires clarity (e.g., intensity of effort) when used, or should be dropped from the lexicon when discussing RT¹⁰. The use of the term intensity in reference to load is a relatively common error in RT publications, however as Leo Tolstoy stated; “*Wrong does not cease to be wrong because the majority share in it*”.¹¹ The maximal number of repetitions performed at the same relative load (% 1RM) shows considerable heterogeneity across the population, as well as variation between exercises.¹²⁻¹⁴ Therefore, the effort required by an individual to complete a set number of repetitions at a particular relative load can differ between and even within individuals. As such, it has been argued that, not only should the term *intensity* be avoided and instead load or effort simply used,¹⁰ but that effort should be considered with respect to proximity to momentary failure and controlled by appropriate definition and applications of set endpoints¹⁵. It is worth noting, that, as Williams, et al.³ identify in the limitations of their meta-analysis, training to momentary failure versus non-failure might affect the adaptive response. If this is the case then it seems folly to attempt to interpret the impact of periodized RT approaches compared to non-periodized RT approaches, or even one form of periodization compared to another, where set end points and thus effort has not been controlled between groups or conditions. Any differences could be confounded by the effects of different degrees of effort. This is particularly relevant when avoiding overtraining, since RT leading to failure considerably increases the time needed for the recovery of neuromuscular function and metabolic and hormonal homeostasis, even when compared to work matched training not to failure.¹⁶

DETRAINING PERIOD

In the recent meta-analysis Williams, et al.³ stated “*However, extended periods of training at a high intensity can greatly increase the risk of stagnation or overtraining*”, citing Herrick and Stone.¹⁷ Herrick and Stone¹⁷ compared previously untrained females divided into one of two groups; either progressive resistance exercise (PRE; 3 sets of 6RM for 15 weeks) or periodized resistance exercise (PER; 8 weeks of 3 sets using 10RM, 2 weeks of 3 sets using 4RM and 2 weeks of 3 sets using 2RM, with 1 week of active rest between each cycle). Both groups performed the bench press, lat pulls, behind-the-neck seated press, parallel squat, leg curl, and leg extension. Herrick and Stone¹⁷ reported that both groups had their loads “*prescribed and adjusted to ensure that the principles of PRE and PER were being followed*” (page 73), and also that the Borg’s rating of perceived exertion (RPE) scale was used to record ‘*intensity*’. Notably, both groups trained to RM

for all sets and exercises, and thus it could be reasonable to assume that they trained to the same intensity of effort throughout the intervention. As such, perhaps the most poignant variation between groups was the week’s active rest (aerobic exercise on a cycle ergometer using a low resistance) for the PER group. The authors reported no significant between-group differences for strength increases for bench press and parallel squat 1RM. However, they speculated that the slope of improvement for the PRE group might be indicative of overtraining toward the end of the intervention, and that this might have been avoided in the PER group due to the periods of active rest.

Other studies have reported similar decreases in progression throughout the duration of a continuous RT intervention when compared to groups performing non-continuous training. For example, Ogasawara, et al.¹⁸ divided participants in to continuous- (CTR) or non-continuous- training groups (RTR) for a 15-week RT intervention. The CTR group trained for 15 weeks without interval whilst the RTR group trained for 6 weeks, then rested for a 3-week detraining period, and then retrained for a further 6-weeks. The authors reported greater increases in the CTR group for the first 6-weeks compared to the final 6-weeks, whereas the RTR showed similar increases through both 6-week phases. Both CTR and RTR groups showed similar increases in both strength (bench press 1RM) and muscle size of the triceps brachii (TB) and pectoralis major (PM) following the 15-week intervention. In a later study Ogasawara, et al.¹⁹ repeated a similar research design across 24 weeks. The CTR group trained continuously for 24 weeks (3 sets of 10 repetitions @ 75% 1RM, 3 days per week), whilst the periodic re-training (RTR) group performed 3 cycles of 6 weeks of RT, with 3-week detraining periods between training cycles. Their results were similar to the previous study; following significant increases in the first 6 weeks, the rate of increase in both strength and muscle cross sectional area (CSA) of the TB and PM for the CTR group decreased throughout the intervention. In contrast the RTR group showed sustained increases across the 3-week detraining/6-week retraining phases, ultimately resulting in both groups showing similar increases in strength and muscle CSA at the conclusion of the 24-week intervention. Additionally, Gentil et al.²⁰ compared strength gains following 20 sessions of continuous and periodic resistance training programs in 60 young women. One group performed two sessions per week for 10 weeks continuously, while the other trained for 5 weeks, detrained for 2 weeks and resumed training for 5 weeks. According to the results, there was no significant difference on knee extensors and elbow flexors peak torque gain between groups.

It is noteworthy that none of this research considering detraining periods¹⁸⁻²⁰ was included in the meta-analysis by Williams, et al.³ or discussed the systematic review by Grgic, et al.¹ In this sense, it appears that authors have defined periodized training by its variation purely in load and repetitions, rather than considering training/detraining/retraining periods. Since this appears to be the variable that determines a sustained increase throughout an intervention, and the reason why Herrick and Stone¹⁷ reported a change in the slope of adapta-

tion, it seems that this might be an important variable for consideration. It should be noted that, though there were differences between the continuous and non-continuous groups in slope of improvements at different time points in the aforementioned studies,¹⁷⁻²⁰ it is naïve to assume that the rate of improvement over these short periods is in anyway indicative of what the slopes of improvement may look like over a longer period of time. The simple fact of the matter is that we do not know the degree to which the continued manipulation in any RT variable over extended periods of time might affect slope of change for any outcome variable.

The consideration of detraining periods is likely complex and dependent upon interindividual responses to RT. However, the evidence presented suggests that short-term (e.g. ≤ 3-weeks) detraining periods might present a useful opportunity to allow recovery from training stress without a fear of losing strength and muscle mass that cannot be recovered. Indeed, over the time course of an intervention (e.g. 10-24 weeks), the data suggests that strength and hypertrophy increases are similar irrespective of detraining periods.

VARIATION IN LOAD

Since variations in load and/or repetitions seem to be the defining characteristics of periodization (see above), at least in most authors minds, it is worth discussing the practicality of reducing the load used in a RT programme. This might serve to increase the number of repetitions possible; however, in doing so a personal trainer or strength coach has not guaranteed a reduction in effort as this is primarily determined by proximity to momentary failure¹⁴. And in fact, he or she might have increased the relative discomfort, possible muscle damage, and required recovery time. Our recent article²¹ comparing heavy-load (HL) and light-load (LL) RT showed similar increases in isometric strength where effort was matched through training to momentary failure (confirmed by assessment of RPE). However, greater values were reported for measures of discomfort for LL compared to HL. In this sense, whilst reducing the load during a training programme might be performed with the intention of reducing the effort and/or risk of overtraining, this might not be achieved, and in fact as a product of the likely greater number of repetitions might produce conflicting results.

Lower loads inherently result in greater volume-loads (e.g. load x repetitions x sets; VOL-L) being performed when they are continued to momentary failure. Genner and Weston²² assessed VOL-L and physiological responses to decreasing training loads (55%, 70% and 85% 1RM). They reported increasing VOL-L as well as BLA and cortisol with decreasing training loads. In a further study, Steele, et al.²³ reported larger weekly VOL-L for a light-load group performing 2 sets of 12-15RM to momentary failure compared to a heavy-load group performing 3 sets of 4-6RM to momentary failure (LL = 1142.4 ± 341.8 kg, HL = 696.4 ± 216.5 kg). Both groups trained twice per week for 9 weeks and analyses revealed similar increases in maximal strength (bench press 1RM) and absolute muscular endurance (number of repetitions @ 70% 1RM for bench press). These studies suggest that strength increases

are similar irrespective of load and VOL-L. It may be that the relatively low frequency of training (twice per week) in this study meant that the potentially negative effects of greater VOL-L from training with lighter loads was inconsequential. As such, we should be cautious to prescribe increased volumes and/or frequencies in combination with reductions in training loads to a high degree of effort (e.g. to momentary failure), in an effort to decrease training-related stress and reduce the risk of overtraining. The evidence suggests that reduction in load may serve to increase VOL-L and catalyze undesirable (and in fact, opposing) physiological responses (i.e., increasing BLA and cortisol). Again though, we would point out the lack of long term data suggesting this is indeed the case i.e. that adaptations to training will differ over longer periods of time in response to the manipulation of either load, repetitions, or frequency.

The general belief is that periodization would be beneficial because the alternation between periods of intensive training with recovery would promote supercompensation, leading to increased results. Based on this, it is usually hypothesized that larger performance increments would be observed after reducing training stress in those who experienced overreaching compared with those who did not.²⁴ However, the efficiency of this practice has been challenged in a recent study. Aubry et al.²⁴ reported that triathletes that showed symptoms of overtraining did not show signs of supercompensation during a taper period; moreover, increases in performance were more evident in people that consistently reported positive results in comparison to those with signs of overreaching. This brings into question if it is necessary to alternate cycles of stress and recovery or simply train with an optimal combination of intensity, volume and recovery. In agreement with this, some studies have shown that periodization showed inferior²⁵ or similar²⁶ results to approaches involving constant training planned to increase specific performance without inducing excessive fatigue and overreaching. Therefore, discussing the effects of periodization without considering the adequacy of the training regimens (i.e. its potential to induce overtraining/overreaching) might be misleading.

In consideration of maximal strength, Mattocks, et al.²⁷ recently demonstrated that performing low-volume single maximal efforts (5 repetitions), described as “*practicing the test*”, produced similar increases in maximal strength to a more traditional (*hypertrophy*) resistance training programme (4 sets of 8-12RM to volitional failure). Whilst the hypertrophy group showed greater increases in muscle hypertrophy, and the study considered untrained participants – which would show greater increases in strength for both groups compared to trained persons, it suggests that a low-volume, skill specific approach to RT can be efficacious for maximal strength increases. Indeed, other authors have also recently highlighted the importance of specificity in maximal strength development as a result of load and skill acquisition.^{28,29} As such, whilst RT at submaximal loads might be useful for strength and hypertrophic adaptations, it seems reasonable to suggest that in preparation for a single event (e.g. a powerlifting competition) a person should be optimising specific adaptation. For muscular hypertrophy,

differing recommendations might exist. For example, research has suggested that muscle growth is similar when training with heavier and lighter loads,^{28,30} however, if metabolic stress is truly a driving force in muscle hypertrophy³¹ then periods of lighter-load resistance training to momentary failure might be purposeful if performed using appropriate frequencies or in coordination with successive detraining periods to allow recovery and avoid overtraining.

VARIATION IN EXERCISE SELECTION

An often overlooked variable in the academic literature considering periodization is that of exercise variation. Whilst it might be argued that exercise variation does not constitute periodization, we believe that variety might play a key role in preventing stagnation, and in stimulating continued and comprehensive adaptations. For example, Fonseca, et al.³² compared 4 groups of participants training using constant load and constant exercise (CICE), varied load and constant exercise (VICE), constant load and varied exercise (CIVE) and varied load and varied exercise (VIVE). All groups showed significant increases in squat 1RM and whole muscle quadriceps CSA following 12 weeks of RT. However, the authors reported more favourable adaptations for hypertrophy of the quadriceps muscle heads (vastus lateralis, medialis and intermedialis and rectus femoris; VL, VM, VI and RF) for the varied exercise groups, and indeed the constant exercise groups did not display hypertrophy in the VM or RF. Furthermore, the CIVE group showed greater strength increases than the other groups, and the group with the largest training variation (VIVE) was more efficient in increasing maximum strength than the group with no variation (CICE).

SUPERVISION

A further comment regarding the recent review articles is the inclusion of studies comparing supervised versus unsupervised RT programs. The study by Storer, et al.³³ which was included in the Williams, et al.³ meta-analysis, did not solely compare periodized versus non-periodized RT, but in fact compared a group supervised by a personal trainer (PTr) versus a group training independently (SELF). It is not a surprise that the PTr group showed greater increases in lean body mass, maximal strength, peak power, and maximal oxygen uptake since previous evidence supports favourable adaptations for supervised compared to unsupervised RT. For example, Mazzetti, et al.³⁴ reported that supervised- compared to non-supervised RT produced greater adaptations, whilst other authors have shown that a favourable supervision ratio (i.e., fewer participants to trainers) also produces superior increases in strength.^{35,36} Williams, et al.³ failed to mention this variable in the context of the Storer, et al.³³ article, or discuss supervision at all within their article which could certainly confound the meta-analytical outcome. Indeed, it has been argued that the greater adaptations produced from supervised training is likely a result of trainees achieving a higher effort.³⁵ We have recently shown in an older population that, after an initial 6 month progressively higher effort RT intervention, those who continued training unsupervised had similar decreases in outcomes as those who

ceased training altogether.³⁷ From a practical perspective, the benefits of supervision for RT adaptations are evident. As such, powerlifters and/or bodybuilders looking to optimise strength or hypertrophic responses to RT should consider the potential advantages of being coached/supervised throughout their program. Indeed, the addition of a training partner might serve the same role with similar benefits and future research should consider this possibility.

CONCLUSION

Whilst the concept of periodization might be rooted in an intuitive and seemingly logical approach to apply variation in an effort to reduce the risk of overtraining, there remains little evidence to empirically support the variation of load and/or repetitions, or indeed frequency, for specific strength or hypertrophic adaptations. As suggested by Nunes, et al.,²⁹ strength adaptation appears to be specific. As such, the skill acquisition of practicing a given exercise with a heavier load might serve to develop the motor schema. This explains why a variety of loads produce similar strength increases, where intensity of effort is similar (e.g., training to momentary failure) and when tested by impartial means.²⁸ Indeed, another recent review of the area concluded that the seemingly favourable adaptations produced by periodized training approaches for strength may be explained almost entirely by the specificity of strength outcomes.²

Any review article considering periodization is notably difficult because of the inferred differences between periodization and programming within RT, as discussed in the introduction. Furthermore, meta-analyses of the topic of periodization are particularly challenging since, by the nature of periodized RT, they attempt to include studies with considerable heterogeneity in the research design and variables considered. Indeed, this is an issue for meta-analyses in RT in general,⁴ let alone those examining periodization. However, within the meta-analysis by Williams, et al.³ there was also considerable disparity in the population samples (e.g., collegiate football- and tennis- players, older adults, adolescents, and overweight men), which serves only to further add uncertainty and thus lessen the value of any conclusions. Perhaps the most valuable part of the discussion surrounding periodized RT might be that of stagnation. Certainly, from a practical perspective the old adage “*a change is as good as a rest*”, inferring change can be physically and mentally restorative, seems rational. However, we should consider in what format that variety is expressed. Deliberate variation in loading schemes and repetition ranges might produce sufficient variation to overcome stagnation, whilst not producing more favourable physiological adaptation, however, as discussed, this might constitute programming rather than periodization. Indeed, variety in exercise and even periods of detraining seem more beneficial in producing favourable and continued strength and hypertrophy adaptations. Yet as noted, whether it is even possible to produce continued long-term improvements and overcome so called ‘stagnation’ is not something with sufficient empirical evidence in our opinion. Recent reviews have noted that hypertrophic adaptations do not occur ad infinitum³⁸ and there is no reason to believe that

strength or any other outcome can adapt as such either. In fact, the effects of variation in RT variables upon strength may merely be due to the specificity of strength outcomes. There may be other benefits to training variation such as increased engagement and thus adherence over the long-term, but this requires further research.

PRACTICAL APPLICATIONS

The reality of periodization is that many strength and conditioning and personal training practitioners likely already provide variety in their trainee's routines. However, there is certainly scope for future research to consider perceptual attitudes towards detraining periods and variation within RT protocols. Furthermore, there are opportunities to consider the effects of programming variety in training in different personality types, and the interaction of variety and supervision upon long term adaptations within a periodized model (e.g. phases of supervised vs. unsupervised training to impact intensity of effort and physiological adaptations).

Where so many variables must be managed and are open to manipulation within strength and conditioning practices, a definitive evidence-based solution might be impossible to draw. However, practitioners should monitor strength and hypertrophy, as well as desirable physical and psychological performance, and adapt training routines appropriately, considering specifically; effort, variety of load and exercise, supervision, and the inclusion of detraining periods which are all evidenced to impact adaptations.

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Conflicts of Interest

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