

The background of the slide is a composite image. The top half shows a dense canopy of green trees against a bright sky. The bottom half shows a classical building with several white columns and a brick facade. A large, semi-transparent blue banner is overlaid across the middle of the image, containing the title and presenter information.

Programming for the Rehab Professional

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Special Thanks



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- Deidra Charity PT, DPT, SCS
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- Identify various periodization types and their benefits and utilization for the Physical Therapist
- Understand various energy systems and their importance when considering exercise and programming selection
- Describe important components to a periodization program
- Formulate ways to create a periodization program as a rehab professional



- There are no hard and fast rules when it comes to strength and conditioning and clinical judgment should always be used when developing rehabilitative programs for athletes

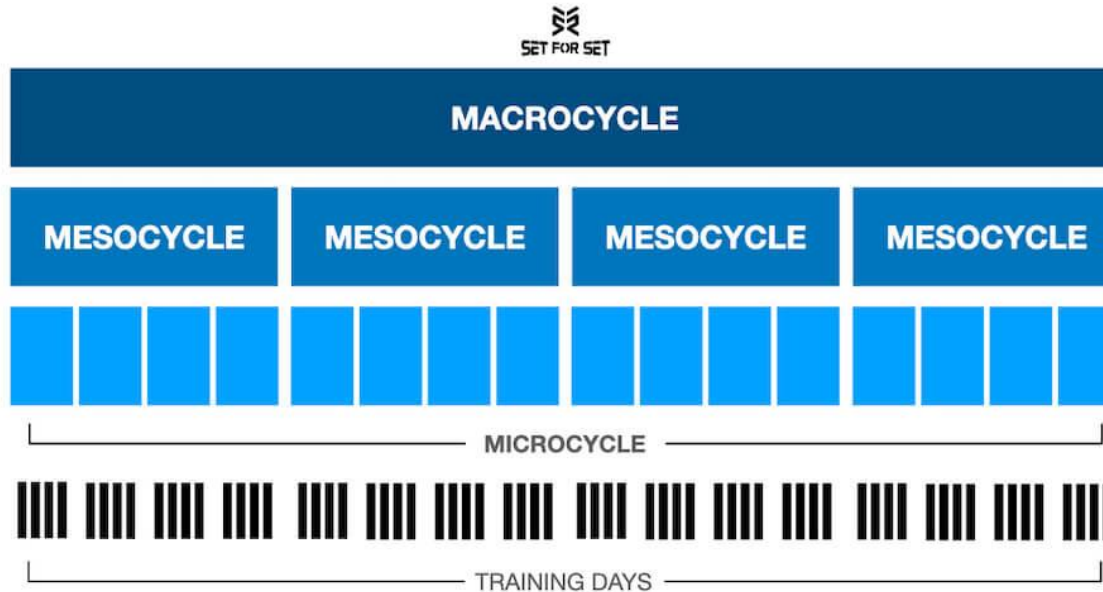


- **Macrocycle:** the longest length of time a program is broken into
 - This can be several months to years
- **Mesocycle:** intermittent lengths of time that are broken into more specific phases
 - Several weeks to months
- **Microcycle:** most granular focus of acute training
 - Weekly to daily

Programming Basics cont.



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<https://www.setforset.com/blogs/news/macrocycle-mesocycle-microcycle-explained>

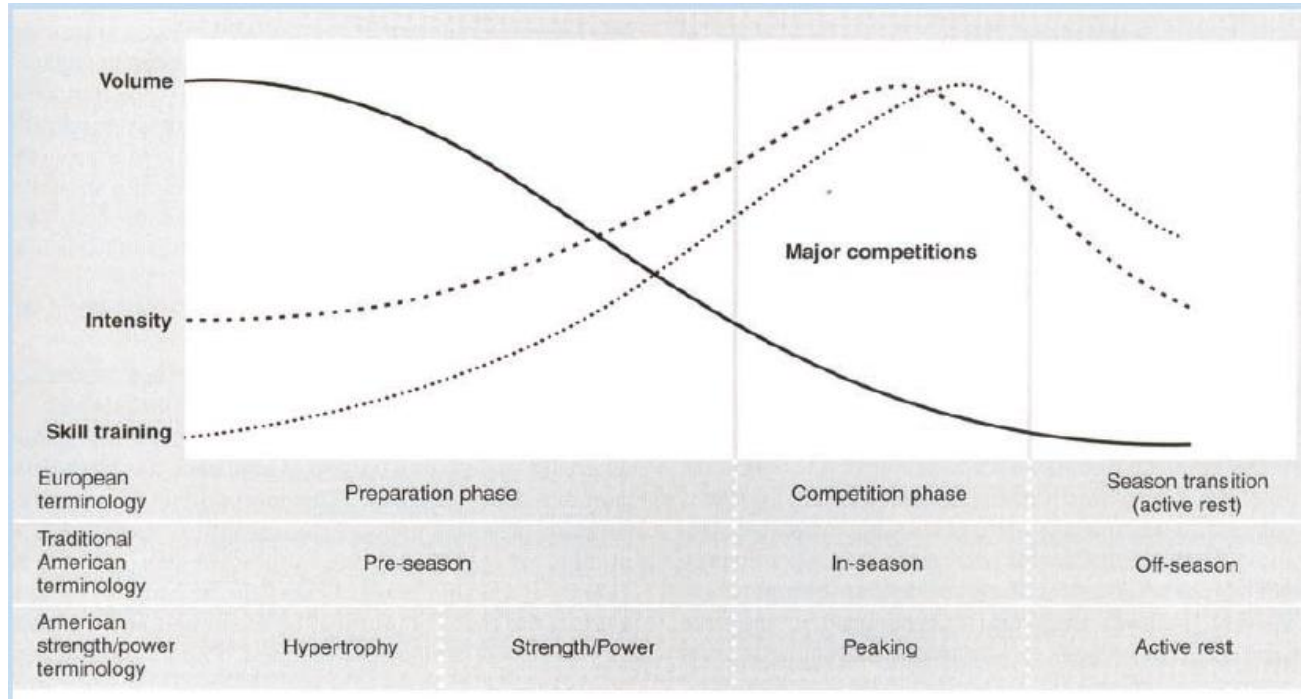


- Planned manipulation of training variables to maximize training adaptations and prevent overtraining syndrome^(Lorenz et al. 2019)
- 4 major types
 - Linear
 - Undulating
 - Blocked
 - Reverse Linear



- Increase in intensity with a decrease in volume over time (Moesgaard et al. 2022)
- Changing exercise volume and load across several predictable mesocycles (Lorenz et al. 2019)
- Mesocycles are broken into distinct time blocks and each block has a specific training adaptation

Linear Periodization



Lorenz et al. 2011

Undulating Periodization



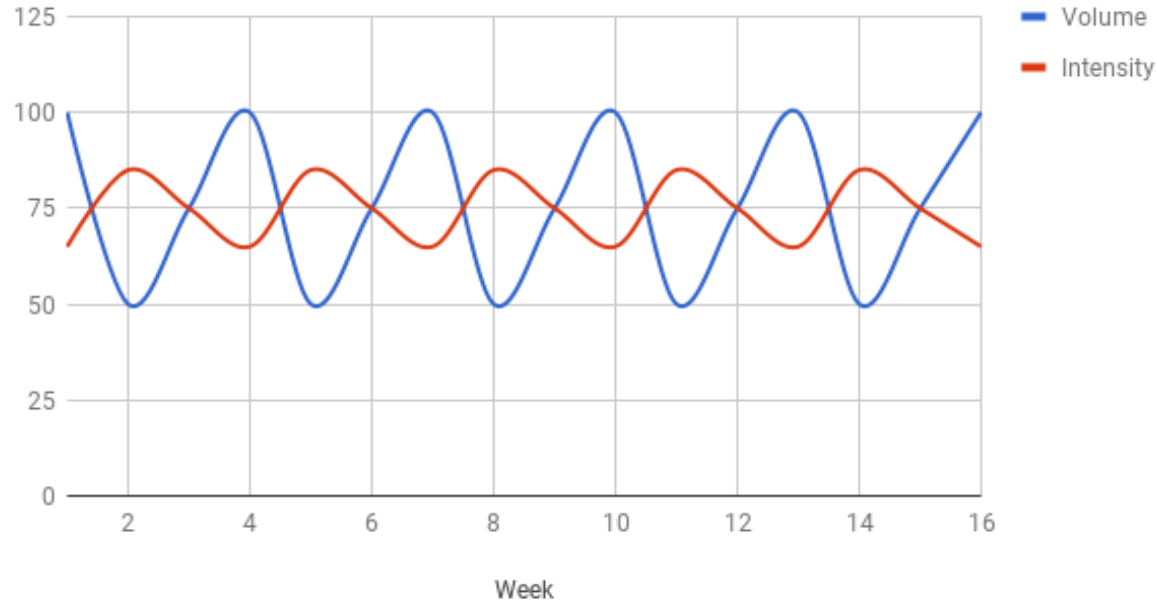
- Volume and load are altered more frequently in order to allow neuromuscular system longer periods of recovery with lighter loads performed more often (Lorenz et al. 2019)
- Training intensities vary on each microcycle
- Two types
 - Weekly
 - Daily

Weekly Undulating Periodization



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Weekly Undulating Periodization Example

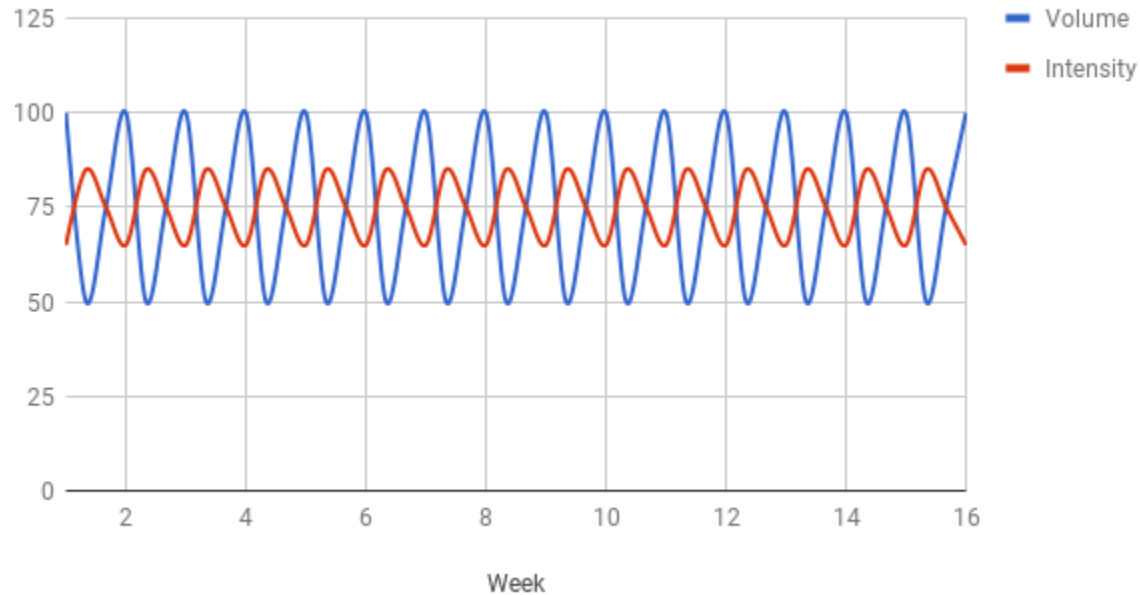


Daily Undulating Periodization



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Daily Undulating Periodization Example



Linear vs Undulating



- Linear
 - Week 1: 3x10 at 75%
 - Week 2: 3x8 at 77.5%
 - Week 3: 3x6 at 80%
 - Week 4: 3x4 at 82.5%
- Undulating
 - Monday (Hypertrophy): 3x8 at 80%
 - Wednesday (Power): 3x1 at 85%
 - Friday (Strength): 3xmax at 85%

Linear vs Undulating



Table 1. Standard linear intensification of training in strength development

Weeks	1-4	5-8	9-12	13-16
Reps	10	5	3	2
Sets	5	3	3	3
Intensity	75%	85%	90%	95%
Volume (total reps)	50	15	9	6

Linear periodization...

-intensity continuously increases, increasing stress with little recovery time

-hypertrophy gained in weeks 1-4 are not maintained due to reps dropping below 5 reps

versus Undulating periodization...

-volume decreases at a slower rate and intensity is more gradual

-shorter phases allow more frequent changes for increased strength gains

Table 2: Alternating accumulation and intensification phases for strength development

Weeks	1-2	3-4	5-6	7-8	8-10	11-12
Reps	10-12	4-6	8-10	3-5	5-7	2-3
Sets	3	5	4	5	4	6
Intensity	70-75%	82-88%	75-78%	85-90%	80-85%	90-95%
Volume (total reps)	30-36	20-30	32-40	15-25	20-28	12-18



- Systematic review and meta-analysis comparing linear to undulating periodization programs
- Measured maximal strength and hypertrophy
- Greater improvements in strength noted after undulating periodization versus linear periodization
- No significant changes in hypertrophy were noted for any periodization program

Blocked Periodization



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- Highly concentrated, specialized workload (Lorenz et al. 2019)
- Typically have large volume of exercises focused on specific, targeted training abilities to ensure maximum adaptation (Lorenz et al. 2019)
- Three separate mesocycles or “blocks”
 - Accumulation:
 - Transmutation
 - Realization

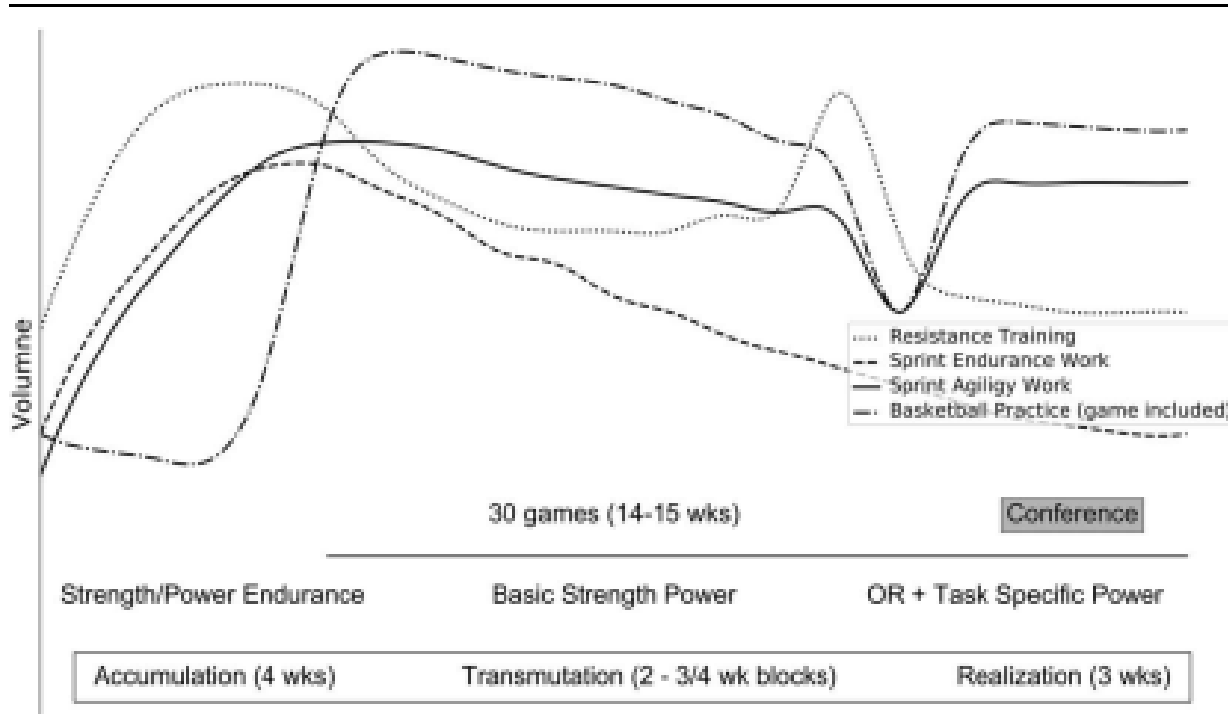
Blocked Periodization (Gleason 2022)



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- Accumulation: 2-4 weeks of concentrated loads to one skill (strength, endurance, etc.)
- Transmutation: 2-4 weeks of normal training loads and shifts prior to accumulation block
- Realization: 1-2 weeks of reduced training (deload and taper) for recovery and adaptation

Blocked Periodization



Stone et al. 2021

Blocked Periodization



Force Dominant Power									
Day 1	Week 1			Week 2			Week 3		
Exercise	Sets	Reps	Load	Sets	Reps	Load	Sets	Reps	Load
Hang Power Clean	3	4	80%	3	3	82.50%	3	2	85%
Heavy Trap Bar Jump	3	4	40% BW	3	4	40% BW	3	4	40% BW
Day 2	Week 1			Week 2			Week 3		
Exercise	Sets	Reps	Load	Sets	Reps	Load	Sets	Reps	Load
Squat Jumps	3	4	40% BW	3	4	42.5% BW	3	4	45% BW
Heavy Med Ball Throws	3	4	20lbs	3	4	25lbs	3	4	30lbs

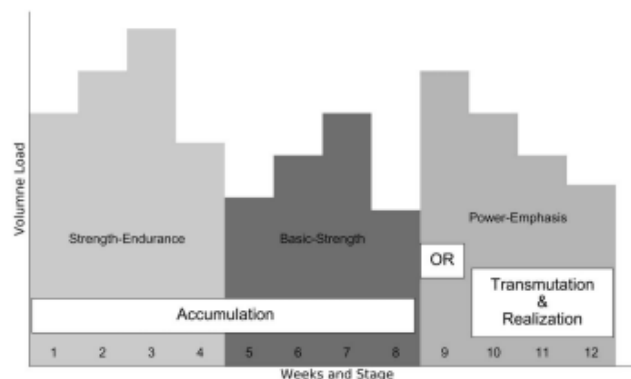


Figure 8. Stage = periodization blocks sequenced to optimize power output.

Reversed Periodization



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- Decrease in intensity and increase in volume over time (Moesgaard et al. 2022)
- High intensity phases are completed first
- Reach peak quicker – ideal for two competitions that are close together
- Peak with low intensity training and more sport specific work

What does the research say?^(Hartmann et al. 2015)



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- Systematic Review comparing the effects of undulating, blocked and non-periodization programs on strength and power gains
- They compared different types of training, frequency, training zones, and rest times
- Results were inconsistent in support of one periodization type but all produced improvements to strength and power



- Systematic review comparing linear and undulating periodization programs
- In each study reviewed it was noted if participants were trained (>1 year of training) or untrained
- Greater gains in maximal strength noted for trained athletes when using an undulating periodization model



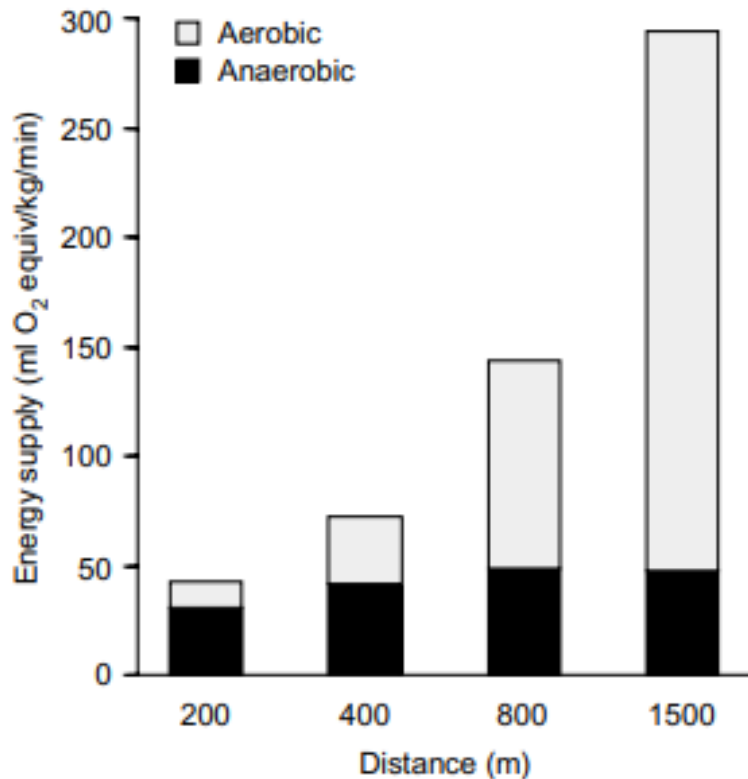
- Three metabolic pathways^(Haff et al. 2016)
 - Phosphagen System: anaerobic, 10-15 seconds
 - Glycolytic System: anaerobic, 30-50 seconds
 - Oxidative System: aerobic, 60+ seconds



Table 1. Energy System Demands

Duration	Intensity	Primary Energy System
0 – 6 seconds	Maximal	Phosphagen
6 – 30 seconds	Near-Maximal	Phosphagen & Anaerobic Glycolysis
30 – 120 seconds	High	Anaerobic Glycolysis
2 – 3 minutes	Moderate	Anaerobic & Aerobic Glycolysis
> 3 minutes	Low	Oxidative

Morrison et al. 2017



- Energy system contributions based on accumulated oxygen deficit method

Gastin 2001

Calculating Intensity



- Maximal aerobic speed (MAS): lowest velocity that VO₂ max is reached^(Rowland 2023)
 - Work above is anaerobic
 - Work below is aerobic
- MAS: Distance/time^(Rowland 2023)
 - **(3000m) / (300 sec) = 10 m/sec**

Table 5. Sustained Effort Training Intensity Zones

Binary Model	Intensity Zone	Heart Rate (Max)	RPE
Low Intensity	Zone 1	55 - 82%	≤ 5
	Zone 2	82 - 87%	5 - 6
High Intensity	Zone 3	88 - 99%	7 - 10

Morrison et al. 2017

Aerobic Training Zones



Table 4. Energy System Training Parameters							
	Work Interval		Recovery		Series		Adaptation
	<i>Intensity</i>	<i>Duration</i>	<i>Intensity</i>	<i>Duration</i>	<i>Number of Series</i>	<i>Weekly Frequency</i>	<i>Timeframe</i>
Short Duration – Repeated Efforts							
Explosive Effort	Maximal	<6 s	Passive	30 to 120 s	2 to 6	2 to 3	2 to 3 weeks
High-Intensity Effort	Maximal	15 to 30 s	RPE <2	30 to 120 s	4 to 10	2 to 3	2 to 3 weeks
Endurance Effort	RPE 8 to 9	2-3 min	RPE <2	2-3 min	6 to 10	2 to 3	2 to 3 weeks
Long Duration – Endurance							
Extensive	Zone 1	20-60 min	Continuous			3 to 5	2 weeks to 3 months
Intensive	Zone 2 Zone 3	6-8 min 4-6 min	Low Zone 1	2-4 min	3 to 6	2 to 3	2+ weeks

Determining Load/Intensity^(Haff et al.)



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- 275 pounds lifted for 3 reps
- **$275 * 1.08 = 297$**
- 297 pounds is predicted 1 rep max

Number of Repetitions Performed	Percent of 1-Repetition Maximum	Multiply Weight Lifted By:
1	100	1.00
2	95	1.05
3	93	1.08
4	90	1.11
5	87	1.15
6	85	1.18
7	83	1.20
8	80	1.25
9	77	1.30
10	75	1.33
11	70	1.43
12	67	1.49
15	65	1.54

Understanding Overall Volume



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- Sets x Reps x Load (Distance)
 - Example: A back squat performed for 4 sets of 3 repetitions at 260lbs would have a total volume load of 3,120lbs
- Session RPE
 - Athlete rated RPE x duration (minutes)
 - An athlete rates their training session on the RPE scale 20-30 minutes following training
 - Training marker for intermittent team sport activities and resistance training



General Adaptation Syndrome

- Alarm
- Resistance
- Exhaustion

Signs and Symptoms

- plateau/decline in performance
- increased exertion for “easy” workouts
- excessive sweating/overheating
- recurrent injuries
- decline in motivation
- change in mood – irritability, anger, restlessness
- increases resting HR/BP



- Things to consider
 - Sport: need to know when competitions/matches, in-season, off-season, practice schedule
 - Goal of training
 - Type of Periodization
 - Cycles – type and duration



- “the clinician has general goals for each phase, precautions, and a vague incomplete list of exercises to be performed” (Lorenz et al.2011)

Programming for Rehabilitation



Table 5 Example of exercises for a soccer player (midfielder) at 6 months post-ACL_R presenting with maladaptive reduced quadriceps capacities

Rehabilitation phase	Training aim	Exercise prescription
Phase 1—Work capacity emphasis	To increase strength endurance of the quadriceps	Unilateral leg extension (3 sets with manageable load until failure) Single leg squat (3 sets until failure)
Phase 2—Strength emphasis	To increase quadriceps muscle strength	Front squat (4 × 6RM) Split squat (4 × 6RM) Romanian deadlift (4 × 6RM)
Phase 3—Power and RFD emphasis	To increase power output and RFD	Split squat (3 × 3RM each leg) Squat jumps (3 × 4) CMJ (3 × 4) SL hop (3 × 4 each leg)
Phase 4—Peak power and RFD emphasis	To increase peak power, RFD and enhanced stiffness	Front squat (3 × 2RM) Drop jumps (5 × 3) Repeated hurdle jumps (5 × 5) SLCMJ (5 × 3 each leg)

The aim is to complete rehabilitation fully and to enhance performance over a 12–16 weeks period

— *RM* repetition maximum, *RFD* rate of force development

Programming for Rehabilitation



Table 1 Examples of different resistance training prescriptions to enhance strength

Example of targeted muscle group	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
<i>Quadriceps</i>	Isometric leg extension 45" × 5 reps @60° knee flexion and @ > 80% 1RM	Isotonic leg extension 5 sets × until failure	Split squat 3–6 reps × 2–6 sets @85–93% 1RM	Eccentric single leg box squat 3–6 reps × 2–6 sets @110–120% 1RM	Contrast approach - Trap bar deadlift 4RM paired with triple hop × 4 sets
Possible performance gains	↑ Peak Power ↑ Strength ↑ RFD ↓ Inter-limb asymmetries ↑ Horizontal force production ↑ Vertical force production				

The assigned exercises are ordered from the lowest to the highest intensity. Potential performance adaptations are also listed

RM repetition maximum, ↑ increased, ↓ decreased, → unchanged

Maestroni et al. 2020



- So what do I do...?
 - Goals and timeframe for rehab program
 - Establish a macrocycle
 - Protocol and precautions?
 - Frame each mesocycle



- Types of training are not mutually exclusive – you can focus on strength while still working power
- Each athlete is different and may require different demands
- Communication between the entire medical staff is necessary for an athletes RTS

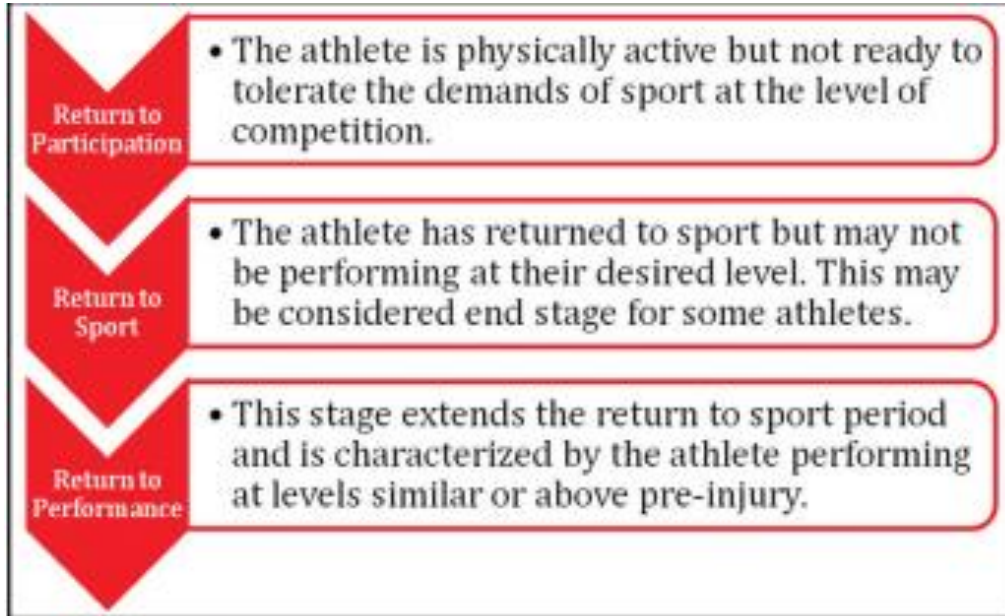


Figure 1. *Return to Play Continuum* .

- “The language that is used when describing the RTP process is familiar to everyone involved, is measurable, and reflects best practice” (Morrison et al. 2017)



1. Campos GE, Luecke TJ, Wendeln HK, et al. Muscular adaptations in response to three different resistance-training regimens: specificity of repetition maximum training zones. *Eur J Appl Physiol*. 2002;88(1-2):50-60. doi:10.1007/s00421-002-0681-6
2. Gastin PB. Energy System Interaction and Relative Contribution During Maximal Exercise. *Sports Med* 2001; 31 (10): 725-741.
3. Haff, G., & Triplett, N. T. (2016). *Essentials of strength training and conditioning*. Fourth edition. Champaign, IL, Human Kinetics.
4. Harries SK, Lubans DR, Callister R. Systematic review and meta-analysis of linear and undulating periodized resistance training programs on muscular strength. *J Strength Cond Res*. 2015;29(4):1113-1125. doi:10.1519/JSC.0000000000000712
5. Hartmann H, Wirth K, Keiner M, Mickel C, Sander A, Szilvas E. Short-term Periodization Models: Effects on Strength and Speed-strength Performance. *Sports Med*. 2015;45(10):1373-1386. doi:10.1007/s40279-015-0355-2
6. Gleason, Benjamin H. Periodization and Programming for Team Sports (Supplement). National Strength and Conditioning Association. 2022. Available at: https://www.nsc.com/contentassets/f9d5e4180ffe4cecb9c8ae2a6c2ac6eb/periodization-and-programming-for-team-sports_supplement.pdf
7. Lorenz, D., Morrison, S., Panariello, R., Maddalone, D. (2019). Principles of Sports Performance Enhancement. *SCS Preparatory Course*. (pp. 1-25). American Academy of Sports Physical Therapy.
8. Lorenz D, Morrison S. CURRENT CONCEPTS IN PERIODIZATION OF STRENGTH AND CONDITIONING FOR THE SPORTS PHYSICAL THERAPIST. *Int J Sports Phys Ther*. 2015;10(6):734-747.
9. Lorenz DS, Reiman MP, Walker JC. Periodization: current review and suggested implementation for athletic rehabilitation. *Sports Health*. 2010;2(6):509-518. doi:10.1177/1941738110375910
10. Maestroni L, Read P, Bishop C, Turner A. Strength and Power Training in Rehabilitation: Underpinning Principles and Practical Strategies to Return Athletes to High Performance. *Sports Med*. 2020;50(2):239-252. doi:10.1007/s40279-019-01195-6
11. Moesgaard L, Beck MM, Christiansen L, Aagaard P, Lundbye-Jensen J. Effects of Periodization on Strength and Muscle Hypertrophy in Volume-Equated Resistance Training Programs: A Systematic Review and Meta-analysis. *Sports Med*. 2022;52(7):1647-1666. doi:10.1007/s40279-021-01636-1
12. Morrison S, Ward P, duManoir GR. ENERGY SYSTEM DEVELOPMENT AND LOAD MANAGEMENT THROUGH THE REHABILITATION AND RETURN TO PLAY PROCESS. *Int J Sports Phys Ther*. 2017;12(4):697-710.
13. Poliquin, Charles. Five steps to increasing the effectiveness to your strength training program. *NSCA Journal*. 1988: 10(3): 34-39.
14. Rowland, Rob. Building Performance or Getting Fatigued? Energy System Development. Feb 23, 2023. Combined Sections Meeting, San Diego, CA.
15. Stone M, Hornsby W, Haff G, et al.. Periodization and Block Periodization in Sports: Emphasis on Strength-Power Training—A Provocative and Challenging Narrative. *Journal of Strength and Conditioning Research*. 2021; 35 (8): 2351-2371. doi: 10.1519/JSC.0000000000004050.
16. .Reiman MP, Lorenz DS. Integration of strength and conditioning principles into a rehabilitation program. *Int J Sports Phys Ther*. 2011;6(3):241-253.