

## Periodization: What is it good for?

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Resistance training increases muscle size and strength and is associated with numerous health benefits. For many, periodization serves as the cornerstone of programming for resistance training and is commonly touted in the literature as a superior method of training.

**Objective:** To review the literature on the effects of periodization for those looking to improve muscle size and strength.

**Design and Methods:** Non-systematic review. Research articles were collected using search terms such as linear periodization, non-linear periodization, non-periodized, undulating periodization, and strength training models.

**Results:** Previous research has found no differences in muscle size between periodized and non-periodized training programs. Further, there are conflicting reports on what periodized program is superior for increasing muscle strength. It is our contention that the proposed superiority in strength with periodized programs is often explained by the principle of specificity.

**Conclusion:** The use of a periodized program may be advantageous for an athlete in certain sports due to practice and competition throughout the season. However, we wish to suggest that the proposed benefits of periodization for those only interested in increasing muscle size and strength are largely founded in conjecture and that there is little compelling evidence that periodization is a superior method of training.

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**Key words:** resistance training ■ periodized ■ hypertrophy ■ strength ■ manipulation

### INTRODUCTION

Resistance training is commonly utilized to increase muscle size and strength and is also associated with numerous health benefits.<sup>1</sup> The American College of Sports Medicine recommends that resistance training be periodized to allow proper recovery between sessions and help prevent overtraining.<sup>2</sup> The periodization of training was made popular by Matveyev from Russia and was later implemented in the United States by Stone, O'Bryant, & Garhammer.<sup>3</sup> This hypothetical model for strength training was initially intended for competitive weightlifters and was later adopted by athletes in sport.<sup>4,6</sup> For many, periodization serves as the cornerstone of programming for resistance training and is commonly touted in the literature as a superior method of training. The purpose of this manuscript is to review the literature on the effects of periodization for those looking to improve muscle size and strength.

#### The Philosophy of Periodization

The concept of periodization is based on Selye's general adaptation syndrome that consists of three different stages and describes how an organism will respond to stress. This model also states that chronic exposure to a particular stressor may lead to an exhaustion phase in which adaptation is lost.<sup>7,8</sup> Therefore, the objective of periodization is to alter volume, intensity, and training frequency to maximize performance and reduce the odds of overtraining.<sup>3,9</sup> However, resistance exercise is an acute stress and is unlikely to parallel the chronic stress model previously proposed by Selye.<sup>7,8</sup> In addition, the

resistance training protocols that have been shown to induce overtraining in humans have been designed to do so and are unlikely to be implemented by those looking to increase muscle size and strength.<sup>10</sup> Nevertheless, there are three different resistance training programs that are commonly applied to induce an increase in muscle size and strength: linear periodization, non-linear periodization, and the traditional non-periodized approach. Linear periodization divides a strength training program into different periods or cycles: macrocycles (9-12 months), mesocycles (3-4 months), and microcycles (1-4 weeks) where intensity (% one repetition maximum (1RM)) is gradually increased across time and volume is subsequently decreased.<sup>3,9,11-13</sup> Non-linear periodization is characterized by more frequent alterations (e.g. daily or weekly) in the intensity and volume.<sup>14</sup> A non-periodized program consists of no planned variation in relative intensity and volume and is typically structured by straight sets of exercise. In order to induce progressive overload, the load is increased as an individual gets stronger in order to maintain the same repetition range (i.e. 3 sets x 6 repetitions).<sup>3,11-13,15</sup>

#### Benefits for muscle growth?

Previous research has suggested that a periodized program induces greater increases in muscle size compared to a non-periodized program.<sup>3,16</sup> This superiority of muscle growth from periodization was originally based on observations from Stone, O'Bryant, & Garhammer<sup>3</sup> who used underwater weighing to determine if there were any changes in lean body mass follow-

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ing either a periodized or non-periodized training program. The periodized program increased lean body mass to a greater extent than the non-periodized program following 3 weeks of resistance training. Interestingly, over the next three weeks both groups continued to lift weights but lost lean body mass at a group level. Based on this finding, it has been suggested that there may be a loss in lean body mass following the transition from the high volume phase to the low volume phase. This finding is one of the reasons it is thought that utilizing non-linear periodization is more beneficial, in that an individual can maintain muscle adaptations across differing phases. However, this loss in lean body mass is not consistent with the rest of the literature. For example, Baker, Wilson, & Carlyon<sup>12</sup> observed a maintenance in lean body mass when transitioning from a high to low volume phase. Even when completely removing the resistance training stimulus for a three week period, muscle size decreased but not back to baseline<sup>17</sup> making the Stone, O'Bryant, & Garhammer<sup>3</sup> observation difficult to explain. It should be mentioned that many of these studies estimated muscle growth based on lean body mass changes from non-direct measurements (i.e. underwater weighing, skin fold testing) and these may not be the best surrogate for changes in muscle size (Table 1). When using the gold standard method of measuring muscle mass (i.e. magnetic resonance imaging) there were no differences observed between a periodized and non-periodized program in cross-sectional area of the quadriceps.<sup>13</sup> Thus, the finding from Stone, O'Bryant, & Garhammer<sup>3</sup> where individuals continued to resistance train but lost lean body mass seems equivocal. Additional studies have found no differences between periodized or non-periodized training programs (Table 1) or even between linear and non-linear training programs in augmenting muscle size.<sup>9,12,15,18-21</sup> By applying a more direct estimate (i.e. MRI and ultrasound) for muscle growth, future research may gain a better understanding of the adaptations occurring from these different resistance training programs.

### Benefits for muscular strength?

Muscle strength is the ability to exert force from a specific muscle or muscle group and is often measured through the performance of a 1RM. Previous studies have suggested that periodization is a superior program to increase muscular strength compared to a non-periodized program.<sup>3,11,22-24</sup> For example, Willoughby<sup>11</sup> investigated two different non-periodized programs against a periodized program in untrained individuals for 16 weeks. At the conclusion of the study, the periodized program resulted in a greater increase in strength for both the bench press and squat. The author suggests that the non-periodized group failed to continuously increase strength over time because individuals may have been in the early stages of overtraining. In contrast, others have not found any significant differences in strength between a periodized and non-periodized program.<sup>12,18,25</sup> One of the pillars of periodization is that the "hypertrophy" phase or day is necessary because a larger muscle is a stronger muscle. Although baseline muscle size is correlated to strength<sup>26</sup>, the change in muscle size with training explains only a small percentage of the variance in the change

in strength with training<sup>27</sup>. It seems unlikely that this change in muscle size is playing a large role with the increase in strength from training, particularly in those who are already well-trained. We suggest that the proposed superiority in strength with periodized programs are often times explained by the principle of specificity.<sup>28-30</sup> For example, the studies that found linear periodization superior to a non-periodized program is likely due to the greater intensity (i.e. training at a higher % 1RM) performed at the end of the program which closely mimics the 1RM test that is used to assess strength (Table 1). Thus, an individual training at a higher load (3 RM) will test better at a 1RM than someone training at a lower percentage of their 1RM (6-10 RM) due to more practice at a greater intensity. The importance of specificity is further supported by data from our laboratory where a condition performing only the 1RM throughout training (1RM was the training) performed just as well in the post-testing 1RM as the condition which performed the 1RM in addition to 3 sets of volume at 70% 1RM (Unpublished Observations).

Muscle strength has also been compared between linear and non-linear periodization programs. In general, some studies observed that non-linear periodization produces greater strength compared to linear periodization during the first few weeks of training.<sup>9,15,20,31</sup> This may be due to more frequent sessions with a greater intensity in a given period compared to linear periodization. However, when comparing both periodized programs at the conclusion of a study, linear periodization is often similar to non-linear periodization due to training at a greater intensity at the end of the program.<sup>12,20,31,32</sup> A study by Monteiro et al.<sup>15</sup> is the only study to our knowledge that largely disagrees with this thesis. This study investigated three different resistance training programs using trained individuals and concluded that non-linear periodization was superior to both a linear periodization program as well as a non-periodized program. The authors suggested that the linear periodization program did not contain enough variability to induce an increase in strength compared to the non-linear periodization program. Also, the non-periodized group may have maintained the same absolute load throughout the study based on the authors' discussion. This apparent lack of progressive overload may have also played a role in the discrepant findings (Table 1). Regardless, these findings are in direct contrast to a similar study by Baker, Wilson, & Carlyon.<sup>12</sup> This study also investigated three different resistance training programs and concluded that there were no significant differences in muscle strength between non-linear periodization, linear periodization, and a non-periodized program. It should be mentioned that the participants in this study progressively increased their load while it is unsure if this was done in the Monteiro et al.<sup>15</sup> study. Overall, it is unclear which periodized program is superior in increasing strength due to conflicting reports.<sup>9,12,13,15,19-21,24,31,32</sup>

### CONCLUSION

Contrary to what is commonly touted in the literature, there is little evidence that a periodized program augments muscle growth over that achieved with a non-periodized program undergoing progressive overload. Due to the conflicting

reports, there is also insufficient evidence to determine the most appropriate periodized training program to increase muscle strength. Regardless, the principle of specificity suggests that those who want to increase strength (e.g. 1RM) the most in a specific lift should exercise at or near their 1RM in that particular lift. However, the use of a periodized program may be advantageous for an athlete in certain sports due to the need to plan training around practice and competitions throughout the season. As for someone who is only interested in augmenting muscle size and strength, it is not necessary to apply this method of training nor does it appear to provide added benefit over traditional progressive resistance exercise. We wish to suggest that the proposed benefits of periodization are largely founded in conjecture and that there is little compelling evidence that periodization is a superior method of increasing muscle size and strength.

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**Table 1** Periodized vs Non-periodized

Reference	Population/ Training status	Resistance Training program	Muscle Growth Measurement	Muscle Strength Assessment	Study Results	Notes
Stone, O'Bryant, & Garhammer <sup>3</sup>	<p>Experiment #1 20 healthy college-age males</p> <p>Observation #1 6 Olympic style weightlifters who were all Class I or better by US standards.</p> <p>Observation #2 31 High school American style football team</p>	<p><i>6 weeks – 3d/wk</i></p> <p><u>Experiment 1</u> Non-periodized Weeks 1-6: 3x6</p> <p>Periodization Weeks 1-3: 5x10 Week 4: 5x5 Week 5: 3x3 Week 6: 3x2</p> <p><u>Observation #1</u> <i>9-week observation</i> Authors do provide program protocol</p> <p>Norwegian system</p> <p>Periodization</p> <p><u>Observation #2</u> Non-periodized Weeks 1-12: 3x6</p> <p>Periodization Weeks 1-3: 5x10 Weeks 4-7: 3-5x5 (1x10) Weeks 8-10: 3x3 (1-3x5) Weeks 11-12: 3x2 (1-2x5)</p>	Underwater weighing	Squat	<p>Linear periodization group significantly different from Non-periodized group.</p> <p>Hypothetical strength training model in both observations increased strength and power greater than non-periodized.</p> <p>Lean body mass was significantly greater in the periodized group. Percent fat was significantly lower in the periodized group.</p>	<p>Periodized group trained at a greater intensity in 5-6 weeks. Therefore, more practice close to the 1RM test.</p> <p>Underwater weighing is not a measure of muscle size.</p> <p>At group level, lean body mass decreased even when lifting weights.</p>
Stowers et al. <sup>22</sup>	<p>84 college-age males</p> <p>Untrained</p>	<p><i>7 weeks – 3 d/wk</i></p> <p><u>Group 1 – 1 set to exhaustion</u> Weeks 1-2: 1x10 light, 1x10-12 to exhaustion Weeks 3-5: 1x10 light, 1x10-12 to exhaustion Weeks 6-7: 1x10 light, 1x10-12 to exhaustion</p> <p><u>Group 2 – 3 sets to exhaustion</u> Weeks 1-2: 1x10 light, 3x10-12 to exhaustion Weeks 3-5: 1x10 light, 3x10-12 to exhaustion Weeks 6-7: 1x10 light, 3x10-12 to exhaustion</p> <p><u>Periodization</u> Weeks 1-2: 1x10 light, 1x10 moderate, 5x10 heavy Weeks 3-5: 1x10 light, 1x10 moderate, 5x3 heavy Weeks 6-7: 1x10 light, 1x10 moderate, 3x3 heavy</p>	N/A	Bench Press  Squat	<p>1RM Bench Press increased in all groups from pre-to-post testing with no significant differences between groups</p> <p>1RM Squat increased in all groups from pre-to-post testing. Periodization significantly different to Group 1 &amp; Group 2.</p>	<p>The periodization group trained at a heavier load from weeks 6-7 where the authors observed the divergence of training programs.</p> <p>Subjects progressed at their own rate.</p>

O'Bryant, Byrd, & Stone <sup>23</sup>	90 males Volunteers from beginning weight training classes	11 weeks – 3 d/wk  <u>Non-periodized</u> Weeks 1-11: 3x6  <u>Linear Periodization</u> Weeks 1-4: 5x10 Weeks 4-8: 3x5, 1x10 Weeks 8-11: 3x2, 1x10	N/A	Squat	Linear and Non-periodized groups significantly increased from pre-to-post training in 1RM squat. Linear Periodization observed a significantly greater 1RM squat at 8 weeks and 11 weeks.	Subjects progressed at their own rate.  The last 3 weeks of Linear Periodization lifted closer to a 1RM. Thus, displaying that specificity plays a role.
Willoughby <sup>11</sup>	92 male college students. All subjects had to have abstained from weight-training at least 6 months immediately preceding the study	16 weeks – 3 d/wk  <u>Group 1 – Non-periodized</u> Weeks 1-16: 5x10 RM  <u>Group 2 – Non-periodized</u> Weeks 1-16: 6x8 RM  <u>Periodization</u> Weeks 0-4: 5x10 RM Weeks 4-8: 4x8 RM Weeks 8-12: 3x6 RM Weeks 12-16: 3x4 RM	N/A	Bench Press  Squat	1RM Bench Press & Squat increased from pre-to-post in all groups. The Linear Periodization group significantly different between the Non-periodized groups	The periodized group performed at a greater intensity compared to Group 1 & 2 towards the end of the study. Thus, the periodized group had more practice with heavier loads, which indicates specificity.
Baker, Wilson, & Carlyon <sup>12</sup>	22 Males At least 6 months of weight training experience but were not competitive strength athletes	12 weeks - 3 d/wk  <u>Non-periodized</u> Weeks 1-12: 3x6  <u>Linear periodization</u> Weeks 1-4: 5x10 Weeks 5-8: 5x5 Weeks 9-11: 3x3, 1x10 Week 12: 3x3  <u>Non-linear periodization</u> Weeks 1-2: 5x10 Weeks 3-4: 5x6 Weeks 5-6: 5x8 Weeks 7-8: 5x4 Weeks 9-10: 5x6 Weeks 11-12: 4x3	Skinfold testing	Bench Press  Squat	All training groups increased 1RM strength in squat and bench press. No difference between groups.  No difference between groups in lean body mass; however, lean body mass maintained in linear periodization at the end.	Subjects progressed at their own rate.
Herrick & Stone <sup>25</sup>	20 college-age women Untrained	15 weeks – 2 d/wk  <u>Progressive Resistance Exercise</u> Weeks 1-15: 3x6  <u>Periodization</u> Weeks 1-8: 3x10 RM Week 9: active rest Weeks 10-11: 3x4 RM Week 12: active rest Weeks 13-14: 3x2 RM	N/A	Bench Press  Squat	Linear periodization and Progressive resistance exercise increased pre-to-post testing. No significant between group differences.	Subjects who recorded below a 16 (hard to very hard) from the RPE scale for any set, increased resistance for the next training session as long as they could complete the required number of repetitions and sets.

<p>Schiotz et al.<sup>18</sup></p>	<p>14 college-age men Trained – enrolled in university’s Army ROTC</p>	<p><i>10 weeks – 4 d/wk</i></p> <p><u>Non-periodized</u> Weeks 1-10 4x6</p> <p><u>Periodization</u> Weeks 1-2: 5x10 Week 3: 3x10, 1x8, 1x6 Week 4: 2x8, 3x5 Week 5: 1x8, 1x6, 3x5 Week 6: 1x8, 4x5 Week 7: 1x8, 2x5, 1x3, 1x1 Week 8: 2x5, 1x3, 1x2, 1x1 Weeks 9-10: 2x3, 4x1</p>	<p>Skinfold testing</p>	<p>Bench Press  Squat</p>	<p>Bench Press and Parallel Squat increased 1RM pre-to-post testing. There were no differences between groups for either lifts.</p> <p>There were no significant differences between groups for lean body mass.</p>	<p>Progressive overload was applied to maintain relative intensity of 80% 1RM in Non-periodized program.</p> <p>Periodization progressively increased from 50% -105% 1RM. Weeks 3 and 7 were unloading weeks.</p>
<p>Stone et al.<sup>24</sup></p>	<p>21 male volunteers</p>	<p><i>12 weeks – 3 d/wk</i></p> <p><u>Non-periodized</u> Weeks 1-12: 5x6 RM</p> <p><u>Stepwise periodization</u> Weeks 1-4: 5x10 Weeks 5-8: 5x5 Weeks 9-11: 3x3, 1x10 Week 12: 3x3</p> <p><u>Overreach periodization</u> Weeks 1-2 5x10 Weeks 3-4: 3x5, 1x10 Weeks 5: 3x3, 1x5 Weeks 6-8: 3x5, 1x5 Week 9: 5x5, 1x5 Week 10: 3x5, 1x5 Week 11: 3x3, 1x5 Week 12: 3x3/1</p>	<p>N/A</p>	<p>Squat</p>	<p>1RM squat increased significantly in Stepwise and Overreaching while Non-periodized did not.</p>	<p>Stepwise and Overreaching periodized programs practiced at a greater intensity compared to the Non-periodized; indicating specificity for the test.</p>
<p>Monteiro et al.<sup>15</sup></p>	<p>27 Males Trained at least 4 d/wk in the past 2 years while regularly performing bench press and squats in their training program</p>	<p><i>12 weeks – 4 d/wk</i></p> <p><u>Non-periodized</u> Microcycle 1: 3x8-10 RM Microcycle 2: 3x8-10 RM Microcycle 3: 3x8-10 RM Microcycle 4: 3x8-10 RM</p> <p><u>Linear periodization</u> Mesocycle 1: 3x12-15 RM Mesocycle 2: 3x8-10 RM Mesocycle 3: 3x4-5 RM Microcycle 4: 3x12-8-4 RM (MWF)</p> <p><u>Non-linear periodization</u> Microcycle 1: 3x12-15 RM Microcycle 2: 4x4-5 RM Microcycle 3: 3x8-10 RM Microcycle 4: 3x12-8-4 RM (MWF)</p>	<p>Skinfold testing</p>	<p>Bench Press  Leg Press</p>	<p>Non-linear Periodization was more effective in increasing strength than Linear and Non-periodized programs</p>	<p>There was no apparent progressive overload for the non-periodized group. The groups appeared to use the same absolute load throughout the training program.</p> <p>Authors suggest that the Linear periodization did not have enough variability to induce strength increases.</p>

<p>Souza et al.<sup>13</sup></p>	<p>37 recreationally active male physical education students No regular strength training for at least 6 months prior to study.</p>	<p>6 weeks -2 d/wk</p> <p><u>Non-periodized</u> Weeks 1-6: Squat 3x8, Knee extensor 2x8</p> <p><u>Linear periodization</u> Weeks 1-4: Monday Squats 3x12, Knee extensor 2x12 Thursday Squats 2x12, Knee extensor 2x12</p> <p>Weeks 5-6: Squats 4x8, Knee extensor 2x8</p> <p><u>Undulating periodization</u> Weeks 1-4: Monday Squats 2x12, Knee extensor 3x12 Thursday Squats 3x8, Knee extensor 3x8</p> <p>Weeks 5-6: Monday Squats 3x10, Knee extensor 2x10 Thursday Squats 4x6, Knee extensors 2x6</p>	<p>MRI</p>	<p>Squat</p>	<p>1RM squat increased in the Non-periodized and Non-linear training programs. Linear Periodization did not see significance pre-to-post testing.</p> <p>Quadriceps CSA increased in all training models similarly with no differences between groups</p>	<p>The authors noted in their discussion that the Linear periodization program performed about half of their training at a lower intensity (i.e. 12 RM) compared to the Non-periodized and Undulating programs.</p>
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\*Willoughby (1992) "A comparison of three selected weight training programs on the upper and lower body strength of trained males." Unable to retrieve a copy despite multiple efforts including contacting the author.

\* 1RM (one repetition maximum)