



Comprehensive Performance Plan- A Living Process for Artemis Analogs

Building 26 Efforts



Agenda



Musculoskeletal Injury Evidence Review

Comprehensive Performance Plan-Living Process

Current State of Performance Plan

Physical Medicine Considerations

Future Considerations for Comprehensive Plan

Conclusion



TOPIC ONE: MUSCULOSKELETAL INJURY EVIDENCE REVIEW



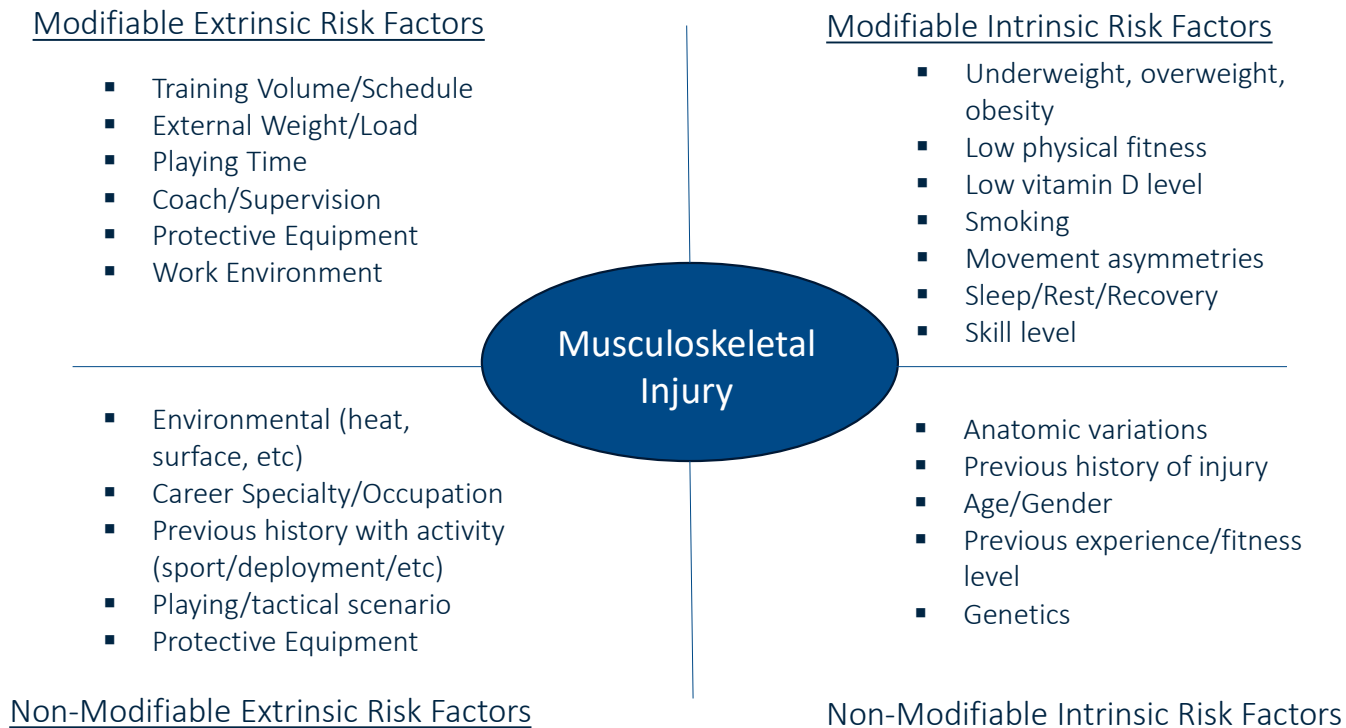
WHAT CONTRIBUTES TO DEVELOPING AN MSK INJURY?

CAN WE ACCURATELY PREDICT THOSE THAT MAY BE AT
RISK OF DEVELOPING AN MSK INJURY?

MULTIFACTORIAL PROBLEMS REQUIRE MULTIFACTORIAL
SOLUTIONS



WHAT CONTRIBUTES TO DEVELOPING AN MSK INJURY?



Rhon 2023, Sammito 2021, De La Motte 2017, Avedesian 2021, Teyhen2022, Bahr 2005



EVIDENCE STRENGTH AND RISK FACTORS

Strong Evidence

- Prior History of Injury*
- Total Volume of Training*
- Advanced Skill Acquisition*
- Body Mass Index
- Total Physical Fitness Performance
- External Load
- Prior fitness/experiencing level
- Smoking

Moderate Evidence

- Asymmetry in movement
- Reduced sleep/recovery time
- Low perceived recovery
- Muscular Strength*
- Muscular Endurance*
- Cardiovascular Endurance*
- Cognitive Performance (specifically reaction time/working memory)

Insufficient Evidence

- Risk scores on movement assessments
- Diet, Alcohol, Calcium consumption
- Balance
- Flexibility
- Individual joint mobility (hip ER)

Rhon 2023, Sammito 2021, De La Motte 2017, Avedesian 2021, Teyhen2022, Bahr 2005



CAN WE ACCURATELY PREDICT THOSE THAT MAY BE AT RISK OF DEVELOPING AN MSK INJURY?



Internet Stock Photos

CAN WE ACCURATELY PREDICT THOSE THAT MAY BE AT RISK OF DEVELOPING AN MSK INJURY?

- Screening tools have poor predictive capability
- Existing MSKI prediction models are poorly developed and have a high risk of bias
- No current models are recommended for use in sports, civilian, or military settings
- Low-Moderate evidence for strength-based ratios and movement-based assessments → utility for association and early intervention

Roberts 2023, Bullock 2022, Bunn 2022, Whittaker 2017



INJURY PREDICTORS VS. ASSOCIATION- A PARADIGM SHIFT!

- *Complex Systems Approach to Monitoring*
 - Injuries are a complex interaction among different factors
- Systems based monitoring allows for identification of modifiable factors where individual intervention can be applied (physical medicine, S&C, training volume, etc)
- Begins to develop a risk profile of the non-linear and complex nature of injuries allowing for effective preventive interventions that are not in isolation

Bittencourt, 2016



MULTIFACTORIAL PROBLEMS REQUIRE MULTIFACTORIAL SOLUTIONS

Modifiable Extrinsic Risk Factors

- Training Volume/Schedule
- External Weight/Load
- Analog/Tool Usage (?)
- Training/Skill Acquisition
- Equipment (?)
- Etc.

- Environmental (heat, surface, etc)
- Analog/Tool Usage (?)
- Previous history with activity (fitness lvl/spaceflight exp/etc)
- Equipment (?)

Non-Modifiable Extrinsic Risk Factors

Modifiable Intrinsic Risk Factors

- Underweight, overweight, obesity
- Physical Fitness
- Movement asymmetries
- Smoking
- Sleep/Rest/Recovery
- Skill level

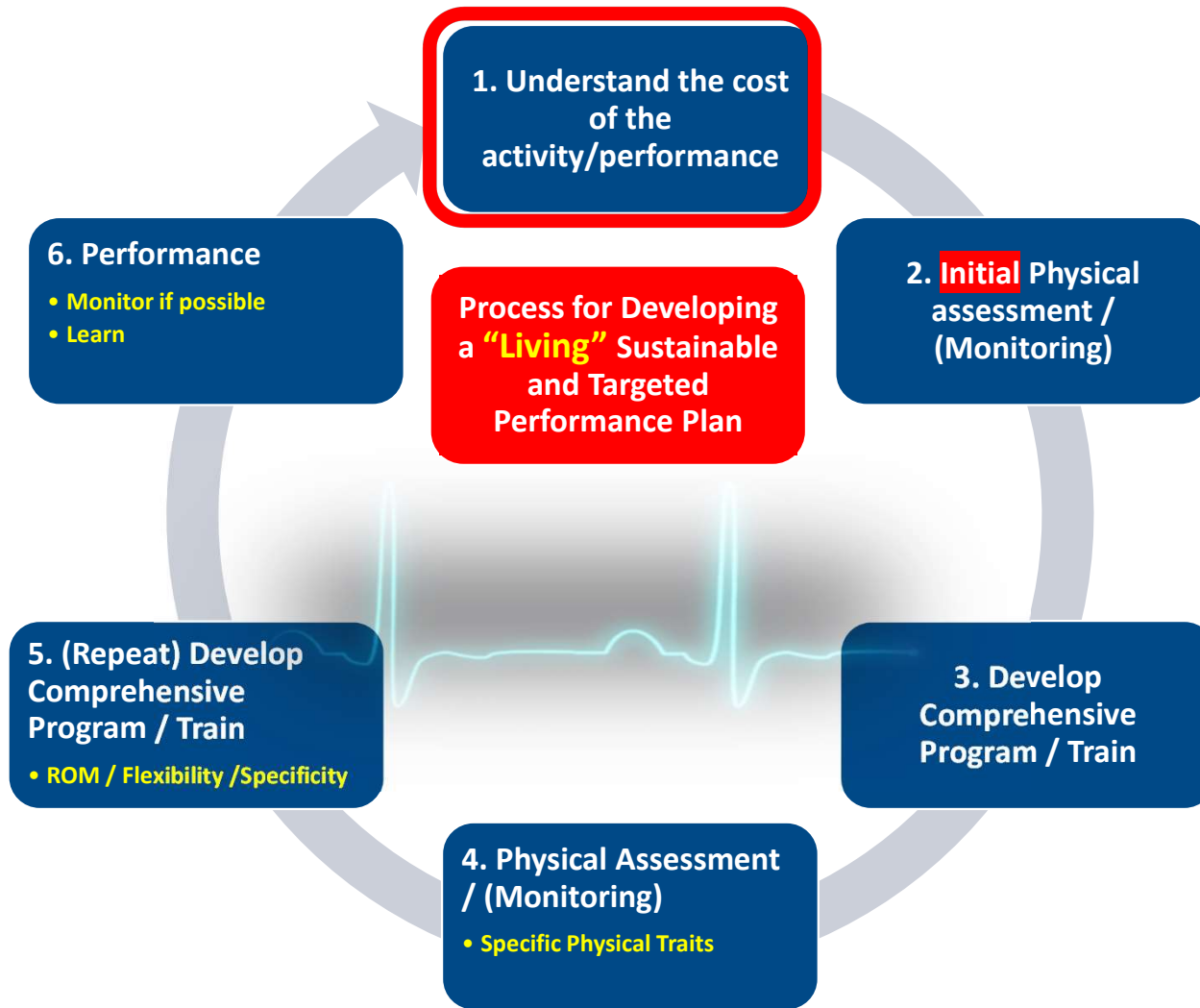
- Anatomic variations
- Previous history of injury
- Age/Gender
- Previous experience/fitness level
- Genetics

Non-Modifiable Intrinsic Risk Factors



TOPIC TWO: PERFORMANCE PLAN- NUTS AND BOLTS (THE LIVING PROCESS)



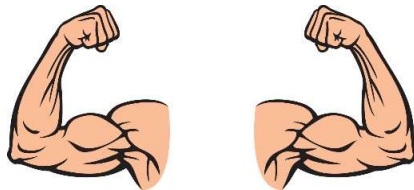


Identify the cost of the activity/performance

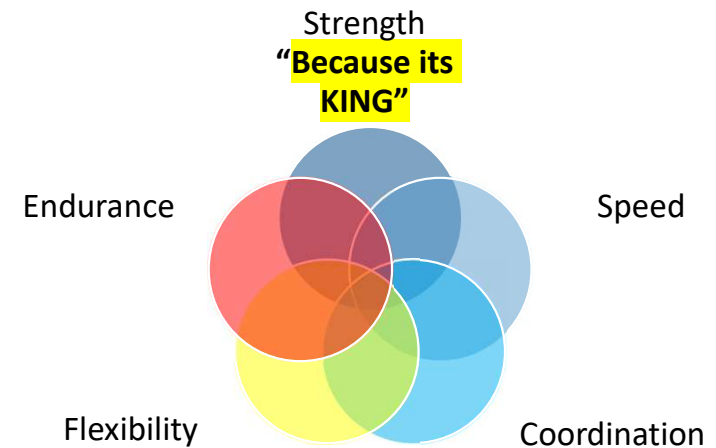
Identify the cost (what physical traits are required for success, and to what extent?)

Metabolic Demands (Energy system demand)
Muscular Strength / Endurance Demands
ROM Range of Motion (Muscular Flexibility, Joint Mobility)
Mechanical Stress (comes back to strength)
Balance Coordination
Skill

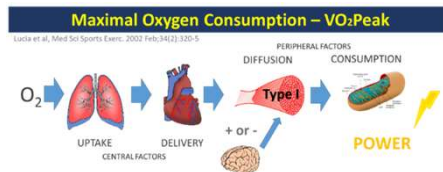
* Muscular Strength remains the cornerstone of performance



Suchomel TJ, Nimphius S, Stone MH. **The Importance of Muscular Strength in Athletic Performance.** Sports Med. 2016 Oct;46(10):1419-49. doi: 10.1007/s40279-016-0486-0. PMID: 26838985.



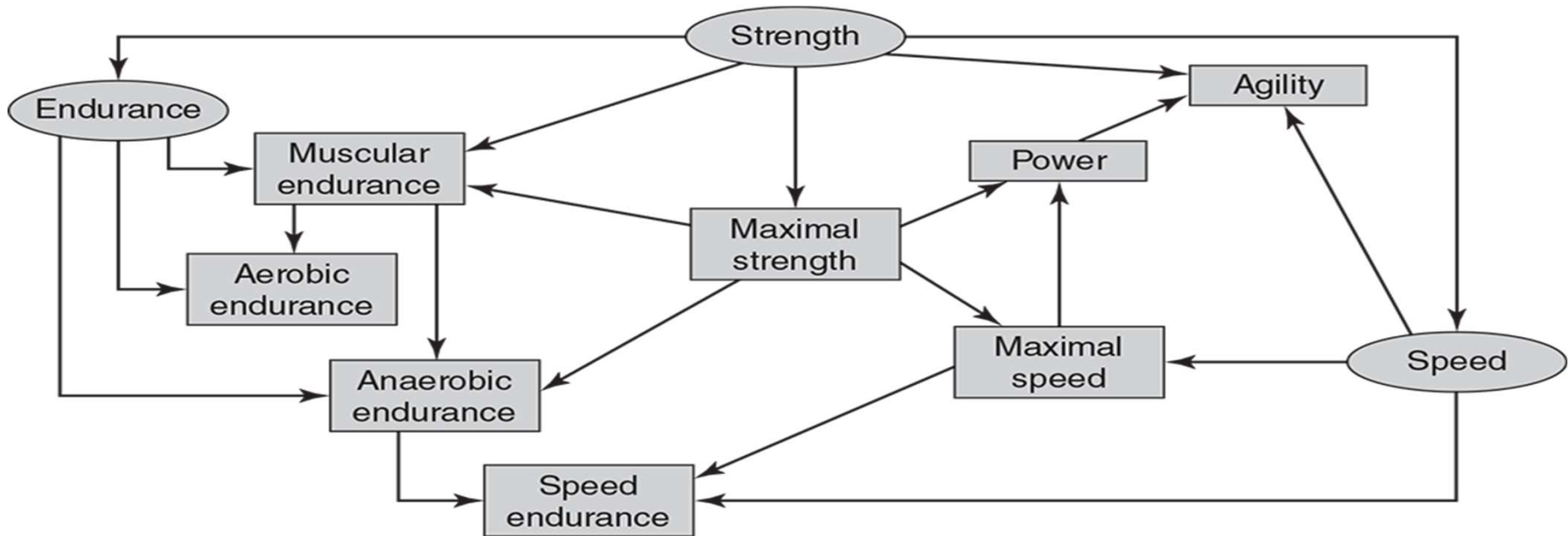
* (Maximum Oxygen Uptake), close 2nd or maybe 1st



Vencunus T, Mieziene B, Emeljanovas A. **Aerobic Capacity Is Related to Multiple Other Aspects of Physical Fitness: A Study in a Large Sample of Lithuanian Schoolchildren.** Front Physiol. 2018 Dec 11;9:1797. doi: 10.3389/fphys.2018.01797. PMID: 30618809; PMCID: PMC6297359.

1. Understand the cost of the activity / performance

Strength is Foundation



T. Bompa and C.A. Buzzichelli, *Periodization: Theory and Methodology of Training*, 6th ed. (Champaign, IL: Human Kinetics, 2019), 231.

1. Understand the cost of the activity / performance

Muscular Strength Influence on Endurance Performance



THE EFFECTS OF RESISTANCE TRAINING ON ENDURANCE DISTANCE RUNNING PERFORMANCE AMONG HIGHLY TRAINED RUNNERS: A SYSTEMATIC REVIEW

LINDA M. YAMAMOTO, REBECCA M. LOPEZ, JENNIFER F. KLAU, DOUGLAS J. CASA, WILLIAM J. KRAEMER, AND CARL M. MARESH

Human Performance Laboratory, Department of Kinesiology, Naag School of Education, University of Connecticut, Storrs, Connecticut

ABSTRACT

Yamamoto, LM, Lopez, RM, Klau, JF, Casa, DJ, Kraemer, WJ, and Maresch, CM. The effects of resistance training on endurance distance running performance among highly trained runners: a systematic review. *J Strength Cond Res* 22(6): 2036–2044, 2008—The current perception among highly competitive endurance runners is that concurrent resistance and endurance training (CT) will improve running performance despite the limited research in this area. The purpose of this review was to search the body of scientific literature for original research addressing the effects of CT on distance running performance in highly competitive endurance runners. Specific key words (including running, strength training, performance, and endurance) were used to search relevant databases through April 2007 for literature related to CT. Original research was reviewed using the Physiotherapy Evidence Database (PEDro) scale. Five studies met inclusion criteria: highly trained runners (≥ 30 mile·wk⁻¹ or ≥ 5 d·wk⁻¹), CT intervention for a period ≥ 6 weeks, performance distance between 3K and 42.2K, and a PEDro scale score ≥ 5 (out of 10). Exclusion criteria were prepubertal children and elderly populations. Four of the five studies employed sport-specific, explosive resistance training, whereas one study used traditional heavy weight resistance training. Two of the five studies measured 2.9% improved performance (3K and 5K), and all five studies measured 4.6% improved running economy (RE; range = 3–8.1%). After critically reviewing the literature for the impact of CT on high-level runners, we conclude that resistance training likely has a positive effect on endurance running performance or

RE. The short duration and wide range of exercises implemented are of concern, but coaches should not hesitate to implement a well-planned, periodized CT program for their endurance runners.

KEY WORDS resistance training, endurance training, endurance athlete, performance

INTRODUCTION

“W”e knew we could run in the mud because of our strength training,” reported Coach Keith Andrew after his Coatesville, Pennsylvania high school boys cross-country team won the 2006 Nike Team Nationals on a waterlogged Portland Meadows 5K course (29). Concurrent resistance and endurance training (CT) challenges the perception that improvements in endurance running performance are achieved only through aerobic training. However, current research indicates that muscular strength and anaerobic power may also be important for increased running performance through neurological and muscular changes (1,21,34). Positive muscular adaptations may include increased anaerobic enzyme activity, increased force production, increased intramuscular glycogen, or shifts within major fiber type groups (1,21,34). Neural adaptations may include improved motor unit recruitment and synchronization, improved force development rate, and improvements in the stretch-shortening cycle (1,21,30,34). In combination, these positive adaptations may enable runners to sustain attacks, climb hills, or sprint in the final

*“Economy is the amount of metabolic energy expended at a given velocity or power output.”

- Training history
- Anthropometrics
- Biomechanics
- Physiology

Suggested that resistance training has a positive effect on highly trained runners/endurance athletes.

- Mechanical efficiency
- Muscle coordination
- Motor recruitment patterns
- Greater total body strength may lead to advantageous mechanical changes in running style.

3k, 5K @ 4.6%, **Running economy** @8.1%

Sports Med (2014) 44:845–865
DOI 10.1007/s40279-014-0157-y

SYSTEMATIC REVIEW

The Effect of Strength Training on Performance in Endurance Athletes

Kris Beattie · Ian C. Kenny · Mark Lyons · Brian P. Carson

Published online: 15 February 2014
© Springer International Publishing Switzerland 2014

Abstract
Background Economy, velocity/power at maximal oxygen uptake ($v\dot{V}O_{2\max}/w\dot{V}O_{2\max}$) and endurance-specific muscle power tests (i.e. maximal anaerobic running velocity; vMART), are now thought to be the best performance predictors in elite endurance athletes. In addition to cardiovascular function, these key performance indicators are believed to be partly dictated by the neuromuscular system. One technique to improve neuromuscular efficiency in athletes is through strength training.
Objective The aim of this systematic review was to search the body of scientific literature for original research investigating the effect of strength training on performance indicators in well-trained endurance athletes—specifically economy, $v\dot{V}O_{2\max}/w\dot{V}O_{2\max}$ and muscle power (vMART).
Methods A search was performed using the MEDLINE, PubMed, ScienceDirect, SPORTDiscus and Web of Science search engines. Twenty-six studies met the inclusion criteria (athletes had to be trained endurance athletes with ≥ 6 months endurance training, training ≥ 6 h per week OR $\dot{V}O_{2\max} \geq 50$ mL/min/kg, the strength interventions had to be ≥ 5 weeks in duration, and control groups used). All studies were reviewed using the PEDro scale.

muscle power and performance. However, it is evident that further research is needed. Future investigations should include valid strength assessments (i.e. squats, jump squats, drop jumps) through a range of velocities (maximal-strength $\leftrightarrow$ strength-speed $\leftrightarrow$ speed-strength $\leftrightarrow$ reactive-strength), and administer appropriate strength programmes (exercise, load and velocity prescription) over a long-term intervention period (>6 months) for optimal transfer to performance.

1 Introduction

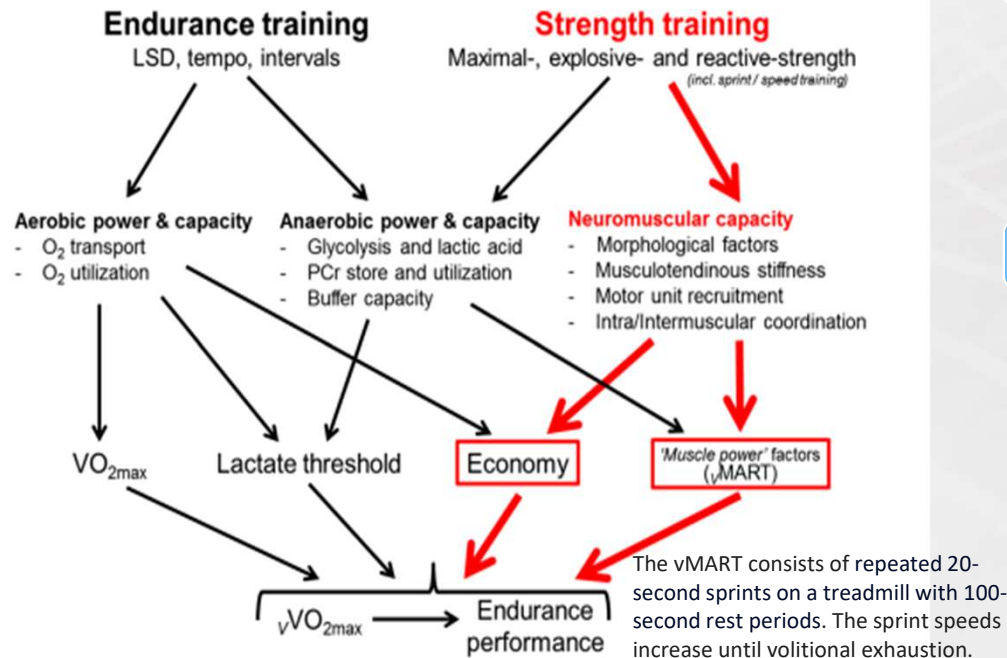
Endurance sport performance relies on a complex interplay of physiological and biomechanical factors. Cardiovascular capacity has often been thought to be the main limiting factor in endurance performance. Classical measures such as maximal oxygen uptake ($\dot{V}O_{2\max}$) and lactate threshold (LT) have been traditionally used in the laboratory to predict the performance potential of runners, cyclists, triathletes and cross-country skiers [1]. Consequently, physical preparation for these sports has generally focused on developing these two physiological qualities. However, elite endurance athletes with similar $\dot{V}O_{2\max}$ levels can have differing abilities

1. Understand the cost of the activity / performance

Hypothetical Model: Muscular Strength Influence on Endurance Performance



Fig. 1 Hypothetical model of the determinants for elite endurance performance and the potential benefits from strength training. *Red font and bold arrows highlight the potential benefit of strength training on endurance performance* (adapted from Paavolainen et al. [5], with permission). *LSD* long slow distance training, *intervals* repeated bouts of exercise lasting ~1 to 8 min and eliciting an oxygen demand equal to ~90 to 100 % of $\dot{V}O_{2max}$, *PCr* phosphocreatine, $\dot{V}O_{2max}$ maximal O_2 uptake, *vMART* peak velocity in maximal anaerobic running test, $\dot{v}O_{2max}$ peak velocity at $\dot{V}O_{2max}$



General Performance Improvements

- *Running economy
- vVO_{2max}
- wVO_{2max}
- Maximal Anaerobic Running Velocity vMART (dictated by the neuromuscular system)

Hypothesized Neuromuscular Adaptations:

- Neuromuscular stiffness
- Motor unit recruitment and synchronization
- Rate coding
- Intra- and Intermuscular coordination
- Neural inhibition

Beattie K, Kenny IC, Lyons M, Carson BP. The effect of strength training on performance in endurance athletes. Sports Med. 2014 Jun;44(6):845-65. doi: 10.1007/s40279-014-0157-y. PMID: 24532151.

1. Understand the cost of the activity / performance



Muscular Strength Influence on Sports Injury Prevention

Review

Strength training as superior, dose-dependent and safe prevention of acute and overuse sports injuries: a systematic review, qualitative analysis and meta-analysis

Jeppe Bo Laursen,^{1,2} Thor Einar Andersen,³ Lars Bo Andersen^{1,4}

► Additional material is published online only. To view please visit the journal online (<http://dx.doi.org/10.1136/bjsports-2018-099078>).

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Published Online First 21 August 2018

ABSTRACT

Objective This review aims to analyse strength training-based sports injury prevention randomised controlled trials (RCT) and present best evidence recommendations for athletes and future research. A priori PROSPERO registration: CRD42015006970.

Design Systematic review, qualitative analysis and meta-analysis. Sorting of studies and quality assessments were performed by two independent authors. Qualitative analyses, relative risk (RR) estimate with robustness and strength of evidence tests, formal tests of publication bias and post-hoc meta-regression were performed.

Data sources PubMed, Embase, Web of Science and SPORTDiscus were searched to July 2017.

Eligibility criteria for selecting studies RCTs on strength training exercises as primary prevention of sports injuries.

Results Six studies analysed five different interventions with four distinct outcomes. 7738 participants aged 12–40 years were included and sustained 177 acute or overuse injuries. Studies were published in 2003–2016, five from Europe and one from Africa. Cluster-adjusted intention-to-treat analysis established RR 0.338 (0.238–0.480). The result was consistent across robustness tests and strength of evidence was high. A 10% increase in strength training volume reduced the risk of injury by more than four percentage points. Formal tests found no publication bias.

Conclusion The included studies were generally well designed and executed, had high compliance rates, were safe, and attained consistently favourable results across four different acute and overuse injury outcomes despite considerable differences in populations and interventions. Increasing strength training volume and intensity were associated with sports injury risk reduction. Three characteristically different approaches to prevention mechanisms were identified and incorporated into contemporary strength training recommendations.

training has proved to be accessible, effective and cost-effective for populations.^{7–11} However, research has yet to establish fundamental strength training prevention mechanisms and parameters for optimization.

In 2013, Laursen *et al.*⁷ quantitatively compared the preventive effects of different types of exercise programmes: strength training, proprioception, stretching and multicomponent interventions. The obvious next step would be a further description and qualitative analysis of these four intervention types. However, several reviews have satisfactorily analysed both proprioception and stretching studies,^{12–15} while multicomponent programmes have proved problematic to analyse qualitatively due to their complex nature.^{16,17} Therefore strength training, which proved the most effective, represented the logical progression and, to our knowledge, existing strength training research has primarily focused on biomolecular aspects, fall prevention in the elderly, general health gains or specific musculoskeletal injuries. Analysis of study design and execution, content of strength training interventions, injury outcomes, intervention safety and extraction of potential general prevention principles should enable the formulation of clinically relevant conclusions and best evidence recommendations for both contemporary prevention programmes and future research. As the current literature and guidelines are not fully developed, the aims of this review were to systematically identify and analyse qualitatively and quantitatively randomised controlled trials (RCTs) of strength training-based sports injury prevention programmes.

METHODS

Search strategy, study selection and qualitative analyses

Definition Sports injury – Injuries occurring during sporting activity.



“Conclusion: The included studies were generally well designed and executed, had high compliance rates, were safe, and attained consistently favorable results across four different acute and overuse injury outcomes despite considerable differences in populations and interventions.

Increasing strength training volume and intensity were associated with sports injury risk reduction. Three characteristically different approaches to prevention mechanisms were identified and incorporated into contemporary strength training recommendations.”

Mechanisms for Prevention of Acute and Overuse Injuries

- **Direct effect** - strengthening of frequently injured muscles
- **Indirect effect** - strengthening core stability, pelvis control, extremity coordination (transfer more advantageous positioning leading to reduced mechanical stress)
- Overuse mechanisms contributed to anatomical adaption (tissue quality)

Strength training programs reduced sports injuries by an average of **66% with little to no adverse events. (average of 8 months lifting)**

1. Understand the cost of the activity / performance

Profiling Traits Needed For Performance = Scientific Realm

Evaluating Task Demands:

- Task demands can be evaluated the same way that maximum aerobic capacity is evaluated – by direct measurement of the oxygen uptake of a person performing the task.
- Indirect methods for estimating task demands:
 - Tabular Values
 - Subjective Evaluation
 - Estimate from HR
 - Job Task Analysis



More Complex
More Accurate

TI 2111 Work System Design and Ergonomics

PPT - 11. Occupational Biomechanics & Physiology PowerPoint Presentation - ID:193323 (slideserve.com)



What physical traits/abilities are essential for individuals to excel and minimize the risk of injury? Furthermore, to what degree do these traits/abilities need to be developed or enhanced?

- Muscular Strength
- VO2Peak
- Body Composition
- Grip??

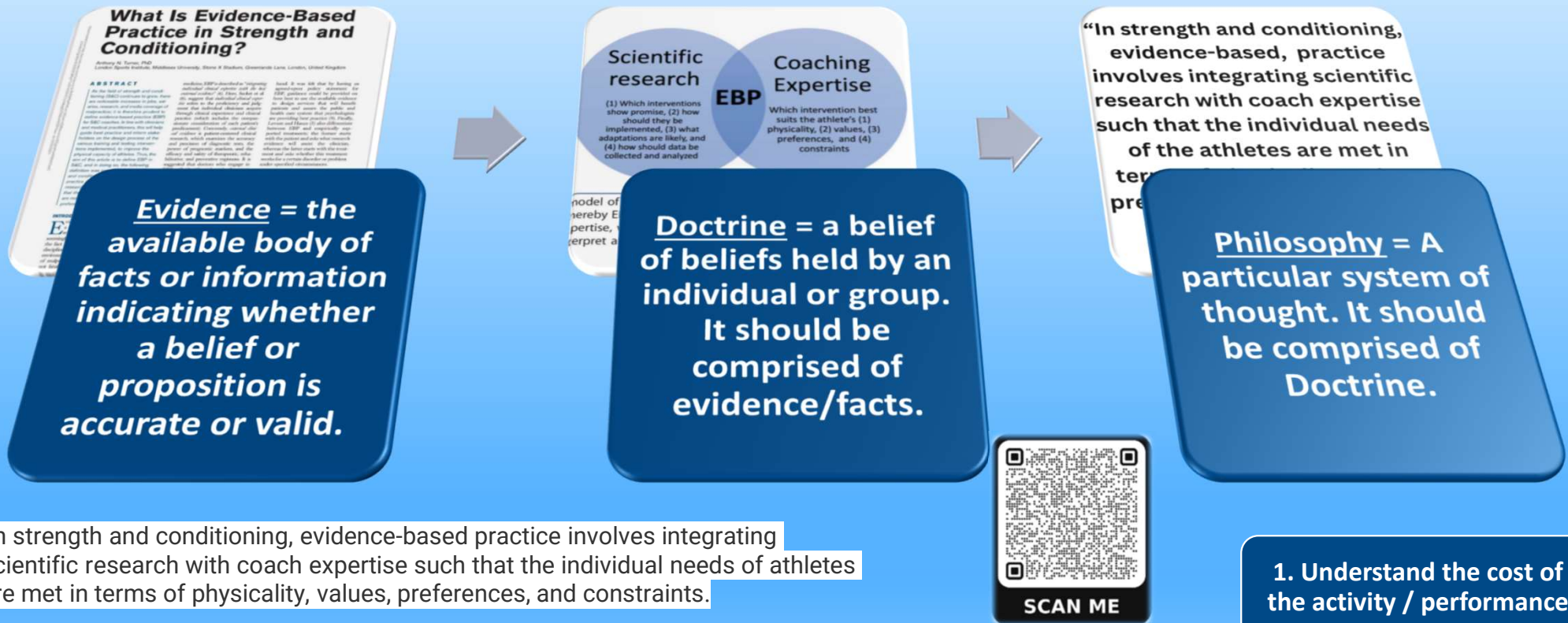


****The better we understand the physical demands of a task, the more efficiently we can prepare individuals for it through performance training.***



1. Understand the cost of the activity / performance

Scientific Research Influence on Applied Practice (Team)



In strength and conditioning, evidence-based practice involves integrating scientific research with coach expertise such that the individual needs of athletes are met in terms of physicality, values, preferences, and constraints.

Barriers to Interdisciplinary Collaboration

1. Common Language / Jargon - Scientists need help with interdisciplinary research due to language barriers and varying definitions of terms. Overcoming these obstacles involves learning and teaching the language of other disciplines to enable effective collaboration.

2. Intellectual Turf - Interdisciplinary collaboration brings researchers with diverse expertise together. However, pride in one's discipline can lead to viewing others as less rigorous. Trust and valuing different methods are essential for successful collaboration, as distrust can hinder cooperation and lead to disagreements.

3. Team Building - Interdisciplinary teamwork relies on trust in others' skills, with challenges in evaluating performance in unfamiliar fields. Good communication, role clarity, and mutual policies are key for success. Relationships, communication, and a sense of community enhance productivity. Alignment of personal and professional goals, along with interpersonal skills, are vital for success in interdisciplinary teams.

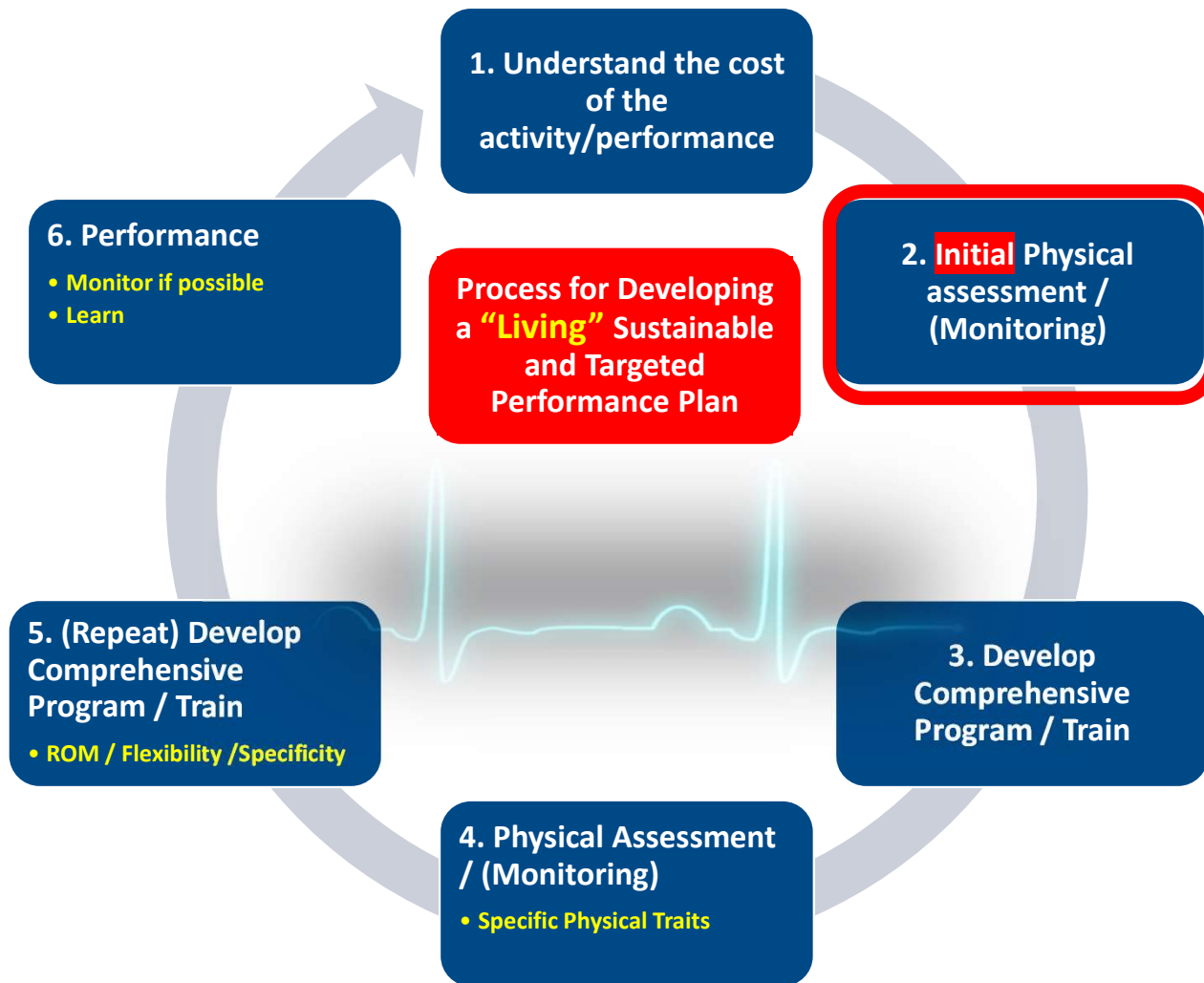
4. Leadership - Leaders of interdisciplinary research teams need vision, creativity, perseverance, credibility, and the ability to manage diverse personalities. Experienced scientists with interdisciplinary research backgrounds are ideal for leading these teams.

5. Facilitating Interactions - Chance interactions like casual discussions and meetings can foster interdisciplinary collaborations. Central facilities and common areas encourage scientific discussions and insights



Institute of Medicine (US) Committee on Building Bridges in the Brain, Behavioral, and Clinical Sciences; Pellmar TC, Eisenberg L, editors. Bridging Disciplines in the Brain, Behavioral, and Clinical Sciences. Washington (DC): National Academies Press (US); 2000. 3, Barriers to Interdisciplinary Research and Training. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK44876/>

1. Understand the cost of the activity / performance



Initial Assessment / Monitoring



We need to assess and understand the following:

- Training Age
- Previous MSK injuries
- Biological Age
- Preference
- *Current Fitness and Skill Level!!
 - Physiological Characteristics or traits (e.g., VO2, Muscular Strength)



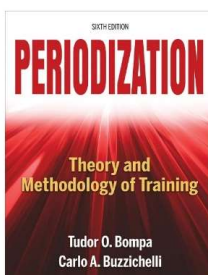
Why do we need to assess these things? Core-Varnian Equation

- Realistic expectations
- Map out the training process (individual variability in stress tolerance)
 1. Prescribe appropriate training dose (e.g., intensity, volume, skill level)
 2. Understand the effectiveness of training over time
 3. Monitor stress

Bird Box



Consequence not assessing



The **ability to adapt to a training load depends** on the individual's capacity. As outlined in the preceding section, many factors contribute to the individualized response to training loads and progressions: the **athlete's training history, health status, life stress, chronological age, biological age, and training age**. **Simply mimicking the training plans of elite athletes will not result in high levels of performance.** Rather, the coach must address the athlete's needs and capacities by developing an individualized program; this requires detailed observations of the athlete's technical and tactical abilities, physical characteristics, strengths, and weaknesses.

2. Initial Physical Assessment / (Monitoring)



Importance of an Assessment

e.g.,



It is customary for individuals to assess their current physical abilities to determine their potential success in a particular task.

In this example, typical questions could include:

- How Fast?
- How Heavy?
- How Far?
- The Y behind the task?

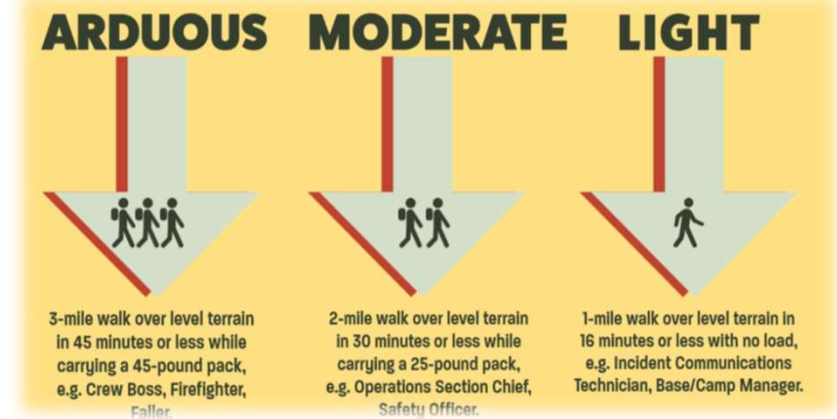
Insufficient comprehension of the physiological traits needed to succeed at a particular task could lead to vulnerable situations.



Rhetorical: Wouldn't you like some objective information about yourself to help you determine your ability level?

- 45lbs Dry (Not including Water)
- 15-Minute Mile Pace
- 3mile Total
- Flat Terrain

Wildland Firefighter Pack Test



Dr. Brian Sharkey, Ph.D.

It is not designed to be a “**performance test**” but to simulate the average energy demand of job task while working **(Based on simulated data).**

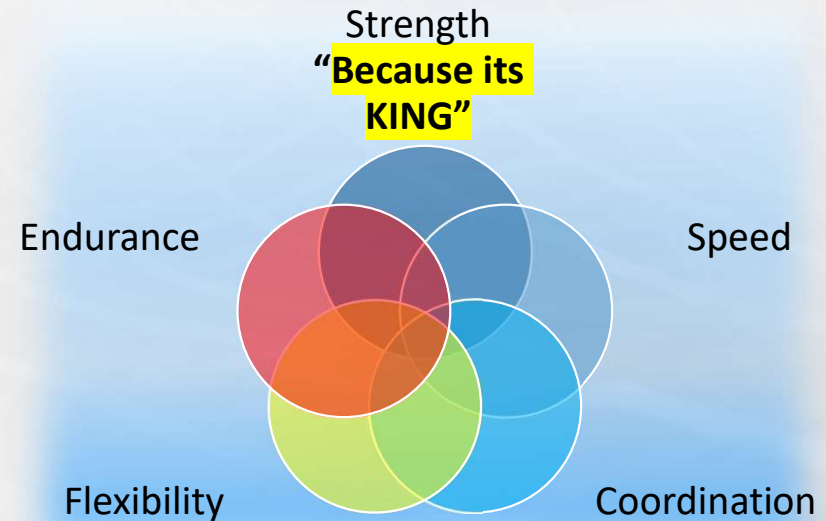


2. Initial Physical Assessment / (Monitoring)

Proposed Artemis Functional Fitness Assessment & Annual

- Body Weight
- Grip Strength
- **Isometric Mid Thigh Pull**
- Isometric Bench Press
- Counter Movement Jump
- Squat Jump or Static Jump
- Cone Agility Test
- Max Pull Ups
- 2-minute Max Hand Release Push Ups
- *Cardiovascular measurements, like VO₂peak (*the maximum oxygen consumption during peak exercise*)

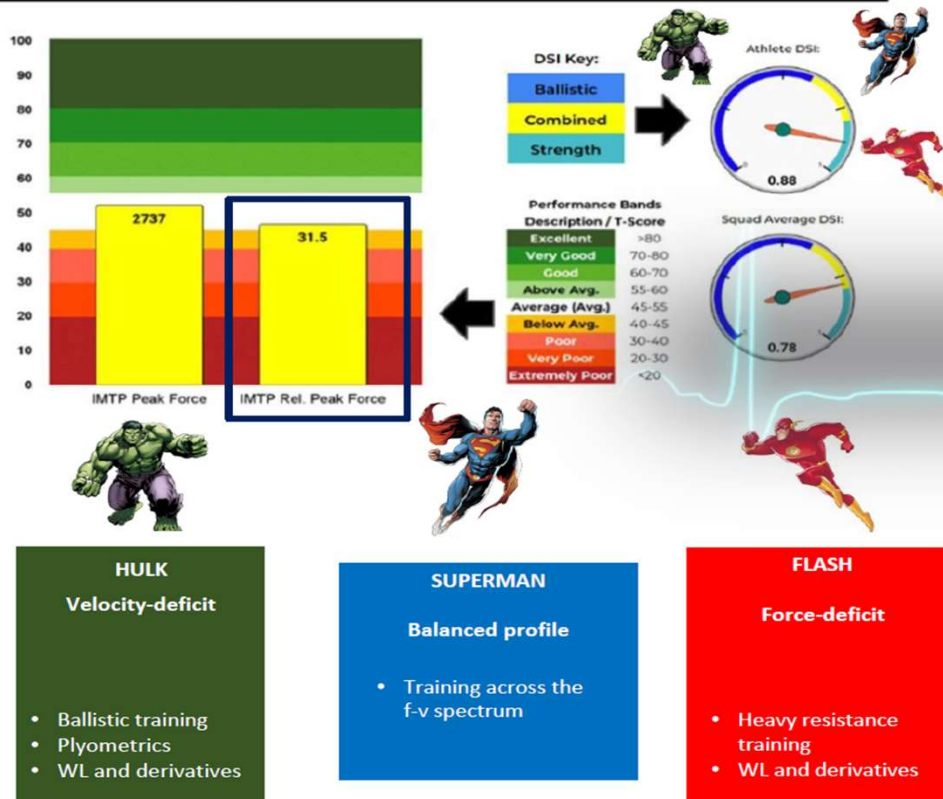
Open Conversation



2. Initial Physical
Assessment /
(Monitoring)

Assessment / Monitoring

Isometric Mid-Thigh Pull & Dynamic Strength Index (DSI) Metrics



In a controlled environment, we must accurately measure skills and abilities to understand trainable solutions clearly.

- Understand them in relationship to the population.
- Understand these abilities relationship to performance at the Task

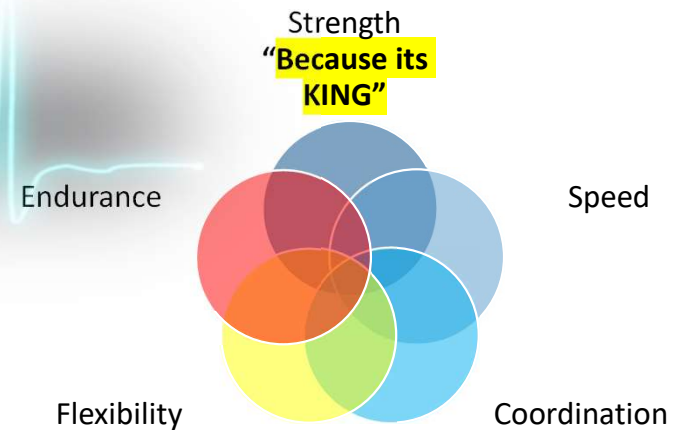


Image provided by Dr. Marcos Soriano

2. Initial Physical Assessment / (Monitoring)

Assessment / Monitoring

Image provided by Dr. Marcos Soriano

La Liga Senior Team Benchmarks ($n = 74$)

Level	CMJ JH (cm)	CMJ mRSI	IMTP PF (N)	CMRJ RSI
Excellent	≥ 50	≥ 0.79	≥ 52	≥ 2.9
Very Good	46 - 50	0.70 - 0.79	48 - 52	2.5 - 2.9
Good	42 - 46	0.62 - 0.69	43 - 48	2.1 - 2.5
Above Avg.	40 - 42	0.58 - 0.62	41 - 43	1.8 - 2.1
Average (Avg.)	36 - 40	0.49 - 0.58	37 - 41	1.4 - 1.8
Below Avg.	34 - 36	0.45 - 0.49	35 - 37	1.2 - 1.4
Poor	30 - 34	0.37 - 0.44	31 - 35	0.8 - 1.2
Very Poor	26 - 30	0.28 - 0.37	27 - 31	0.4 - 0.8
Extremely Poor	≤ 26	≤ 0.28	≤ 27	≤ 0.4

mRSI = modified reactive strength index; CMJ = countermovement jump; RSI = reactive strength index (please note that rebound modified RSI is actually calculated like RSI (jump height divided by contact time); IMTP = isometric mid-thigh pull; DSI = dynamic strength index; CMRJ = countermovement rebound jump; JH = jump height; PF = peak force)

*The more we comprehend an individual's actual and perceived needs in preparation for a task, the more effectively we can equip that individual for a given task.

What is the measure?



What does it mean?

2. Initial Physical Assessment / (Monitoring)

*Not to Identify for exclusion, but to Identify individuals, we can help through physical preparation

Data takes time



HOUSTON FOOTBALL 2022 - GPS DATA SUMMARY

Fall Camp #3 August 6th 2022 Uppers

IRON MAN AWARD: [REDACTED] (825)

BULLET AWARD: [REDACTED] (20.98)

PHYSICALITY AWARD: N/A



TEAM	PARAMETER→ WHAT'S MEASURED?→	MAX SPEED MPH		PLAYERLOAD WORK		LOAD/MIN INTENSITY		DISTANCE YARDS		HI-SPEED DIST 90%+ SPEED		C.O.D. INTENSITY IMA		FATIGUE RATING	FOOTBALL RATING	NOTES/SUMMARY
			%AVG		%AVG		%AVG		%AVG		%AVG		%AVG			
	TEAM TOTALS	17.57	100.0%	551	94.0%	3.09	89.9%	4575	92.6%	32	144.3%	32	86.6%	6.1	6.4	Velocity increased 4% from the previous day. PL decreased 6% from the previous day. Intensity decreased 13% from the previous day.
	OFF TOTALS	17.29	97.7%	582	93.0%	3.25	88.6%	4975	91.4%	38	160.6%	37	99.9%	6.2	6.5	
	DEF TOTALS	17.78	100.0%	528	95.3%	2.97	91.3%	4279	94.1%	28	135.4%	28	75.6%	5.9	6.0	

		PARAMETER→	MAX SPEED		PLAYERLOAD		LOAD/MIN		DISTANCE		HI-SPEED DIST		C.O.D. INTENSITY		FATIGUE	FOOTBALL	NOTES/SUMMARY	
		WHAT'S MEASURED?→	MPH		WORK		INTENSITY		YARDS		90%+ SPEED		IMA		RATING	RATING		
SE	QB	POSITION AVG FOR DAY	12.09	64.2%	470.00	103.5%	2.62	98.7%	5359.00	106.9%	0.00	0.0%	131.00	136.9%	5	7	93 (53, 39, 1)	
			12.09	%TOP	470	%AVG	2.62	%AVG	5359	%AVG	0	%AVG	131	%AVG	5	7		
				64.2%		103.5%		98.7%		106.9%		0.0%		136.9%				
	RUNNING BACKS		MAX SPEED	MPH		PLAYERLOAD		LOAD/MIN		DISTANCE		HI-SPEED DIST		C.O.D. INTENSITY		FATIGUE	FOOTBALL	NOTES/SUMMARY
						WORK		INTENSITY		YARDS		90%+ SPEED		IMA		RATING	RATING	
			16.27	93.3%	501.00	87.6%	2.80	83.2%	4002.00	77.3%	23.50	172.2%	24.00	99.1%	4.5	5		
			12.64	%TOP	529	%AVG	2.95	%AVG	3327	%AVG	0	%AVG	17	%AVG	5	5		
											#DIV/0!							
				71.3%		87.2%		82.9%		68.7%		102.0%		102.0%				
	TE/FB		19.89	%TOP	473	%AVG	2.64	%AVG	4677	%AVG	47	%AVG	31	%AVG	4	5		
				100.0%		90.3%		85.9%		92.6%		114.8%		140.9%				
		15.26	%TOP	492	%AVG	2.74	%AVG	4437	%AVG	0	%AVG	29	%AVG	4	6			
										#DIV/0!								
			89.8%		84.0%		79.6%		78.8%		85.3%		85.3%					
		MAX SPEED	MPH		PLAYERLOAD		LOAD/MIN		DISTANCE		HI-SPEED DIST		C.O.D. INTENSITY		FATIGUE	FOOTBALL	NOTES/SUMMARY	
				WORK		INTENSITY		YARDS		90%+ SPEED		IMA		RATING	RATING			
		14.40	90.7%	491.00	102.4%	2.74	97.7%	4984.00	98.6%	0.00	0.0%	31.67	127.2%	6.3333	6.3333			
		14.00	%TOP	502	%AVG	2.80	%AVG	5032	%AVG	0	%AVG	27	%AVG	6	6			
										#DIV/0!								
			84.0%		102.6%		94.9%		104.1%				122.7%					
		14.47	%TOP	496	%AVG	2.77	%AVG	4581	%AVG	0	%AVG	31	%AVG	7	7			
			90.2%		98.3%		93.9%		94.7%		#DIV/0!		140.9%					
		14.73	%TOP	475	%AVG	2.65	%AVG	5339	%AVG	0	%AVG	37	%AVG	6	6			
			88.8%		106.8%		101.9%		101.5%		0.0%		120.7%					

*Aggregate data may take time before it can effectively inform communities.

2. Initial Physical Assessment / (Monitoring)



Proprietary Core-Varnian Equation



Cost / Energy Demands

- 1. Understand the cost of the activity / performance

Current Ability / Fitness

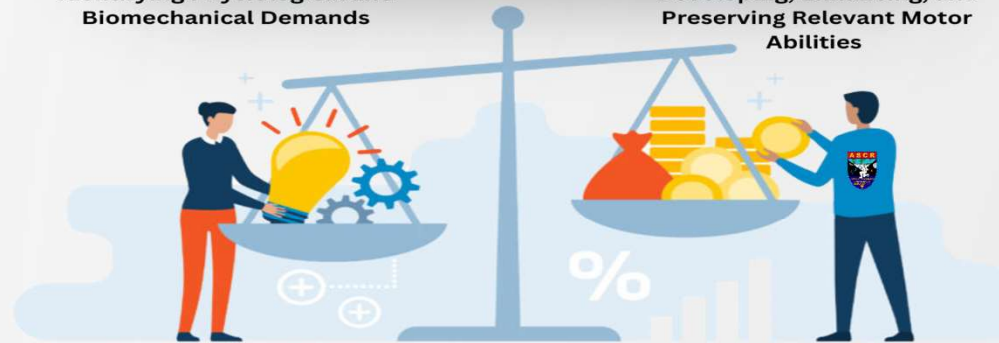
- 2. Initial Physical Assessment / (Monitoring)

Needs



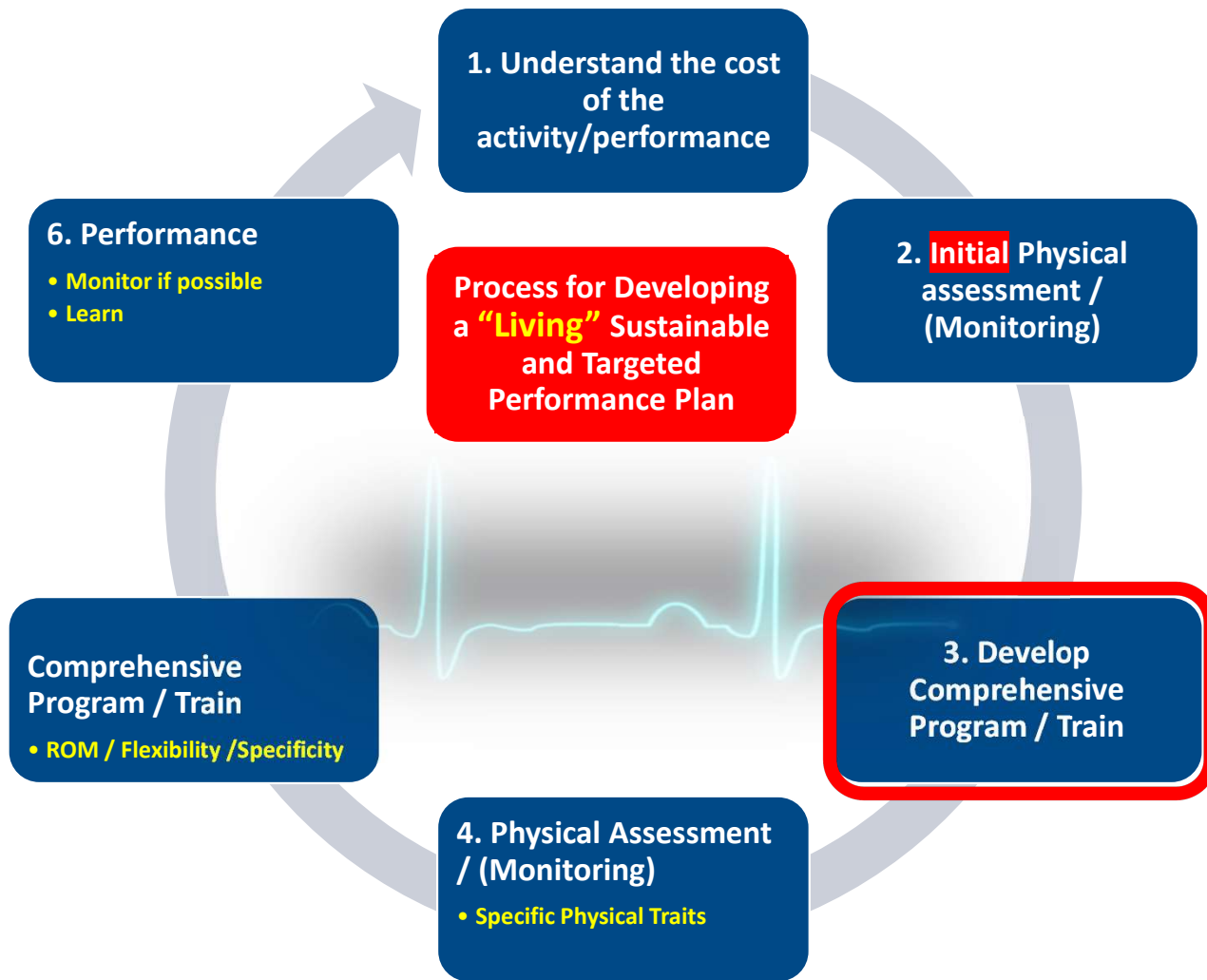
Identifying Physiological and Biomechanical Demands

Developing, Enhancing, and Preserving Relevant Motor Abilities

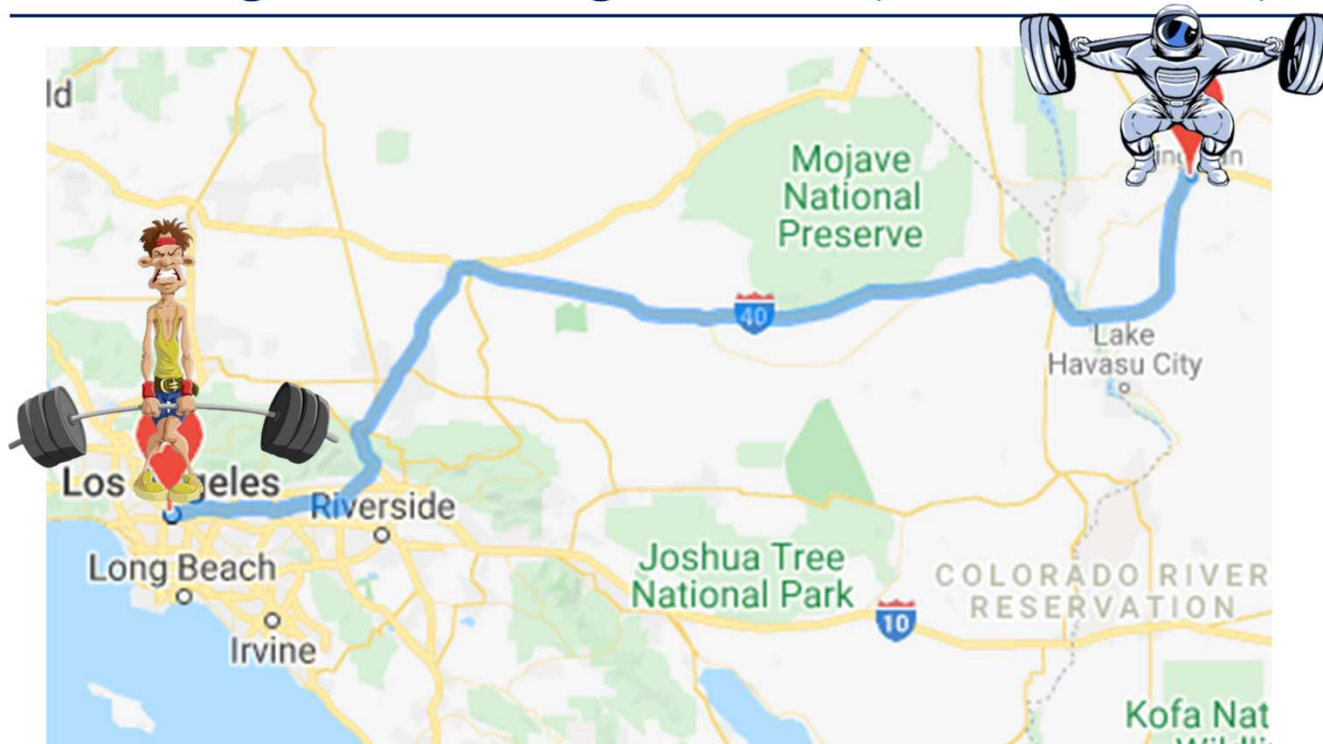


2. Initial Physical Assessment / (Monitoring)





Planning the Training Process (Periodization)



Simply, we are charting a path from our current fitness or skill level to our desired destination at a set timepoint.

“Periodization should probably be considered a flexible concept or method, rather than a rigid model, and a systematic attempt to gain control of the adaptive response to training in preparation for competition.”

Gambetta V. Periodization and the systematic sport development process. Olympic Coach 2004;16(2):8–13.

“Periodization provides the overall concept of training and deals with subdividing the training process into specific time periods and fitness phases.” DeWeese et al.



3. Develop Comprehensive Program / Train

Mujika I, Halson S, Burke LM, Balagué G, Farrow D. **An Integrated, Multifactorial Approach to Periodization for Optimal Performance in Individual and Team Sports.** Int J Sports Physiol Perform. 2018 May 1;13(5):538-561. doi: 10.1123/ijsp.2018-0093. PMID: 29848161.

Why Periodization (High-Level Overview)

Research Quarterly for Exercise and Sport
©2004 by the American Alliance for Health,
Physical Education, Recreation and Dance
Vol. 75, No. 4, pp. 413-422

A Meta-Analysis of Periodized Versus Nonperiodized Strength and Power Training Programs

Matthew R. Rhea and Brandon L. Alderman

The purpose of this study was to quantitatively combine and examine the results of studies examining the effectiveness of periodized (PER) compared to nonperiodized (Non-PER) training programs for strength and/or power development. Two analyses were conducted to (a) examine the magnitude of treatment effect elicited by PER strength training programs compared to Non-PER programs and (b) compare these effects after controlling for training volume, frequency, and intensity. Studies meeting the inclusion criteria were coded based on characteristics that might moderate the overall effects (i.e., participant characteristics and characteristics related to the training program). Effect sizes (ESs) were calculated for each study, and an overall ES of 0.84 (± 1.41) favoring PER training was found. Further analyses identified the treatment effect specific to training variation to be ES = 0.25. Significant moderating variables included age, training status, and length of training program. As a result of this statistical review of the literature, it is concluded that PER training is more effective than Non-PER training for men and women, individuals of varying training backgrounds, and for all age groups. In line with the overload principle, additions to volume, intensity, and frequency result in additional training adaptations.

Key words: periodization, progressive resistance exercise, resistance training

Periodization, representing planned variations of training variables (i.e., volume, intensity, frequency, etc.), is one of the most written and talked about topics in strength and conditioning circles. The purported benefits of such training variation have included preparing athletes to peak at the right time, avoiding plateaus in training adaptations, decreasing risk of overtraining, and increasing adaptations as compared to nonperiodized training (Fleck & Kraemer, 1996a, 1996b; National

(Non-PER) training. A critical review of such studies (Fleck, 1999) yielded only eight experimental studies published on the topic. While it was concluded that PER was more effective than Non-PER training at eliciting strength gains, a limitation of this review, and the few individual studies it examined, was the reliance on probability values ($p < .05$) and percent changes to make decisions regarding the superiority of PER.

Reliance on p values limits the evaluation of an intervention, because it offers no measure of the actual magnitude of the treatment effect. The reproducibility of a study's results may also be limited by statistical power,

“As a result of this statistical review of the literature, it is concluded that PER training is more effective than Non-PER training for men and women, individuals of varying training backgrounds, and for all age groups. In line with the overload principle, additions to volume, intensity, and frequency result in additional training adaptations.”



The “Y” behind periodization Turner et al 2011

- GAS General Adaptation Syndrome (Body's response to stress) Hans Seyle
- Fitness-Fatigue Paradigm
- Stimulus-Fatigue-Recovery-Adaptation Theory (Haff)
- Said Principle

Training Load
Recovery
Adaptation

Outcomes of periodized training programs

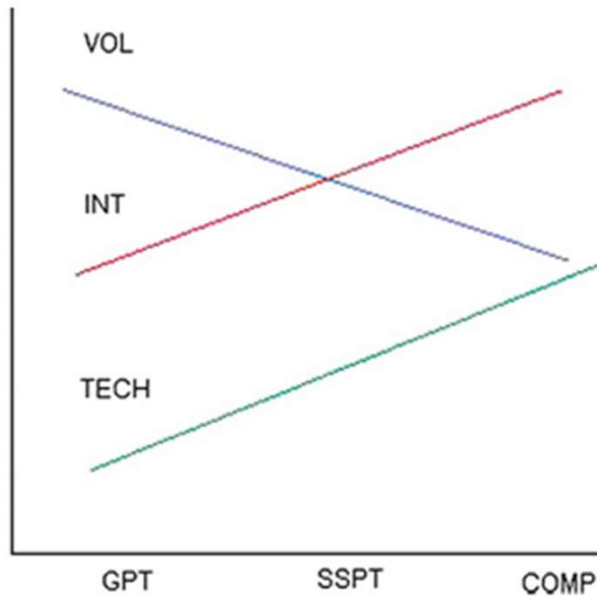
- Elicits the ability to train at higher volumes and intensities without overtraining (Fitness and Fatigue Theory)
- Optimize performance at specific time points
- Potentiate training effect
- Avoid Plateaus
- Decrease the risk of overtraining (Manage Fatigue)
- Reduce the risk of injury from training

*The main reasons we get injured during exercise

1. Intensity is too high
2. Volume is too high
3. Poor Technique (exercise inappropriate to skill level)
4. Excessive fatigue that exploits 1, 2, and 3

**3. Develop
Comprehensive
Program / Train**

Planning the Training Process (Periodization)



We are gaining control of the training process to achieve specific training outcomes at designated time points.



Training Load - the overall workload experienced in training.

- **External Load** - "The external training load is an objective measure of the work that an athlete completes either during training or competition and is measured independently of the internal workload." Iñigo Mujika
- **Internal Load** - "The internal workload is the biological stress imposed by the training session and is defined by the disturbance in homeostasis of the physiological and metabolic processes during the exercise training session." Iñigo Mujika

Training Effect – Response to training (Physiological or Performance)

Figure 1. The inverse relationship between volume and intensity. In general, as the periodized program advances and competition nears, intensity increases, whereas volume decreases. VOL = volume; INT = intensity; TECH = technique; GPT = general physical training; SSPT = sport-specific physical training; COMP = competition.

Turner, Anthony. (2011). *The Science and Practice of Periodization: A Brief Review*. Strength & Conditioning Journal. 33. 34-46. 10.1519/SSC.0b013e3182079cdf.



3. Develop Comprehensive Program / Train

Vertical Integration & Sequencing of Training Plan

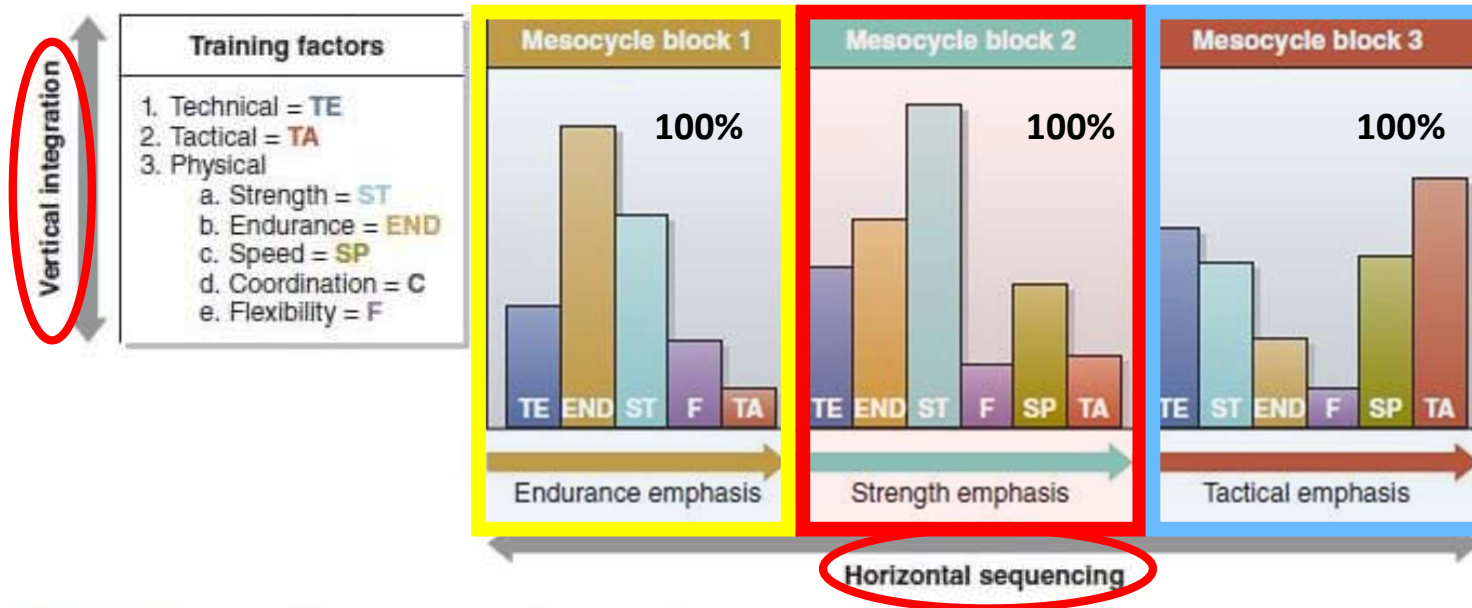
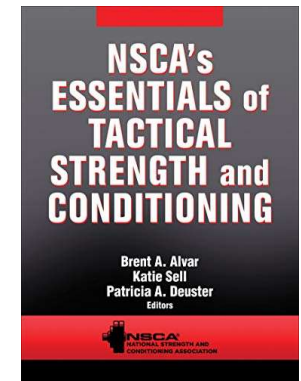


Figure 10.11 Vertical integration and horizontal sequencing.

**Graphs Printed with Dr. Greg Haff's permission*

“Vertical integration: The emphasis and de-emphasis of training qualities yet keeping them present at all times.”

Horizontal Sequencing: Training residuals from the prior phase can influence training outcomes in the following phase.



3. Develop Comprehensive Program / Train

Training Compatibility, Residual Training Effect, Phase Potentiation

Training Compatibility	
Dominant Training Modality	Compatible Training Modalities
Aerobic Endurance	Alactic sprint abilities, Strength endurance (Aerobic), Maximum strength, Hypertrophy
Glycolytic Endurance	Strength Endurance (anaerobic), Aerobic restoration, Aerobic-anaerobic (mixed) endurance
Alactic Sprints	Aerobic Endurance, Explosive strength, Maximum Strength, Hypertrophy, Aerobic restoration
Maximum Strength/Hypertrophy	Maximum strength, flexibility, aerobic restoration
Learning new technical elements	Any kind of training modalities after the primary/dominant task

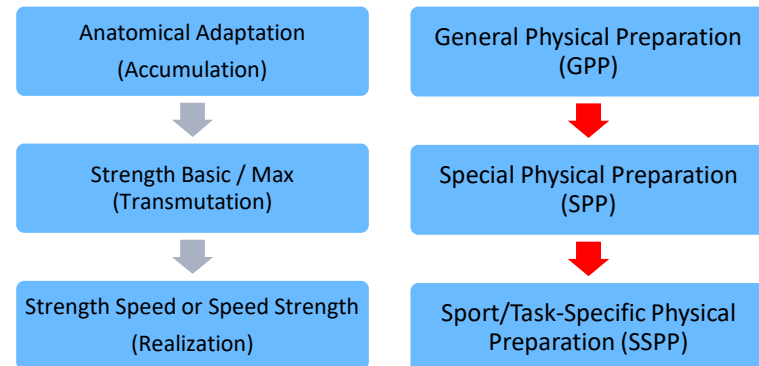
Adapted from: Issurin, V. (2008). "Block Periodization: Breakthrough in Sports Training." New York, NY: Ultimate Athlete Concepts.

Residual Training Effects		
Motor Ability	Retention	Physiological
Oxidative Energy System	30±5	Increased number of aerobic enzymes, mitochondria, capillary density, hemoglobin capacity, glycogen storage, higher rate of fat metabolism
Strength	30±5	Improvement of neural mechanism, muscle hypertrophy
Glycolytic Energy System	18±4	Increased anaerobic enzymes, buffering capacity and glycogen storage, higher possibility of lactate accumulation
Repeat-Power	15±5	Improved aerobic/ anaerobic enzymes, improved local blood circulation and lactate tolerance, repeat sprint ability
ATP/CR-P	5±3	Enhanced resynthesis of CR-P
Speed	5±3	Improved neuromuscular interactions and motor control, increases anaerobic power

Adapted from: Issurin, V. (2008). "Block Periodization: Breakthrough in Sports Training." New York, NY: Ultimate Athlete Concepts.

Phase potentiation refers to the deliberate arrangement of programming phases to enhance the likelihood of leveraging skills acquired in one phase to optimize performance in subsequent phases. (e.g., Max strength before power)

Leo Matveyev Periodization



3. Develop Comprehensive Program / Train

Artemis Analog Fitness Goals and Template							
<u>Phase 1 Goals</u> 1. Fundamentals of fitness/education 2. Basic muscular strength and endurance development of upper body, lower body and spine (isometric) 3. Development of general flexibility progressing to expression of mobility (flexibility under load) 4. Aerobic base (I.e Low, slow aerobic work)		<u>Phase 2 Goals</u> 1. Progression of medium to maximum strength of upper body, lower body, and spine 2. Progression to speed and power-based movements 3. Agility training as it applies to the task 4. Transition of flexibility to mobility with load through full ranges where appropriate 5. Maintain aerobic base (I.e Loaded Low, slow aerobic work (ruck marching)/incline walking) 6. Threshold emphasis (I.e intervals, threshold work)			<u>Phase 3 Goals</u> 1. Continued advancement of the abilities from phase 1 and phase 2 2. Maximum Muscular Strength, Muscular Endurance, Aerobic Endurance, Threshold, Mobility, Power, and Agility		
Phase 1 (2 weeks prep, 4 weeks GPP)							
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Estimated 7 hours Total time
Rest	Aerobic Zone 2- 60-90 min	Lift A	Aerobic Zone 2- 45-60 min	Lift B	Aerobic Zone 2- 45-60 min (with light load)	Active recovery	
Optional Deload in Week 5							
Phase 2 (6-9 Weeks)							
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Estimated 8-9 Hours Total time
Rest	Dynamic WU/Agility Interval/Threshold	Lift A	Dynamic WU/Agility Aerobic Zone 2- 45 min-60 min	Lift B	Aerobic Zone 2- 60-90 min (loaded)	Active recovery	
Optional Deload in Week 10							
Phase 3 (11-14 weeks)							
Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Estimated 8-9 Hours Total time
Rest	Dynamic WU/Agility High Intensity Interval Training	Lift A- Heavy LQ with Metabolic Conditioning	Tempo Work	Lift B- Heavy UQ with Metabolic Conditioning	Aerobic Zone 2- 60-90 min (loaded)	Active recovery	

Key

Low

Moderate

High

Bird's-Eye View

3. Develop Comprehensive Program / Train



Phase 1: Resistance Training

1. General Adaptation

Goals

- **Endurance / Physical Literacy**
- Athletes and Coaches are on the same page.
- Skill acquisition / Physical literacy
 - Strengthening Joints, Tendons, and Ligaments
- ROM *Daneshjoo et al. 2023*
 - Flexibility
- Injury Mitigation, *Louersen et al. 2018*

3. Develop Comprehensive Program / Train

Phase 1																		
Lift A			Week 1				Week 2				Week 3				Week 4			
EXERCISE (60s rec)	Sets	Reps	WT1	WT2	WT3	WT4	WT1	WT2	WT3	WT4	WT1	WT2	WT3	WT4	WT1	WT2	WT3	WT4
RAMP Warmup	10min																	
Primary Leg	3	12	5rpe	5rpe	5rpe		5rpe	5rpe	5rpe		6rpe	6rpe	6rpe		8 rpe	8 rpe	8 rpe	
Posterior Chain	3	12	5rpe	5rpe	5rpe		5rpe	5rpe	5rpe		6rpe	6rpe	6rpe		8 rpe	8 rpe	8 rpe	
Upper Warm-up	2	12	5rpe	5rpe			5rpe	5rpe			6rpe	6rpe			6 rpe	6 rpe		
Vertical Press	3	12	5rpe	5rpe	5rpe		5rpe	5rpe	5rpe		6rpe	6rpe	6rpe		8 rpe	8 rpe	8 rpe	
Vertical Pull	3	12	5rpe	5rpe	5rpe		5rpe	5rpe	5rpe		6rpe	6rpe	6rpe		8 rpe	8 rpe	8 rpe	
Core Circuit	10 min																	
Cool Down	5 min																	
			Session RPE =				Session RPE =				Session RPE =				Session RPE =			
Lift B			Week 1				Week 2				Week 3				Week 1			
EXERCISE (60s rec)	Sets	Reps	WT1	WT2	WT3	WT4	WT1	WT2	WT3	WT4	WT1	WT2	WT3	WT4	WT1	WT2	WT3	WT4
RAMP Warmup	10min																	
Primary Leg	3	12	5rpe	5rpe	5rpe		5rpe	5rpe	5rpe		6rpe	6rpe	6rpe		8 rpe	8 rpe	8 rpe	
Posterior Chain	3	12	5rpe	5rpe	5rpe		5rpe	5rpe	5rpe		6rpe	6rpe	6rpe		8 rpe	8 rpe	8 rpe	
Upper Warm-up	2	12	5rpe	5rpe			5rpe	5rpe			6rpe	6rpe			6rpe	6rpe		
Horizontal Press	3	12	5rpe	5rpe	5rpe		5rpe	5rpe	5rpe		6rpe	6rpe	6rpe		8 rpe	8 rpe	8 rpe	
Horizontal Pull	3	12	5rpe	5rpe	5rpe		5rpe	5rpe	5rpe		6rpe	6rpe	6rpe		8 rpe	8 rpe	8 rpe	
Core Circuit	10 min																	
Cool Down	5 min																	
			Session RPE =				Session RPE =				Session RPE =				Session RPE =			

Phase 2: Resistance Training

Phase 2																		
Lift A			Week 7				Week 8				Week 9				Week 10			
EXERCISE (90s rec)	Sets	Reps	WT1	WT2	WT3	WT4	WT1	WT2	WT3	WT4	WT1	WT2	WT3	WT4	WT1	WT2	WT3	WT4
RAMP Warm up	10min																	
Primary Leg (Bilateral)	4	6	7rpe	8rpe	9rpe	9rpe	7rpe	8rpe	9rpe	9rpe	7rpe	8rpe	9rpe	9rpe	7rpe	8rpe	9rpe	9rpe
Secondary Leg (Unilateral)	3	10	7rpe	8rpe	9rpe		7rpe	8rpe	9rpe		7rpe	8rpe	9rpe		7rpe	8rpe	9rpe	
Posterior Chain	4	6	7rpe	8rpe	9rpe	9rpe	7rpe	8rpe	9rpe	9rpe	7rpe	8rpe	9rpe	9rpe	7rpe	8rpe	9rpe	9rpe
Upper Warm-up	2	12	6rpe	6rpe			6rpe	6rpe			6rpe	6rpe			6rpe	6rpe		
Vertical Press	3	6	9rpe	9rpe	9rpe		9rpe	9rpe	9rpe		9rpe	9rpe	9rpe		9rpe	9rpe	9rpe	
Vertical Pull	3	6	9rpe	9rpe	9rpe		9rpe	9rpe	9rpe		9rpe	9rpe	9rpe		9rpe	9rpe	9rpe	
Horizontal Press (optional)	3	6	9rpe	9rpe	9rpe		9rpe	9rpe	9rpe		9rpe	9rpe	9rpe		9rpe	9rpe	9rpe	
Horizontal Pull (optional)	3	6	9rpe	9rpe	9rpe		9rpe	9rpe	9rpe		9rpe	9rpe	9rpe		9rpe	9rpe	9rpe	
Grip Training	5 min		8rpe	8rpe			8rpe	8rpe			8rpe	8rpe			8rpe	8rpe		
F-METCON see tab	8 min																	
Cool Down	5 min																	
			Session RPE =				Session RPE =				Session RPE =				Session RPE =			
Lift B			Week 7				Week 8				Week 9				Week 9			
EXERCISE (90s rec)	Sets	Reps	WT1	WT2	WT3	WT4	WT1	WT2	WT3	WT4	WT1	WT2	WT3	WT4	WT1	WT2	WT3	WT4
RAMP Warm up	10min																	
Primary Leg	4	6	7rpe	8rpe	9rpe	9rpe	7rpe	8rpe	9rpe	9rpe	7rpe	8rpe	9rpe	9rpe	7rpe	8rpe	9rpe	9rpe
Secondary Leg (Unilateral)	3	10	7rpe	8rpe	9rpe		7rpe	8rpe	9rpe		7rpe	8rpe	9rpe		7rpe	8rpe	9rpe	
Posterior Chain	4	6	7rpe	8rpe	9rpe	9rpe	7rpe	8rpe	9rpe	9rpe	7rpe	8rpe	9rpe	9rpe	7rpe	8rpe	9rpe	9rpe
Upper Warm-up	2	12	6rpe	6rpe			6rpe	6rpe			6rpe	6rpe			6rpe	6rpe		
Vertical Press	3	6	9rpe	9rpe	9rpe		9rpe	9rpe	9rpe		9rpe	9rpe	9rpe		9rpe	9rpe	9rpe	
Vertical Pull	3	6	9rpe	9rpe	9rpe		9rpe	9rpe	9rpe		9rpe	9rpe	9rpe		9rpe	9rpe	9rpe	
Horizontal Press (optional)	3	6	9rpe	9rpe	9rpe		9rpe	9rpe	9rpe		9rpe	9rpe	9rpe		9rpe	9rpe	9rpe	
Horizontal Pull (optional)	3	6	9rpe	9rpe	9rpe		9rpe	9rpe	9rpe		9rpe	9rpe	9rpe		9rpe	9rpe	9rpe	
Grip Training	5 min		8rpe	8rpe			8rpe	8rpe			8rpe	8rpe			8rpe	8rpe		
F-METCON see tab	8 min																	
Cool Down	5 min																	
			Session RPE =				Session RPE =				Session RPE =				Session RPE =			

2. General – Specific

Goals

- Strength - Maximum Expression
- Strength - Speed
- ROM *Daneshjoo et al. 2023*
- Flexibility
- Injury Mitigation, *Louersen et al. 2018*

3. Develop Comprehensive Program / Train

Phase 3: Resistance Training

MAX STRENGTH TRANSITION TO POWER / FUNCTIONAL SPECIFICITY																		
Day 1			Week 11				Week 12				Week 13				Week 14			
EXERCISE (120s rec)	Sets	Reps	WT1	WT2	WT3	WT4	WT1	WT2	WT3	WT4	WT1	WT2	WT3	WT4	WT1	WT2	WT3	WT4
Lower Body Warm-up	2	10	5rpe	5rpe			5rpe	5rpe			5rpe	5rpe			5rpe	5rpe		
Lower Body Plyo	4	12	BW	BW	BW	BW	BW	BW	BW	BW	BW	BW	BW	BW	BW	BW	BW	BW
Upper Body Plyo	4	12	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB
Triple Extension	4	3-4	80%	82%	85%	87%	82%	85%	87%	90%	85%	87%	90%	94%	85%	87%	90%	94%
Hamstring	4	3-4	80%	82%	85%	87%	82%	85%	87%	90%	85%	87%	90%	94%	85%	87%	90%	94%
Vertical Press	4	3-4	80%	82%	85%	87%	82%	85%	87%	90%	85%	87%	90%	94%	85%	87%	90%	94%
Vertical Pull	4	3-4	80%	82%	85%	87%	82%	85%	87%	90%	85%	87%	90%	94%	85%	87%	90%	94%
Horizontal Pull	4	3-4	80%	82%	85%	87%	82%	85%	87%	90%	85%	87%	90%	94%	85%	87%	90%	94%
Grip Specific Exercise	3	x																
METCON	1	8min	end				end				end				end			
			Session RPE =				Session RPE =				Session RPE =				Session RPE =			
Day 2			Week 11				Week 12				Week 13				Week 14			
EXERCISE (120s rec)	Sets	Reps	WT1	WT2	WT3	WT4	WT1	WT2	WT3	WT4	WT1	WT2	WT3	WT4	WT1	WT2	WT3	WT4
Lower Body Warm-up	2	10	5rpe	5rpe			5rpe	5rpe			5rpe	5rpe			5rpe	5rpe		
Upper Body Plyo	4	12	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB	MB
Triple Extension	4	3-4	80%	82%	85%	87%	82%	85%	87%	90%	85%	87%	90%	94%	85%	87%	90%	94%
Horizontal Press	4	3-4	80%	82%	85%	87%	82%	85%	87%	90%	85%	87%	90%	94%	85%	87%	90%	94%
Horizontal Pull	4	3-4	80%	82%	85%	87%	82%	85%	87%	90%	85%	87%	90%	94%	85%	87%	90%	94%
Vertical Pull	4	3-4	80%	82%	85%	87%	82%	85%	87%	90%	85%	87%	90%	94%	85%	87%	90%	94%
Grip Specific Exercise	3	x																
METCON	1	8min	end				end				end				end			
			Session RPE =				Session RPE =				Session RPE =				Session RPE =			

3. Specific

Goals

- Strength - Power – Better Recruitment
- Speed-Strength
 - Translate strength to task
- ROM *Daneshjoo et al. 2023*
 - Flexibility
 - Injury Mitigation, *Louersen et al. 2018*

*Percentages for performance RPE for stimulus

3. Develop Comprehensive Program / Train

Cardiovascular/Cardiorespiratory Fitness Training Model

Low Intensity

Phase 1:

-Zone 2 HR Target/any mode
-45-60 minutes, building to 90 minutes
-Unloaded first 4 weeks, light load last 2 weeks
-Even terrain

Phase 2:

-Zone 2 HR Target/any mode
-60-90 minutes
-1 day a week with load relative to body weight
-Variations of terrain

Phase 3:

-Zone 2 HR Target/any mode
-90 minutes or more
-1 day a week with load relative to body weight
-Variations of terrain

Physiology

Adenosine triphosphate (ATP) provided by oxidative phosphorylation
Ventilation increases linearly with Oxygen consumption
Lactate levels are low

Protocol

1. RPE of 4-5
2. HR Zone 3 or about 70% of maximum HR
3. Conversation Pace (if you are unable to have a conversation then the intensity is too high)
4. Easy Pace

Suggested Mode

1. Biking!!!
2. Running
3. Stairmaster
4. Rucking

Examples For Running

Example 1

Moderate Intensity

Phase 1:

-Not focused/prioritized

Phase 2:

-Bike preferred
-Zone 3 Target
-Highest intensity sustained f/30 minutes (at Z3)

Phase 3:

-Bike or row machine
-Zone 3 Target
-Highest intensity sustained f/30 minutes (at Z3)

Physiology

Recruitment of some type II muscle fibers
Mix of aerobic and anaerobic energy systems for ATP production
Ventilation still matches Oxygen consumption
Lactate Levels rise, but lactate clearance is greater than accumulation

Protocol

1. RPE of 6-7
2. HR Zone 3 or about 70% of maximum HR
3. Fastest even pace you can sustain for a minimum of 20min
4. Threshold is = to you average 5k race pace

Suggested Mode

1. Biking!!!
2. Running
3. Stairmaster

Examples For Running

Example 1

High Intensity

Phase 1:

-Not focused/prioritized

Phase 2:

-Not focused/prioritized

Phase 3:

- Any mode
-HR Zones 1-4, RPE 8-9
-5-7 Sets, 2:30- 10:00 minute intervals

Physiology

Greater use of Type II Muscle, require large amounts of ATP
Anaerobic glycolysis is the primary energy source; high amounts of CO2
Ventilation disproportionate to Oxygen consumption, increased need to breath out CO2
Muscle lactate levels rise exponentially and exceed clearance capacity

Protocol

1. RPE of 8-10
2. HR Zone 4-5 or about 80% + of maximum HR

Suggested Mode

1. Biking!!!
2. Running
3. Stairmaster
4. Jacobs Ladder

Examples For Running

Example 1



Low Intensity



Moderate Intensity

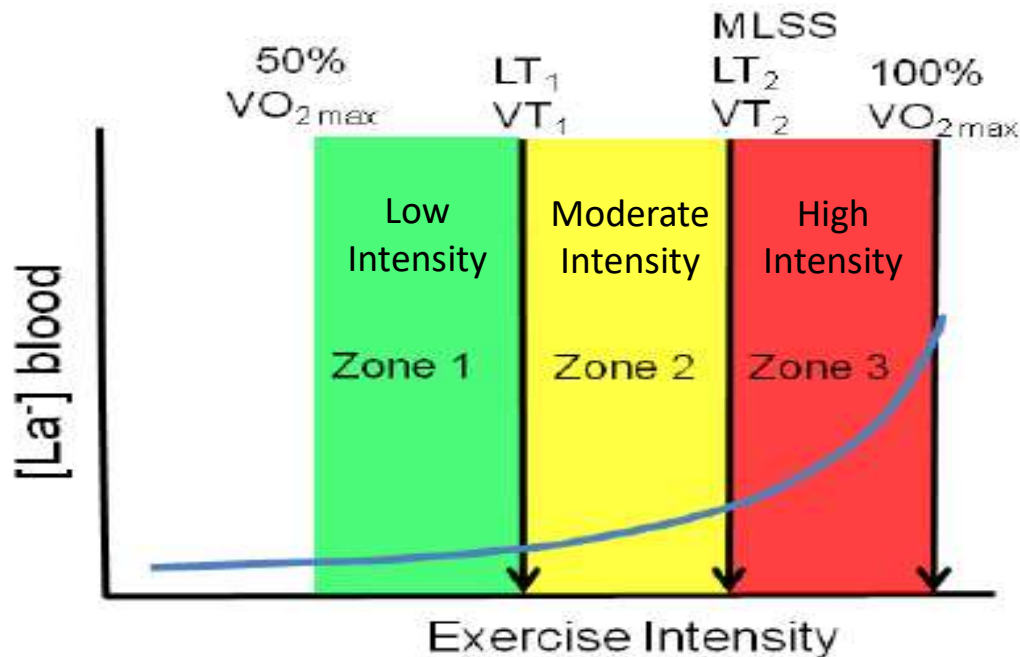


High Intensity

3. Develop Comprehensive Program / Train



Exercise Prescription: Cardiovascular / Cardiorespiratory



Two best ways to prescribe cardiovascular exercise

- % of Maximum Oxygen Uptake
- % of Blood Lactate Concentration

Establish / Relationships

- % of Max Heart Rate
- Talk Test
- RPE
- Pace / Work Rate

Opinion: 3 Zone Model:

- ☐ Zone 1: Low-Intensity Exercise, Below VT₁ (Ventilatory Threshold 1)
- ☐ Zone 2: Moderate-Intensity Exercise between VT₁ and 95% of VT₂
- ☐ Zone 3: All High-Intensity Exercise above VT₂ intensity

Seiler, Stephen & Tønnessen, Espen. (2009). **Intervals, Thresholds, and Long Slow Distance: the Role of Intensity and Duration in Endurance Training**. SPORTSCIENCE · sportsci.org. 13. 32-53.

3. Develop Comprehensive Program / Train

Exercise Prescription: Cardiovascular / Cardiorespiratory

Five Intensity Zones

A typical five-zone scale to prescribe and monitor training of endurance athletes

Intensity Zone	VO ₂ (%max)	Heart Rate (%max)	Lactate (mmol·L ⁻¹)	Duration	
1	45-65	55-75	0.8-1.5	1-6 h	'Zone 1'
2	66-80	75-85	1.5-2.5	1-3 h	
3	81-87	85-90	2.5-4	50-90 min	'Zone 2'
4	88-93	90-95	4-6	30-60 min	
5	94-100	95-100	6-10	15-30 min	'Zone 3'

Session RPE

Category Ratio Scale		Session RPE		
0 -	Nothing at all	0 -	Rest	'Zone 1' (<2 mmol/L)
1 -	Very weak	1 -	Very easy	
2 -	Weak	2 -	Easy	
3 -	Moderate	3 -	Moderate	
4 -	Somewhat strong	4 -	Somewhat hard	'Zone 2' (2-4 mmol/L)
5 -	Strong	5 -	Hard	
6 -		6 -		'Zone 3' (>4 mmol/L)
7 -	Very strong	7 -	Very hard	
8 -		8 -	Very, very hard	
9 -		9 -	Near maximal	
10 -	Very very strong	10 -	Maximal effort	

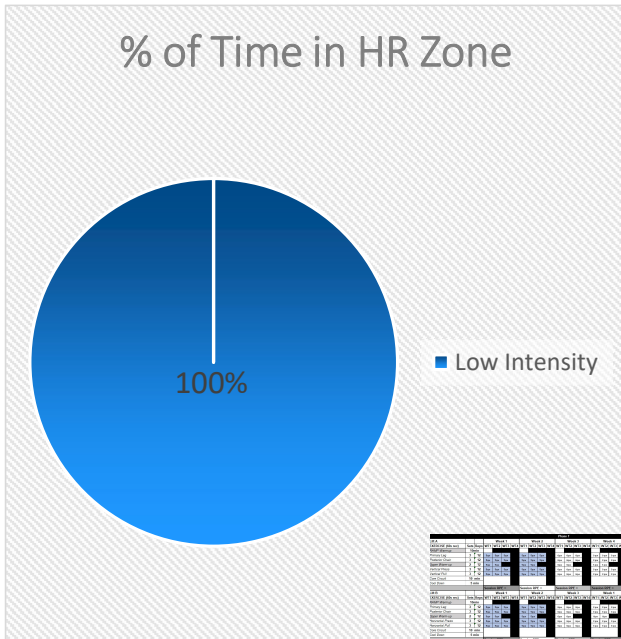
Borg → Foster → Seiler

Frankie TAN, PhD Senior Sports Physiologist Singapore Sports Institute

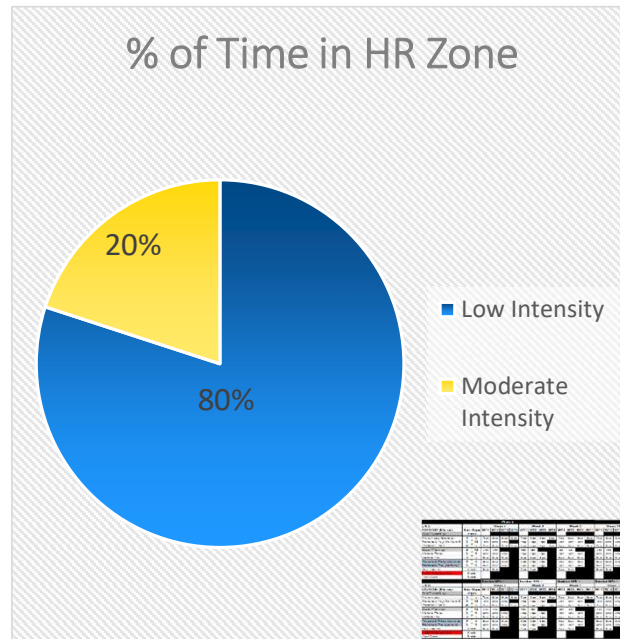


3. Develop Comprehensive Program / Train

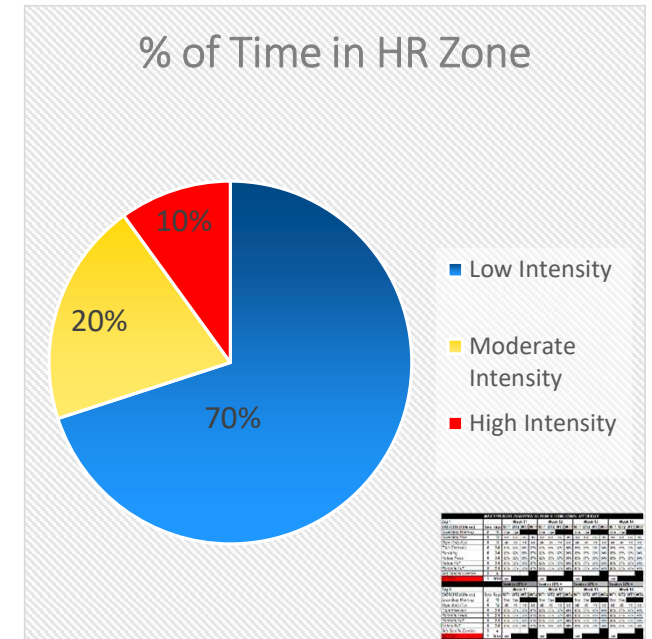
(Sample Microcycle)-Neglecting Volume / Mode



Phase 1



Phase 2



Phase 3

Effective monitoring capabilities are paramount in determining the optimal approach to harmonizing or **integrating** training stress.

3. Develop Comprehensive Program / Train

Prescribed in a (Four-Pronged) Fashion (EDUCATION)




Low Intensity

Aerobic Training

- 1.RPE 1-4
- 2.Jack Daniels VDOT - Pace (Derived from Performance)
- 3.Zone 1 (About 60%)
- 4.Easy Pace

e.g., Conversation Pace = intensity that allows a conversation during training for min 30min.




Moderate Intensity

Tempo / Threshold Training

- 1.RPE 5-6
- 2.Jack Daniels VDOT- Pace (Derived from Performance)
- 3.Zone 2 (About 85%)
- 4.Moderate Pace

e.g., The fastest even sustainable pace for minimum 20min



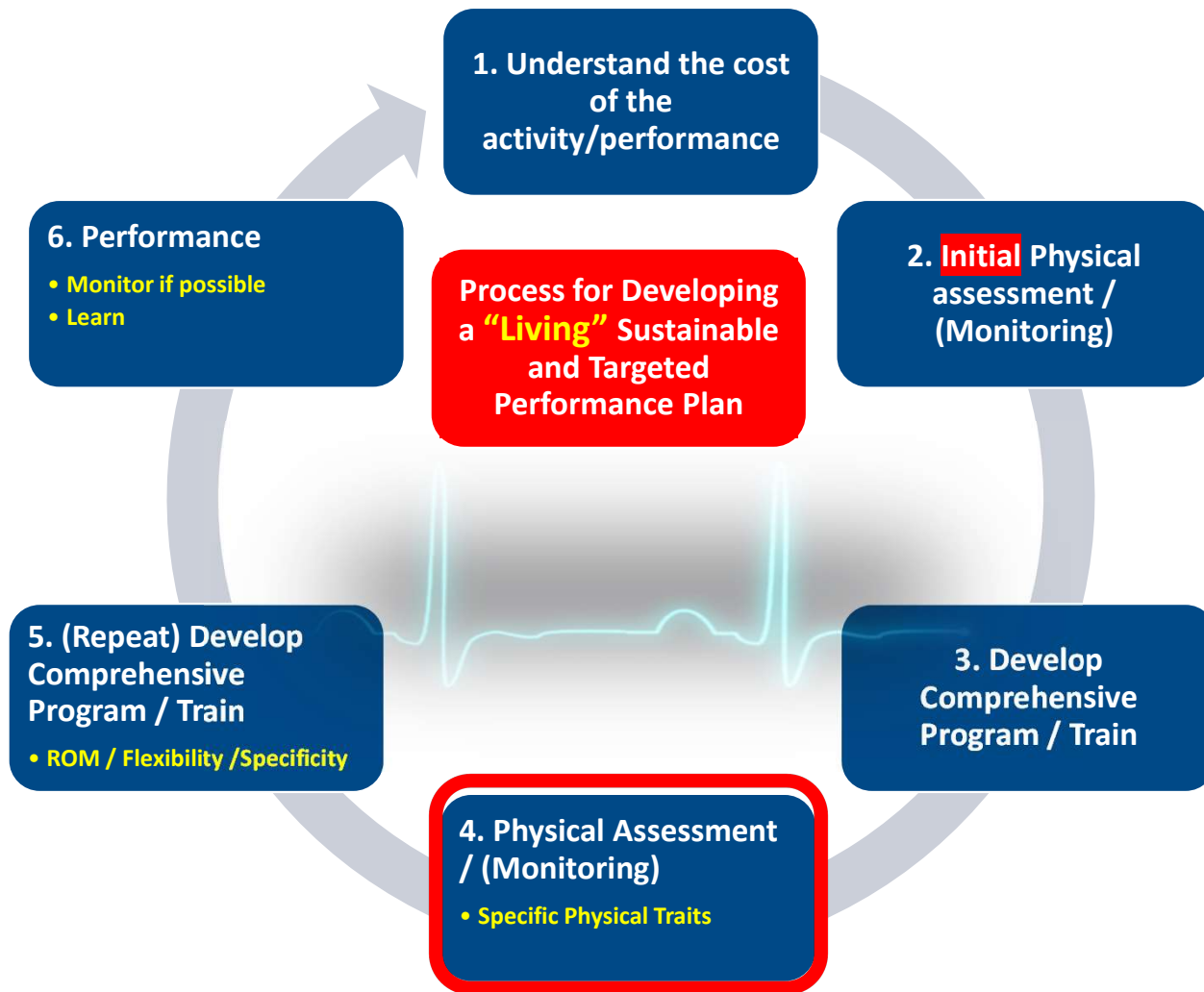

High Intensity

Interval Training

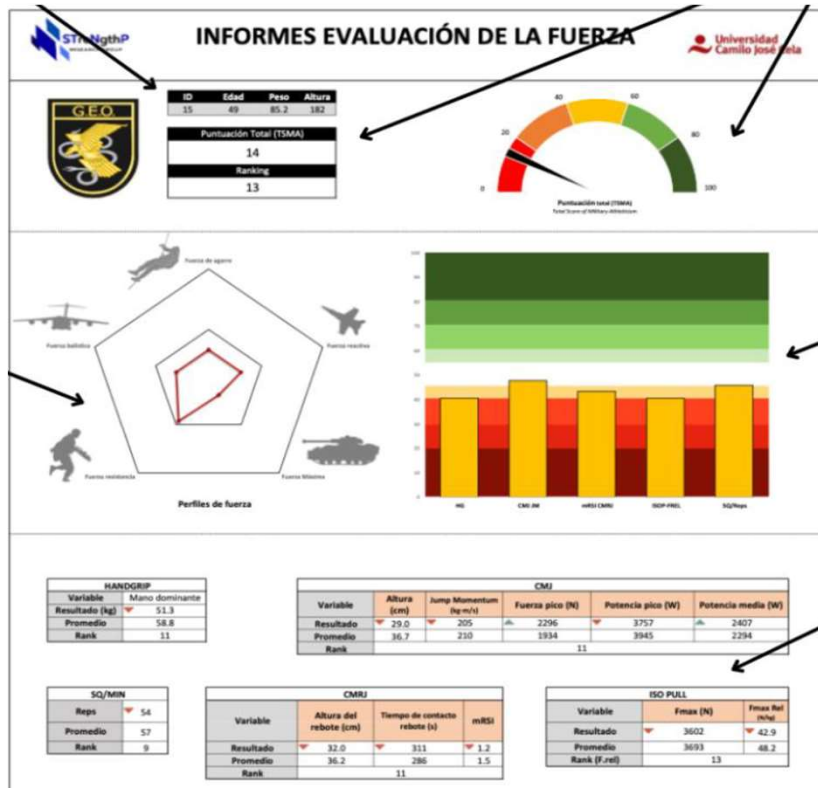
- 1.RPE 7-10
- 2.Jack Daniels VDOT - Pace (Derived from Performance)
- 3.Zone 3 (About 90%+)
- 4.Hard Pace

e.g., 1min Hard, 2min Easy @ 1:2 intervals, 4 rounds

3. Develop Comprehensive Program / Train



Monitoring the Process



An evidence-based and systematic approach is crucial for assessing health and fitness, comprehending the body's response to training stimuli, and optimizing performance through appropriate exercise intensity, all while mitigating the risk of overtraining-induced injury.

Three critical reasons for operational monitoring:

1. Benchmarking of physical abilities
2. Assessing training efficacy!
3. Monitoring load/intensity, fatigue or **response to exercise dose**, and adaptation



4. Physical Assessment / (Monitoring)

- **Specific Physical Traits**

Pictures provided by Dr. Marcos Soriano

Monitoring the Process

Rerouting....



Simply, we are charting a path from our current fitness or skill level to our desired destination at a set timepoint.

“Periodization should probably be considered a flexible concept or method, rather than a rigid model, and a systematic attempt to gain control of the adaptive response to training in preparation for competition.”

Gambetta V. Periodization and the systematic sport development process. Olympic Coach 2004;16(2):8–13.

“Periodization provides the overall concept of training and deals with subdividing the training process into specific time periods and fitness phases.” DeWeese et al.

Mujika I, Halson S, Burke LM, Balagué G, Farrow D. **An Integrated, Multifactorial Approach to Periodization for Optimal Performance in Individual and Team Sports.** *Int J Sports Physiol Perform.* 2018 May 1;13(5):538-561. doi: 10.1123/ijsp.2018-0093. PMID: 29848161.

4. Physical Assessment / (Monitoring)

- Specific Physical Traits

Physical Assessment/Monitoring Timepoints



Calendar

January S M T W T F S	February S M T W T F S	March S M T W T F S
April S M T W T F S	May S M T W T F S	June S M T W T F S
July S M T W T F S	August S M T W T F S	September S M T W T F S
October S M T W T F S	November S M T W T F S	December S M T W T F S



Macro-Level Monitoring (6-12 Months)

- Effectiveness of the program
- Gross training adaptation



Meso-Level Monitoring (8-12 weeks)

- Scheduled around pre-post periodization scheme
- Train power then test power expression
- Feeds into the macro-level training program



Micro-Level Monitoring (Bi-Weekly, weekly, intra-weekly)

- Neuromuscular fatigue
- Detraining
- Feeds into the macro-level training program

Merrigan, Justin & Stone, Jason & Martin, Joel & Hornsby, Guy & Galster, Scott & Hagen, Josh. (2021). **Applying Force Plate Technology to Inform Human Performance Programming in Tactical Populations**. Applied Sciences. 11. 10.3390/app11146538.

4. Physical Assessment / (Monitoring)

- Specific Physical Traits



No monitoring = No Living Program

Flatline



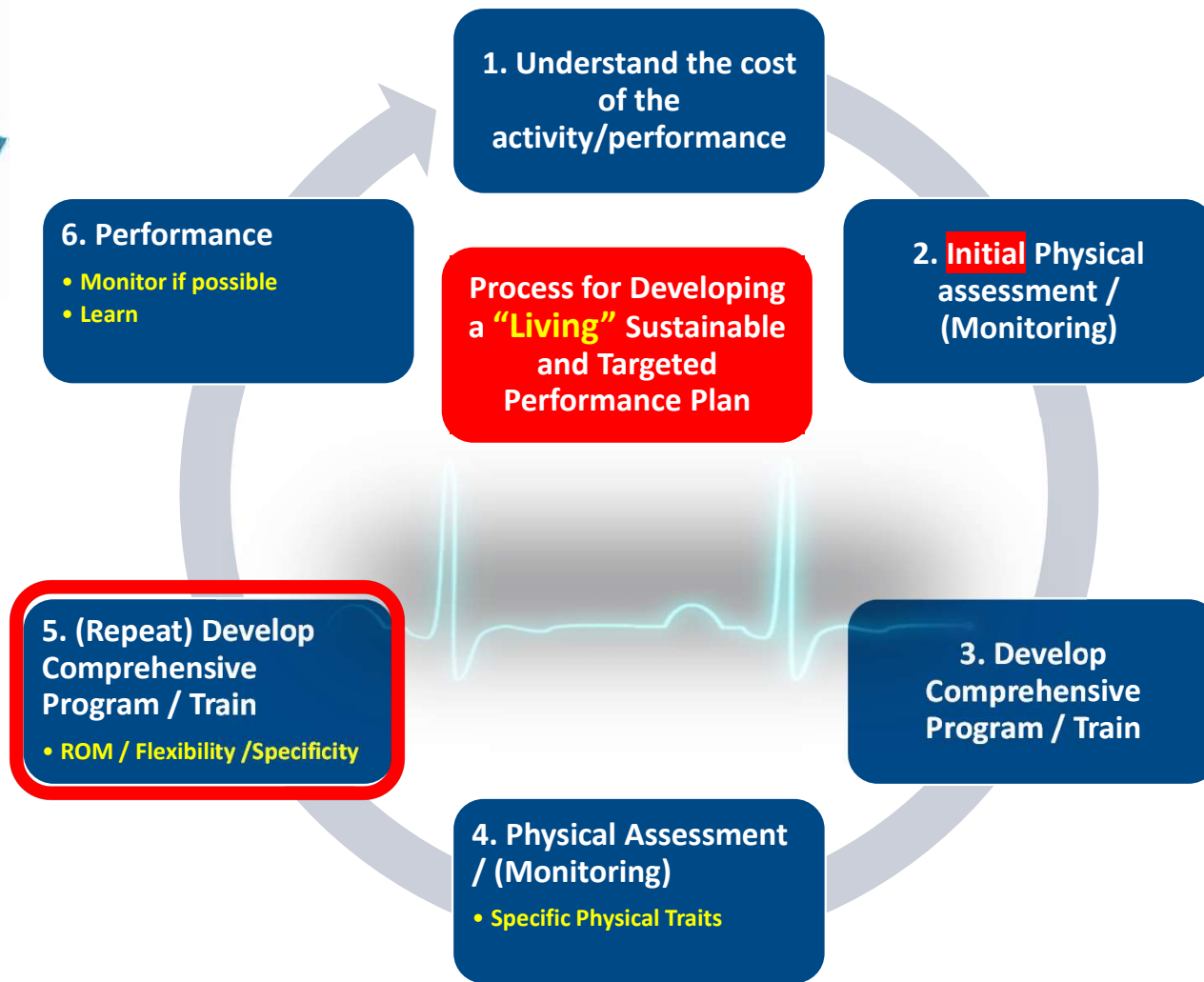
*"Performance Optimization" is a moving , necessitating ongoing evaluation to refine the ideal approach.

Negative Consequences of Not Monitoring

- No understanding of the efficacy of your training program
- Inability to understand dose response to exercise
- No idea of what qualities/abilities will have an impact on performance
- **Methodology with poor rationale may get accredited**

4. Physical Assessment / (Monitoring)

- **Specific Physical Traits**



Repeat: Vertical Integration & Horizontal Sequencing

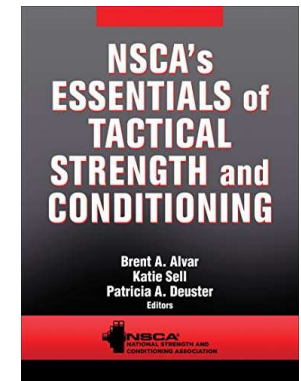
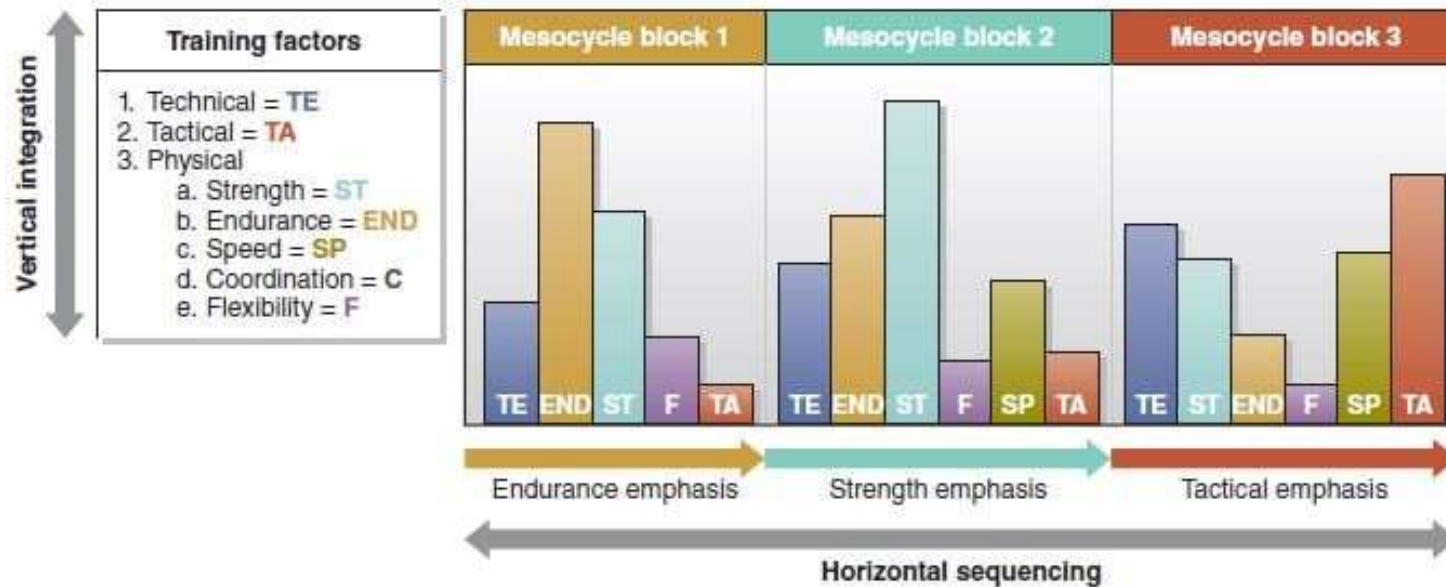


Figure 10.11 Vertical integration and horizontal sequencing.

*Graphs Printed with Dr. Greg Haff's permission

5. (Repeat) Develop Comprehensive Program / Train
 • ROM / Flexibility / Specificity

Training Specificity Categorized

“Specificity is the degree of metabolic and mechanical similarity between the desired performance characteristics and training exercises. The aim of increased specificity throughout the training process is to enhance the transfer of training effect, which is a measure of how much the training transfers to actual sport performance. If athletic performance enhancement is a primary goal, then specificity of exercise and training arguably becomes the most important consideration for selecting methods and modes for resistance training. There are two basic aspects to specificity: mechanical and metabolic.”

1. **“Task specificity** is concerned, at least in large part, with the manner in which the motor cortex organizes motor unit activation (intra-muscular tasks) and whole muscle activation patterns (inter-muscular tasks). There is good evidence that both intra- and inter-muscular task specificity aspects play a major role in strength–power training.” **Basically, the greater similarity training exercise has to the actual physical performance, the greater the probability of transfer.”**
2. **“Mechanical specificity** refers to the **kinetic (force) and kinematic (displacement, velocity, power, RFD)** associations between a training exercise and a physical performance. Mechanical specificity includes movement patterns (e.g., range of movement, open vs. closed kinetic chain exercise, etc.), **peak force, rate of force development, acceleration patterns, and velocity parameters.** Conceptually, mechanical specificity has strong support based on observations of inter- and intra-muscular task specificities.”

*Observing from a distance and attempting to replicate a perceived effort or a particular movement pattern in an analogy to a specific exercise at the gym is not recommended.



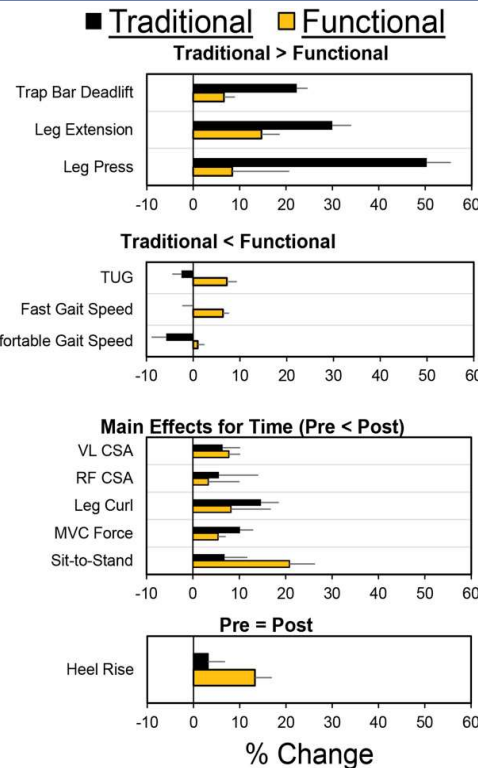
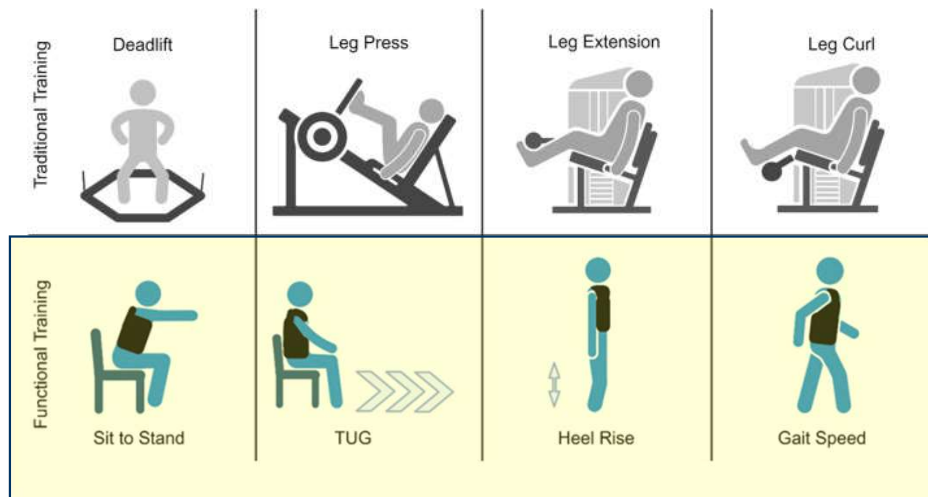
DeWeese, Brad & Hornsby, Guy & Stone, Meg & Stone, Michael. (2015). *The training process: Planning for strength—power training in track and field. Part 1: Theoretical aspects.* Journal of Sport and Health Science. 4. 10.1016/j.jshs.2015.07.003.

5. (Repeat) Develop Comprehensive Program / Train

• ROM / Flexibility /Specificity

Training Specificity (SAID Principle)

The closer training or preparation is to the task the more likely there is to be transfer or carryover of those subsequent skills or abilities



Key

Tug = standing up from a chair and walking along a marked line on the floor for a short distance (3 m), turning around to return to the chair, and sitting down on the chair.

Comfortable / Fast Gait Speed = 4m walking test 6 trials 3 fast, 3 slow

VL CSA = Ultrasound of vastus lateralis cross-sectional area

RF CSA = Ultrasound of rectus femoris cross-sectional area

MVC Force = Maximum voluntary contraction of seated knee extension / dominant knee

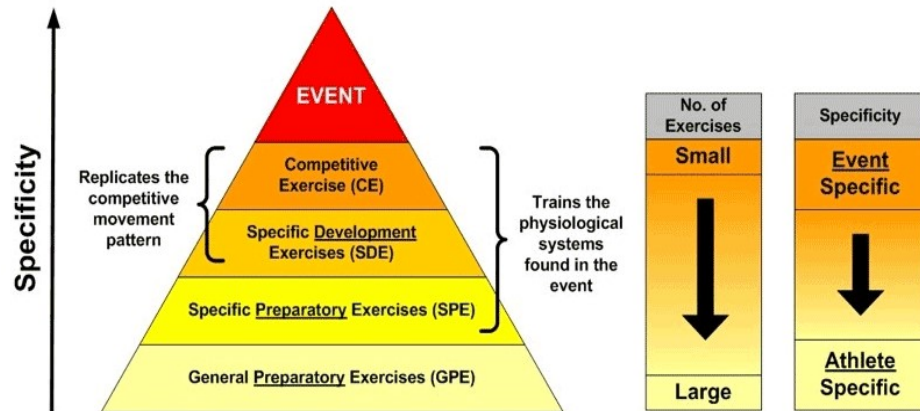
5. (Repeat) Develop Comprehensive Program / Train

• ROM / Flexibility / Specificity

Pagan JJ, Bradshaw BA, Bejtle B, Hart JN, Perez V, Knowles KS, Beausejour JP, Luzadder M, Menger R, Osorio C, Harmon KK, Hanney WJ, Wilson AT, Stout JR, Stock MS. **Task-specific resistance training adaptations in older adults: comparing traditional and functional exercise interventions.** Front Aging. 2024 Apr 30;5:1335534. doi: 10.3389/fragi.2024.1335534. PMID: 38746477; PMCID: PMC11091347.

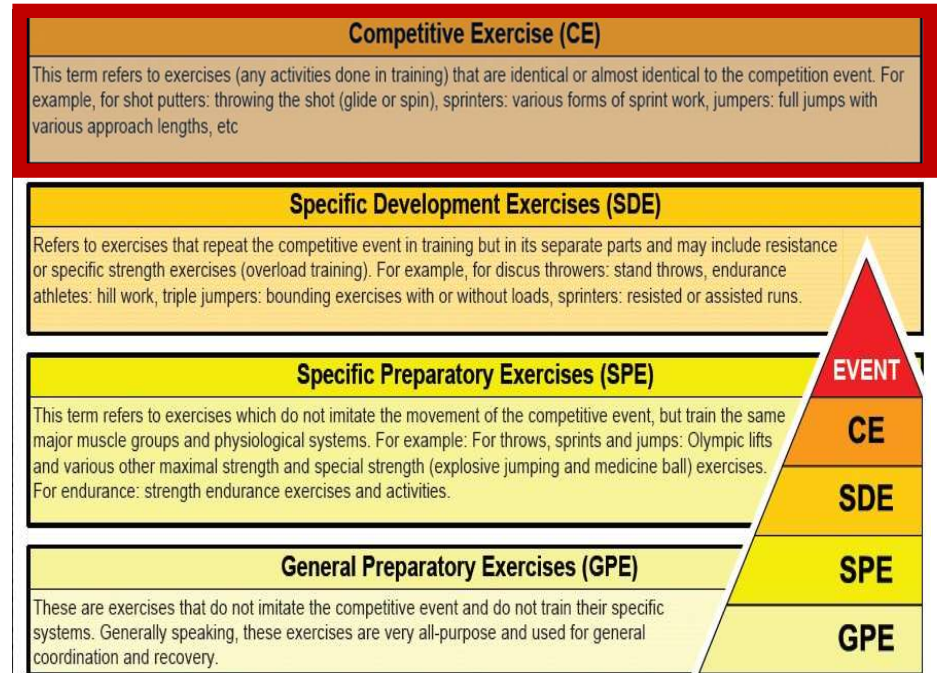
Specificity: Classification of Exercises

Dr. Anatoliy Bondarchuk's Classification of Exercises



Anatoliy Pavlovych Bondarchuk ([Ukrainian](#): [Анатолій Павлович Бондарчук](#), born 31 May 1940) is a retired Ukrainian [hammer thrower](#) who competed for the [Soviet Union](#). An Olympic gold medallist, he is also regarded as one of the most accomplished [hammer throw coaches](#) of all time. **He is the author of a two-volume book *Transfer of Training*, which was translated from Russian to English by [Michael Yessis](#).**

“Training stimuli can be categorized into **general** and **specific**. Specific qualities are *movements, mental states* and *physical attributes* that are seen in the sport the athlete is preparing for, while general qualities are defined as variation of sport-specific attributes that build the base that allows specific qualities to flourish in the long term.” [Geoffrey Chiu](#)



5. (Repeat) Develop Comprehensive Program / Train
 • ROM / Flexibility / Specificity

ROM – Understanding Mobility and Flexibility as it applies

Muscular Flexibility - the ability of a muscle or muscle group to lengthen through a range of motion. Can expand to all body tissues like fascia, etc. (i.e., elasticity)

- **Static Flexibility** - Passively through ROM
- **Dynamic Flexibility** - Motion assisted through ROM

Mobility- a joint's ability to move **actively** through a range of motion with (motor control).

- **ROM = Flexibility + Mobility**

More a Product of Strength vs Mobility or Flexibility

Can we improve it?

More a product of Strength vs flexibility

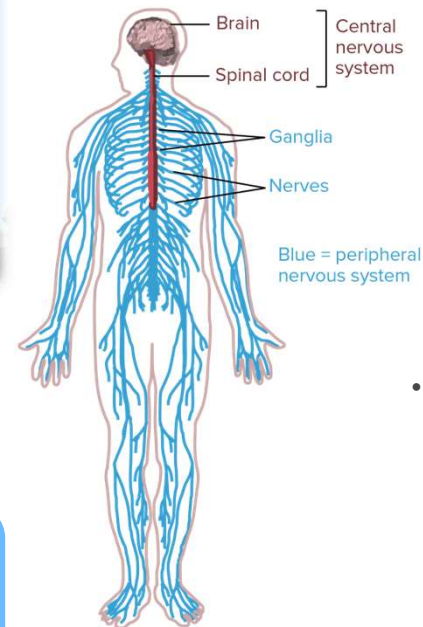
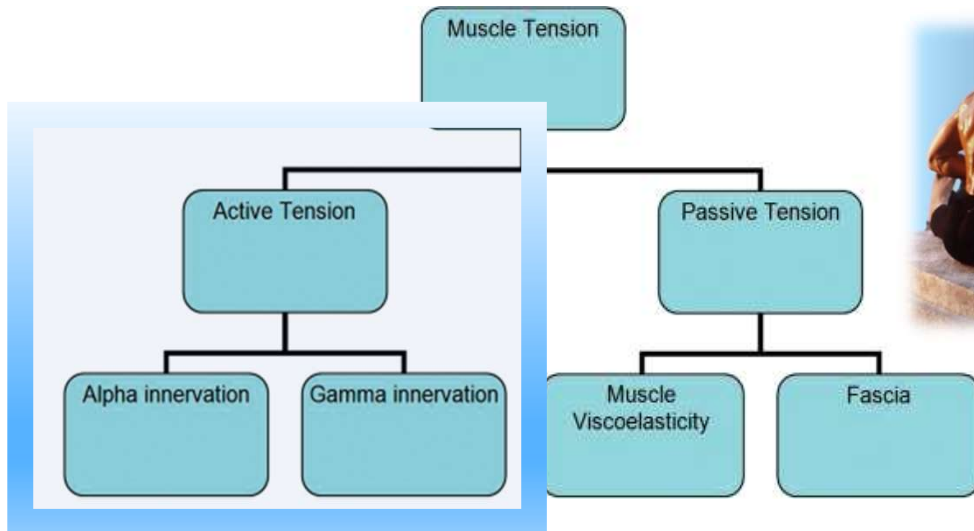


End-of-range strength refers to the exertion of force when a muscle is at its longest or shortest. Think about raising your leg in front of you as high as you can. You'll reach a point where you cannot lift any higher, no matter how hard you try. This is your end-of-range strength and the point where your active mobility ends.

5. (Repeat) Develop Comprehensive Program / Train

- **ROM / Flexibility / Specificity**

Nervous System Influence on ROM (Muscular Flexibility)



- **Alpha (α) motor neurons** (also called alpha motoneurons), are large, multipolar lower motor neurons of the brainstem and spinal cord. They innervate extrafusal muscle fibers of skeletal muscle and are directly responsible for initiating their contraction.
- **The gamma motor neurons** innervate the muscle spindle at each end. They allow contraction of the intrafusal fibers and increase their sensitivity to stretch.

The central nervous system (CNS) holds a crucial responsibility in determining the extent to which we can stretch, basing its judgment on the perceived safety within that particular range of motion. It enables rapid actions within familiar ranges where muscular coordination is well-established, emphasizing a feeling of confidence when it recognizes mastery over our motions.

Page P. Current concepts in muscle stretching for exercise and rehabilitation. *Int J Sports Phys Ther.* 2012 Feb;7(1):109-19. PMID: 22319684; PMCID: PMC3273886.

5. (Repeat) Develop Comprehensive Program / Train

- ROM / Flexibility / Specificity

ROM – Understanding Mobility and Flexibility as it applies

SYSTEMATIC REVIEW



Resistance Training Induces Improvements in Range of Motion: A Systematic Review and Meta-Analysis

Shahab Alizadeh¹ · Abdolhamid Daneshjoo² · Ali Zahiri¹ · Saman Hadjizadeh Anvar¹ · Reza Goudini¹ · Jared P. Hicks¹ · Andreas Konrad^{1,3,4} · David George Behm¹ 

Accepted: 14 December 2022 / Published online: 9 January 2023
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Abstract

Background Although it is known that resistance training can be as effective as stretch training to increase joint range of motion, to date no comprehensive meta-analysis has investigated the effects of resistance training on range of motion with all its potential affecting variables.

Objective The objective of this systematic review with meta-analysis was to evaluate the effect of chronic resistance training on range of motion compared either to a control condition or stretch training or to a combination of resistance training and stretch training to stretch training, while assessing moderating variables.

Design For the main analysis, a random-effect meta-analysis was used and for the subgroup analysis a mixed-effect model was implemented. Whilst subgroup analyses included sex and participants' activity levels, meta-regression included age, frequency, and duration of resistance training.

Data Sources Following the systematic search in four databases (PubMed, Scopus, SPORTDiscus, and Web of Science) and reference lists, 55 studies were found to be eligible.

Eligibility Criteria Controlled or randomized controlled trials that separately compared the training effects of resistance training exercises with either a control group, stretching group, or combined stretch and resistance training group on range of motion in healthy participants.

Results Resistance training increased range of motion (effect size [ES]=0.73; $p<0.001$) with the exception of no significant range of motion improvement with resistance training using only body mass. There were no significant differences between resistance training versus stretch training (ES=0.08; $p=0.79$) or between resistance training and stretch training versus stretch training alone (ES=-0.001; $p=0.99$). Although "trained or active people" increased range of motion (ES=0.43; $p<0.001$) "untrained and sedentary" individuals had significantly ($p=0.005$) higher magnitude range of motion changes (ES=1.042; $p<0.001$). There were no detected differences between sex and contraction type. Meta-regression showed no effect of age, training duration, or frequency.

Conclusions As resistance training with external loads can improve range of motion, stretching prior to or after resistance training may not be necessary to enhance flexibility.

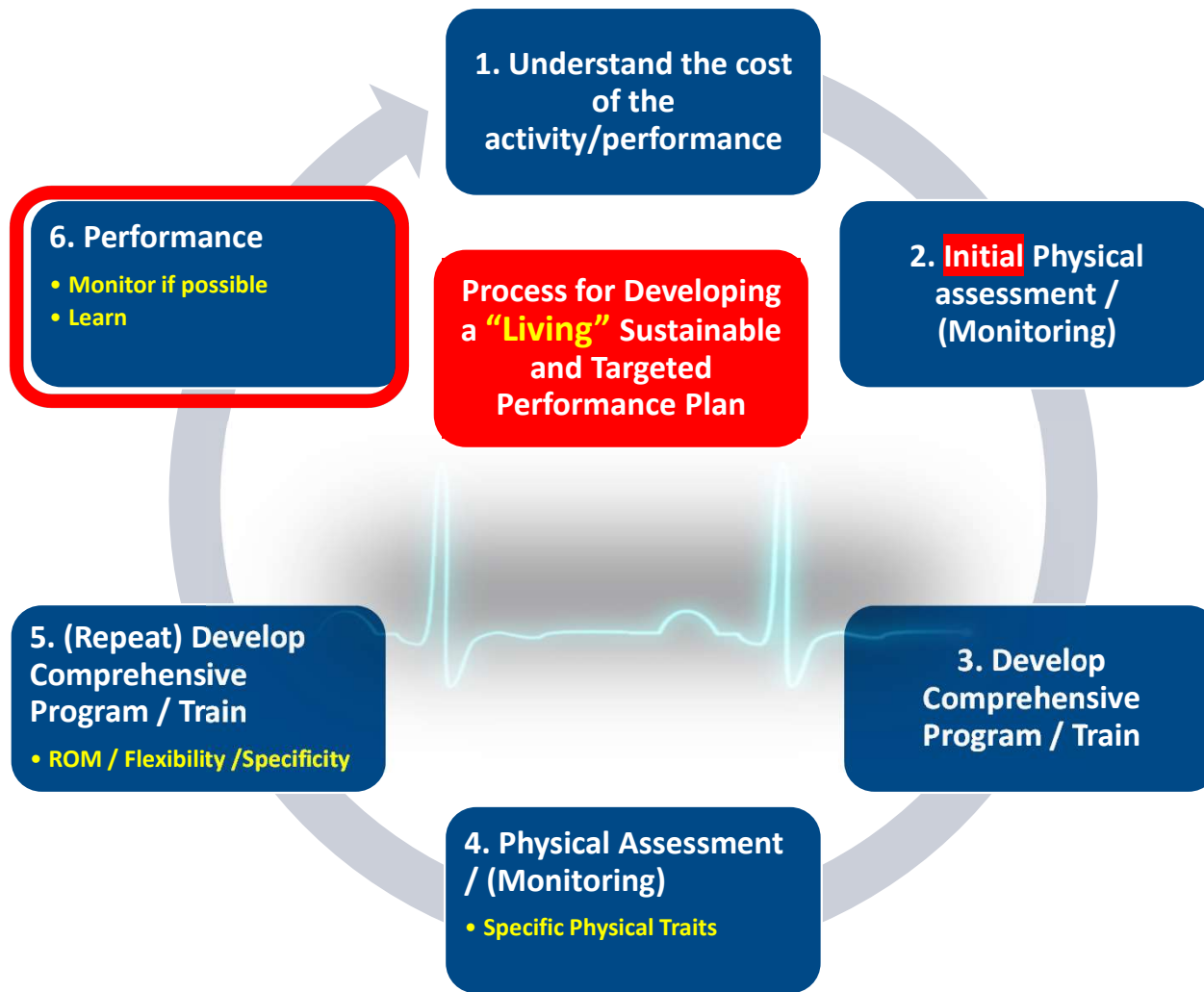
“Conclusions: As resistance training with external loads can improve range of motion, stretching prior to or after resistance training may not be necessary to enhance flexibility.”



Rosenfeldt, M., Stien, N., Behm, D.G. *et al.* Comparison of resistance training vs static stretching on flexibility and maximal strength in healthy physically active adults, a randomized controlled trial. *BMC Sports Sci Med Rehabil* 16, 142 (2024).
<https://doi.org/10.1186/s13102-024-00934-1>

5. (Repeat) Develop Comprehensive Program / Train

• ROM / Flexibility /Specificity



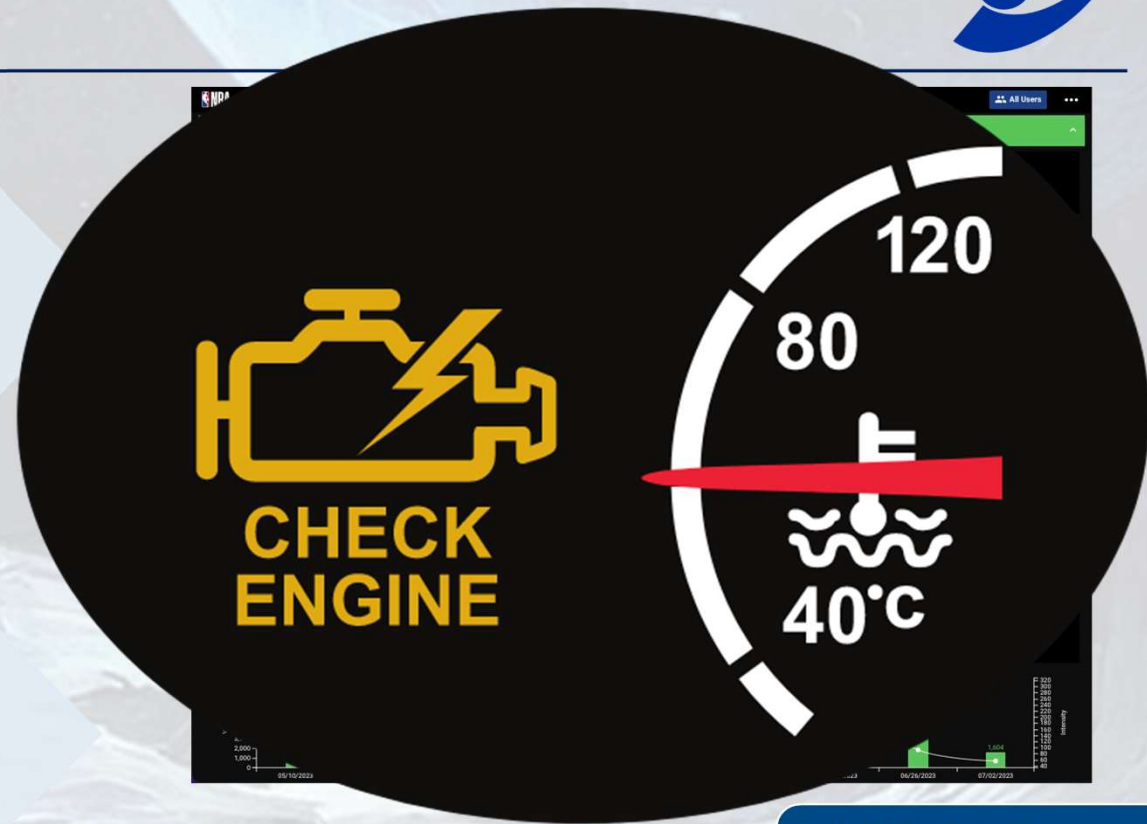
Monitoring the Analogs

Internal Load - "The internal workload is the biological stress imposed by the training session and is defined by the disturbance in homeostasis of the physiological and metabolic processes during the exercise training session."
Iñigo Mujika

- RPE
- Biochemical analyses
- Questionnaires
- Heart Rate
 - RHR, HRR, HRV

External Load - "The external training load is an objective measure of the work that an athlete completes either during training or competition and is measured independently of the internal workload."
Iñigo Mujika

- Volume Load = Sets x Reps x Load
- Pace
- Training Density (Combines volume within the duration of your workout)



6. Performance

- Monitor if possible
- Learn

Leveraging all Monitoring to Tell A Story

Monitoring the Performance in the Environment (Practice)

Internal Load - "The internal workload is the biological stress imposed by the training session and is defined by the disturbance in homeostasis of the physiological and metabolic processes during the exercise training session." Iñigo Mujika

- RPE
- Biochemical analyses
- Questionnaires
- Heart Rate
 - RHR, HRR, HRV

External Load - "The external training load is an objective measure of the work that an athlete completes either during training or competition and is measured independently of the internal workload." Iñigo Mujika

- Volume Load = Sets x Reps x Load
- Pace
- Training Density (Combines volume within the duration of your workout)

Is there a relationship?

Underling Ability in Controlled Environment Monitoring

- Grip Strength
- Body Weight
- Isometric Mid Thigh Pull
- Isometric Bench Press
- Counter Movement Jump
- Static Jump
- Cone Agility Test
- Max Pull Ups
- 2-minute Max Hand Release Push Ups
- VO2max

6. Performance

- Monitor if possible
- Learn

Performance - Monitoring Analogs

It is a great physical training environment and the best opportunity to learn about physical needs and abilities.

- = to Practice for an Athlete
- The analogs are the closest thing we have to target task and mechanical specificity.
- All information from this monitoring can go back into the process to continue to tailor training based on needs.
- **Monitoring the analogs is also a great way to regulate the intensity and skill level.**



NASA Stock Photos; pulled 6/2024, Andre Douglas at JETT 5

Physical Preparation



Practice



Game / Performance



6. Performance

- **Monitor if possible**
- **Learn**

TOPIC THREE: CURRENT STATE OF PERFORMANCE PLAN



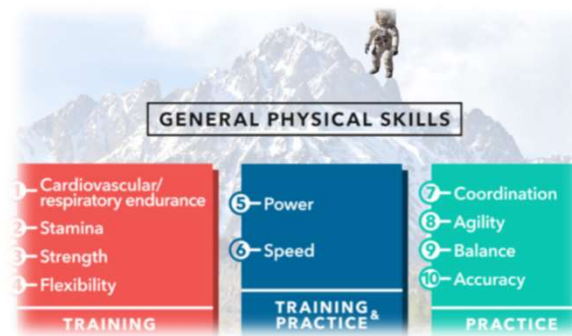
The Nature of Training Templates

The current state of Lunar Extravehicular Activity (EVA) performance, or the plan for work hardening, is a **template** built on evidence from our current knowledge, with the expectation that it will adapt as our understanding evolves.

“A template = is a form, mold, or pattern used as a guide to make something.”

Templates are helpful; however, they still have some weaknesses.

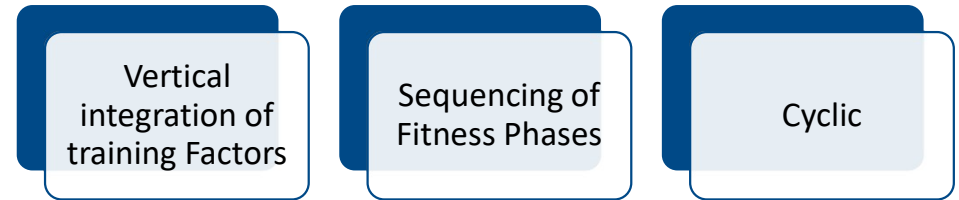
- Comes with risk
- Neglects Individual variability
- Neglects Individual Skill level
- Neglects Individual orthopedic limitations



It's off the rack, so don't expect it to fit perfectly!



Pillars of Fitness are Generally = Focused Performance Plan



Training Compatibility, Residual Training Effect, Phase Potentiation

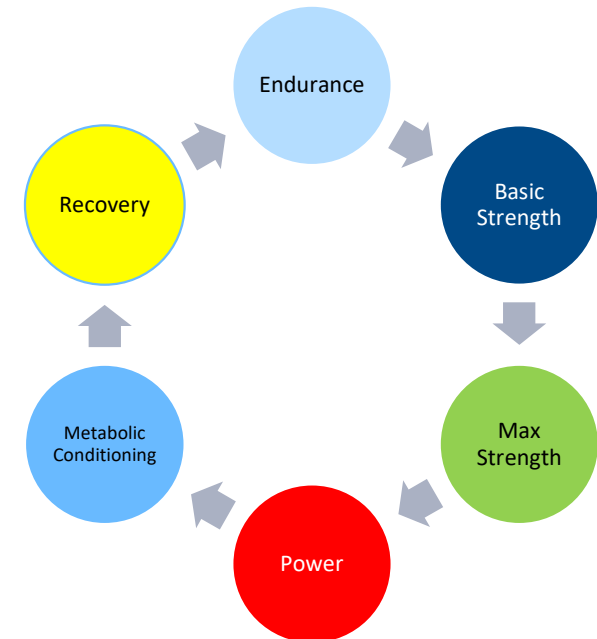
Training Compatibility		Residual Training Effects		
Dominant Training Modality	Compatible Training Modalities	Motor Ability	Retention	Physiological
Aerobic Endurance	Alactic sprint abilities, Strength endurance (Aerobic), Maximum strength, Hypertrophy	Oxidative Energy System	30±5	Increased number of aerobic enzymes, mitochondria, capillary density, hemoglobin capacity, glycogen storage, higher rate of fat metabolism
Glycolytic Endurance	Strength Endurance (anaerobic), Aerobic restoration, Aerobic-anaerobic (mixed) endurance	Strength	30±5	Improvement of neural mechanism, muscle hypertrophy
Alactic Sprints	Aerobic Endurance, Explosive strength, Maximum Strength, Hypertrophy, Aerobic restoration	Glycolytic Energy System	18±4	Increased anaerobic enzymes, buffering capacity and glycogen storage, higher possibility of lactate accumulation
Maximum Strength/ Hypertrophy	Maximum strength, flexibility, aerobic restoration	Repeat-Power	15±5	Improved aerobic/ anaerobic enzymes, improved local blood circulation and lactate tolerance, repeat sprint ability
Learning new technical elements	Any kind of training modalities after the primary/dominant task	ATP/CR-P	5±3	Enhanced resynthesis of CR-P
		Speed	5±3	Improved neuromuscular interactions and motor control, increases anaerobic power

Phase potentiation refers to the deliberate arrangement of programming phases to enhance the likelihood of leveraging skills acquired in one phase to optimize performance in subsequent phases. (e.g., Max Strength before power)



3

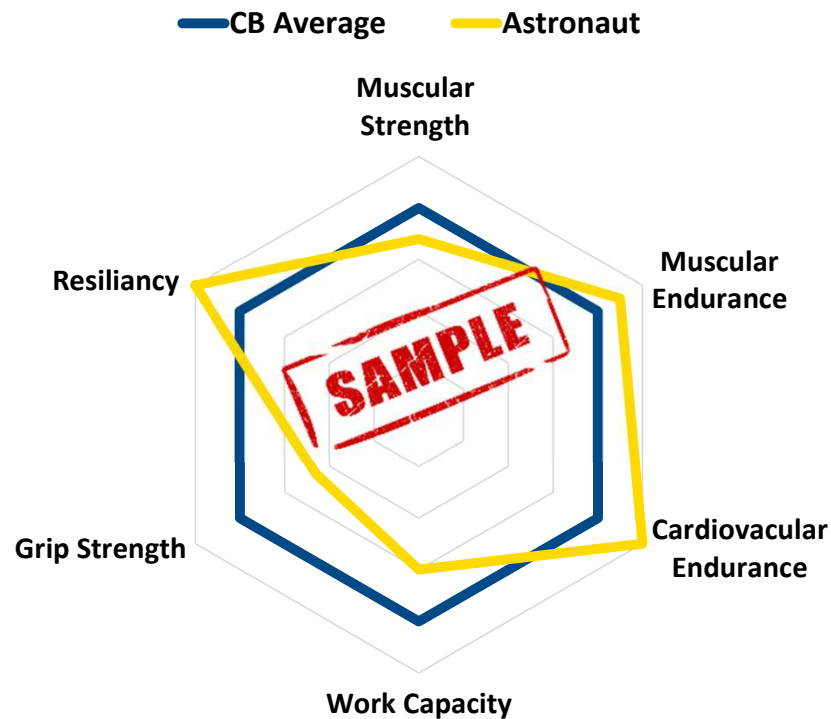
3. Develop a vertically integrated sequential training plan on needs (Train)



Adapted from: Issurin, V. (2008). "Block Periodization: Breakthrough in Sports Training." New York, NY: Ultimate Athlete Concepts.

Adapted from: Issurin, V. (2008). "Block Periodization: Breakthrough in Sports Training." New York, NY: Ultimate Athlete Concepts.

What is Fitness



Fitness Defined—Your fitness level is not solely determined by strength or endurance; rather, it is determined by your ability to effectively demonstrate proficiency in all necessary skills for the specific environment at any given moment. This holistic assessment of your physical capabilities truly defines fitness.



For example, while having impressive muscular strength is commendable, it should be complemented by sufficient cardiovascular endurance to improve overall fitness performance; otherwise, one may be considered unfit.



This highlights the importance of two key aspects:

1. Periodization still exists in general fitness.
2. When facing diverse physical challenges, a well-rounded readiness approach that encompasses a variety of physical capabilities becomes essential.



Tangent “TTMMWTGOABMHOTC”



Light Resistance

Heavy Resistance



Grip and Forearm Strength and Endurance

1. What does someone need?
2. What do you have?
3. Expected Fatigue

A. Training Suggestions



B. Training Suggestions

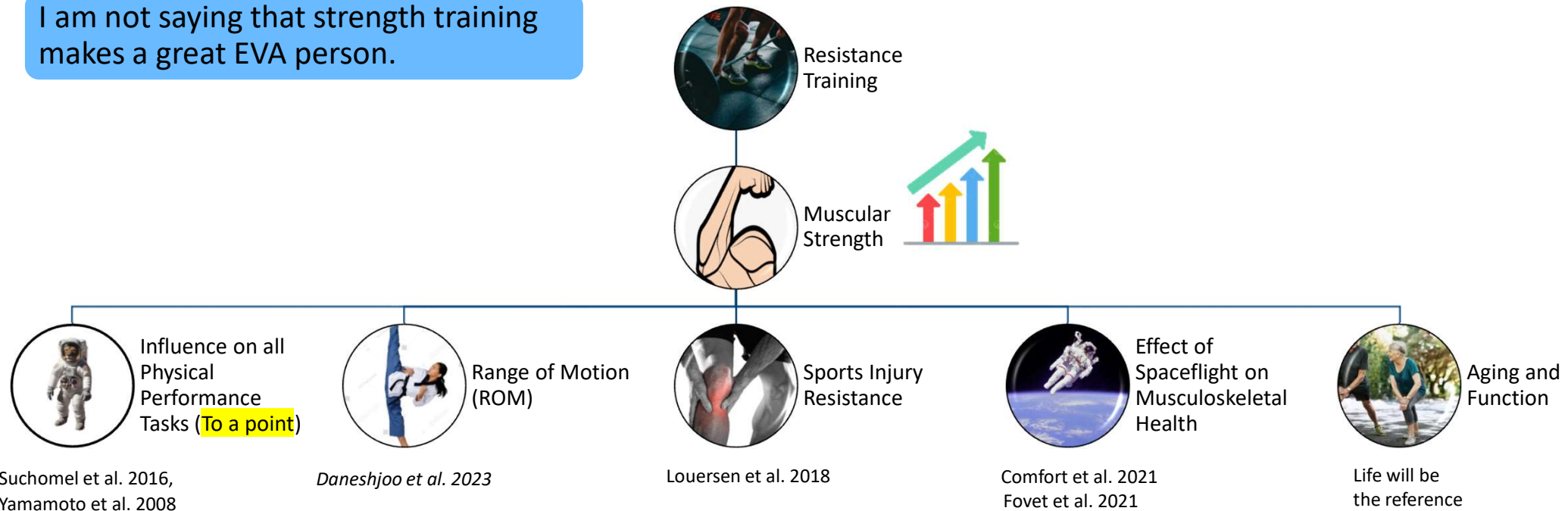


C. Training Suggestions



*For Clarity,

I am not saying that strength training makes a great EVA person.

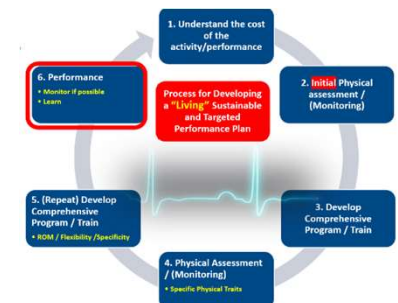


In Summation, Feed the Process and Learn

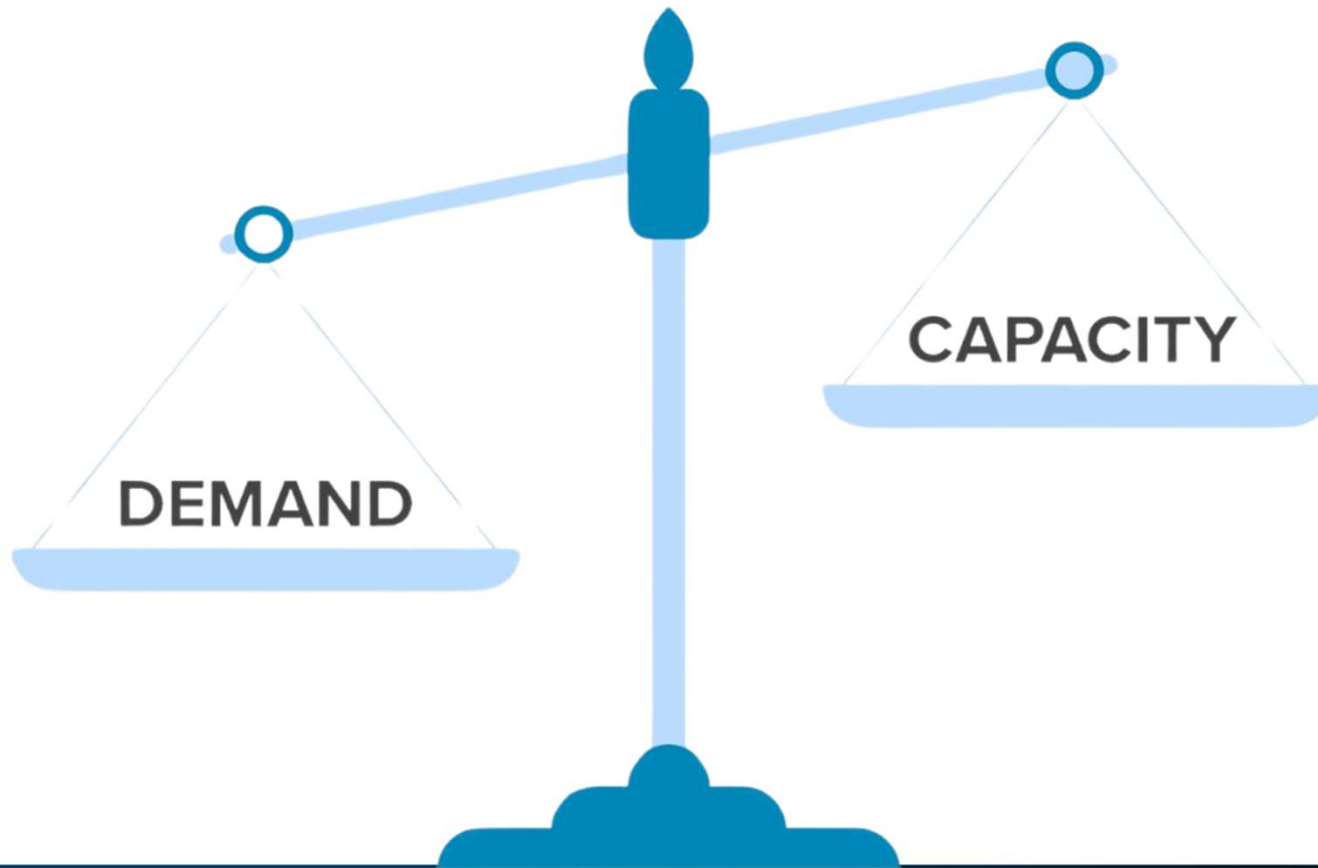


The process efficiently tackles performance training issues by providing a structured and systematic response.

- Understand the Cost
- Understand current ability (Measure)
- Acknowledge needs (actual and perceived) / and address them through a comprehensive, **integrated, sequential, and cyclic** approach.
- Monitor
- Perform
- Repeat

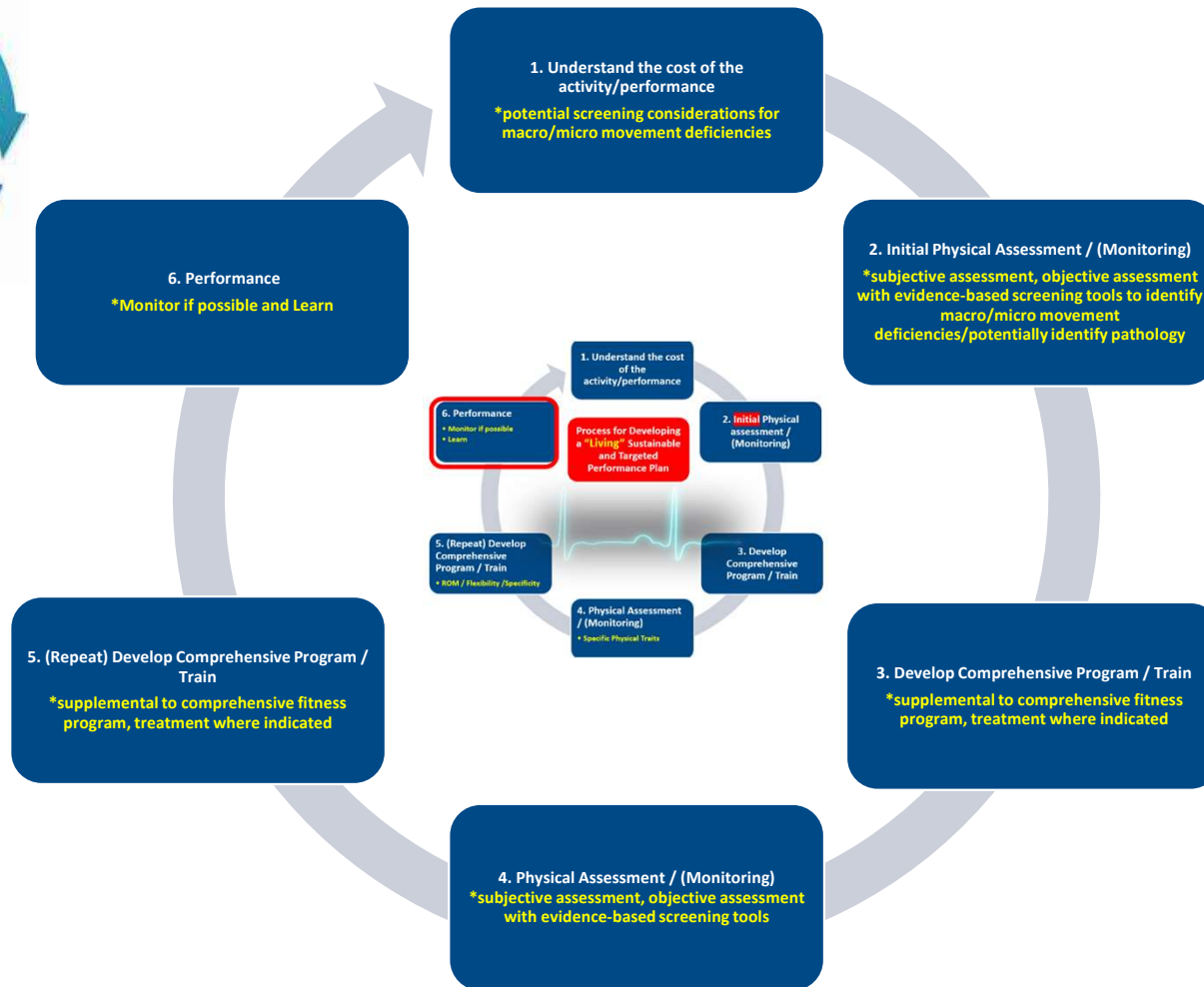


The End



TOPIC FOUR: PHYSICAL MEDICINE CONSIDERATIONS



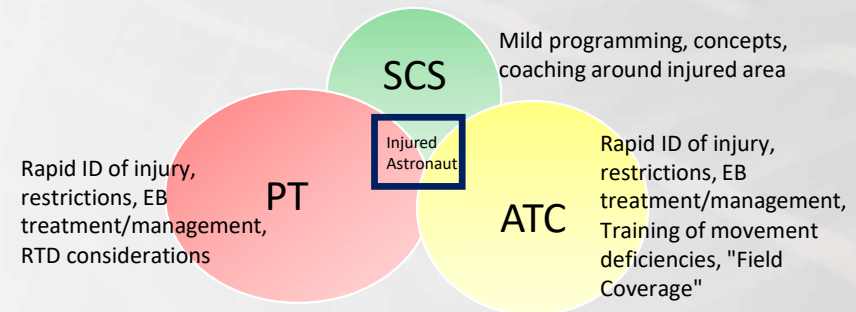
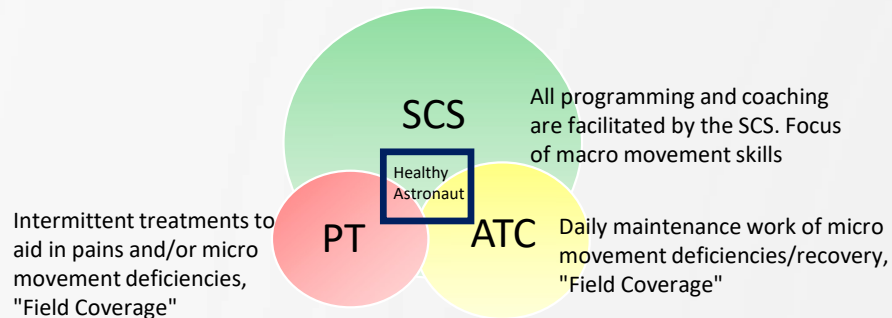


Reinold, 2020



Physical Medicine Considerations

- Educational session with crew on anatomical limits and physical domain considerations for in-suit training
- Robust Human Performance Team with skill set across the full physical domain



TOPIC FIVE: FUTURE CONSIDERATIONS FOR PERFORMANCE PLAN



Suited Physiological Cost Understanding

- Current understanding of the demand with ongoing understanding to grow
- Several studies to inform training:
 - POLAR, High Tempo EVA, xEMU Argos, JETT, etc.
 - Ability to inform more accurate prescription
 - Ability to help tie biomotor monitoring to performance indicators and potential injury contributors
 - Challenge: currently no process to retrieve this information
- These findings also inform other domains of HPO- nutrition and cognitive performance- can we better fuel and prepare cognitively (reaction time?)

Performance/Fitness Data

- Only performed 1-2 times maximum prior to flight or 1 time annually (not a firm requirement and can be waived)
 - Assesses for spaceflight deconditioning NOT for training recommendations or performance
- Do not routinely get physiologic monitoring from the Analogues (RPE, HR data, MET rate data, etc)
- Scheduled training time for assigned crew, needs to be prioritized for all eligible crew members
- Not currently assessing end range hip mobility under load- area to consider for “screening”
- **EMR system is not ideal to integrate all aspects of the data in to a usable “Data Management Platform”**



SCHEDULING AND TOTAL WORK-LOAD CONSIDERATIONS

CY 25												CY 26																	
J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	
FY25												FY26												FY27					
												20 Lunar Dev Runs*												10 Lunar Dev Runs*					
Artemis III Training (24 months)																													
1 NBL Runs (4 Crew)					8 NBL Runs (4 Crew)													4 NBL Runs (4 Crew)										13	
EV1					A'				C'		E'					H-			J''		K''		L''	M''				8	
EV2					A'				D'	E'				G-				J''		K''		L''	M''				8		
EVB						B'			D'				F'			H-		I''		Suits loaded on HLS								5	
EVC						B'			C'				F'	G-				I''									5		

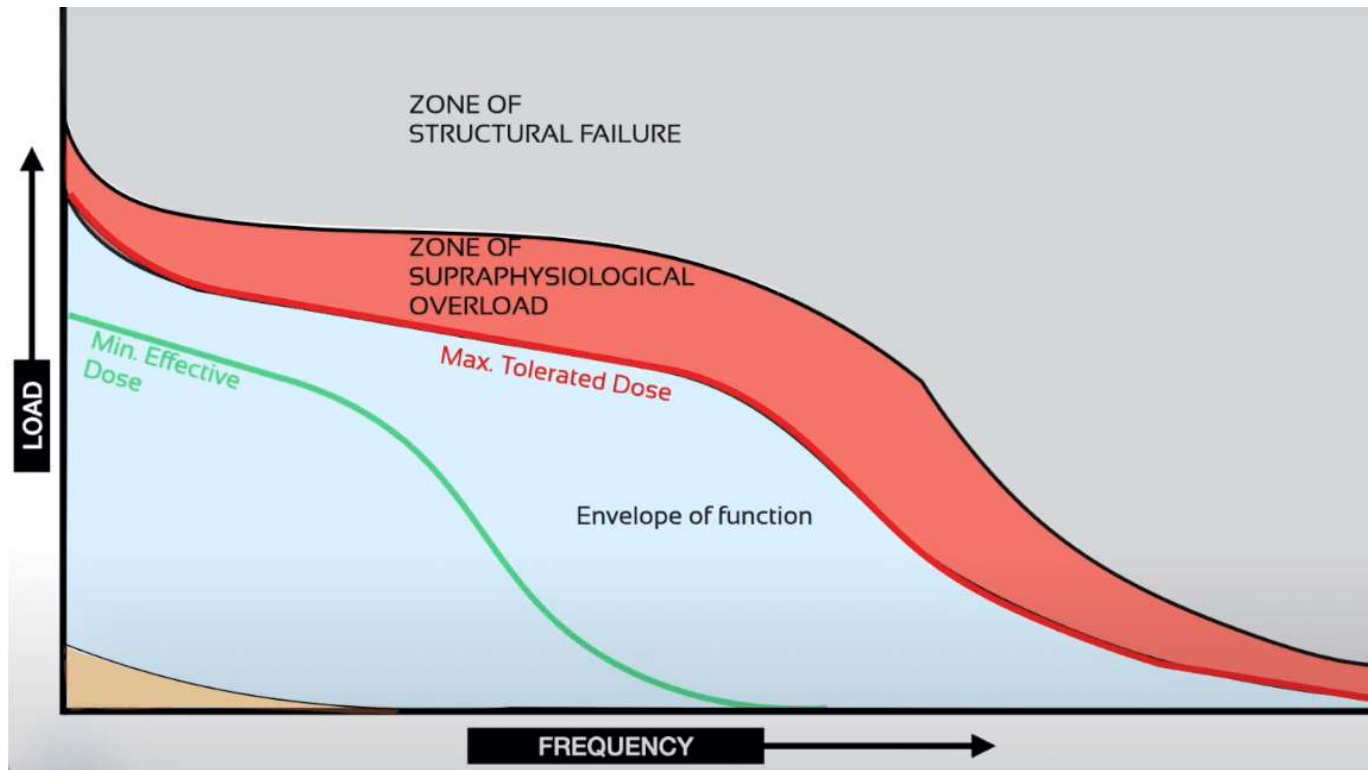
The Relationship Between Acute: Chronic Workload Ratios and Injury Risk in Sports: A Systematic Review

- Acute and Chronic Workload Ratios (ACWR) proposed mechanism for measuring workload as it ties to injury risk
- **Training load** is described as both external and internal load:
 - External: “Any external stimulus applied to the athlete that is measured independently of their internal characteristics”
 - Internal: “Load measurable by assessing internal response factors within the biological system, which may be physiological, psychological, or other”
 - Analogues- understanding the external and internal load could help us categorize the expected intensity/holistically look at each individual
- Identified ratios of acute vs chronic workload from 0.80-1.30 demonstrate lowest risk of injury in sports settings

Maupin, 2020



Load Management- The Envelop of Function



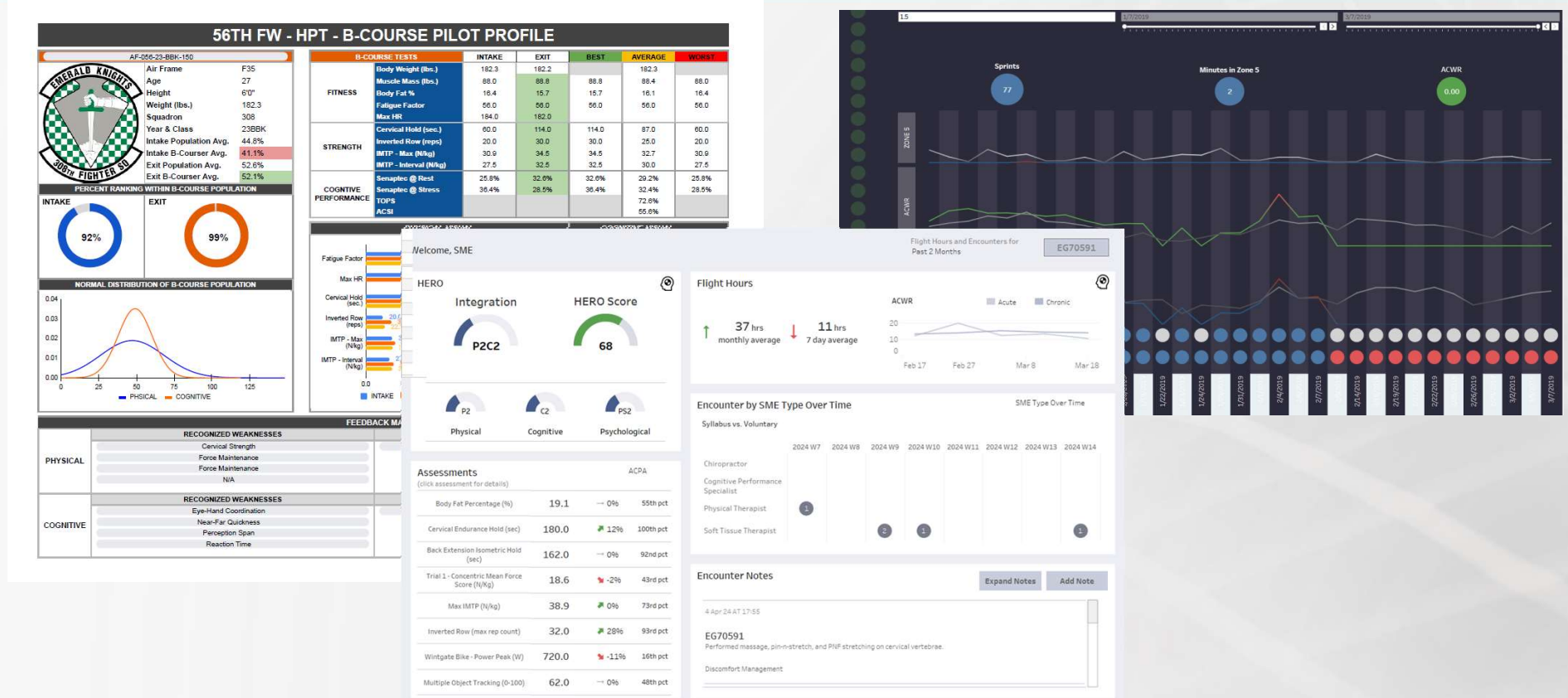
Maupin, 2020

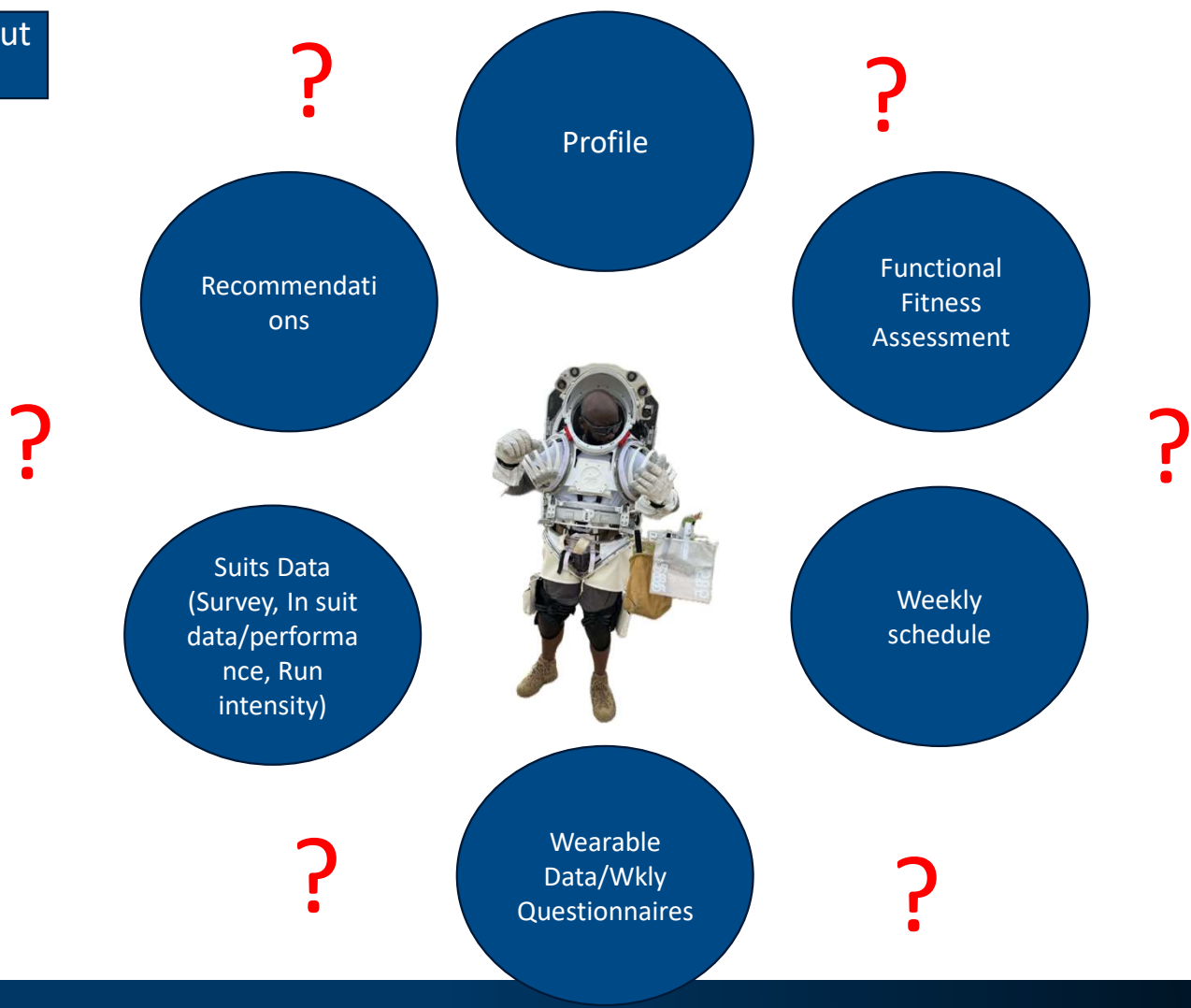


Data Integration Consideration

- Integrated Data Platform
 - Limit's ability to effectively monitor crew in a concise fashion that allows for more precise programming
 - Limit's ability to make connections between the Biomotor abilities being evaluated, suited performance/potential injury risk profiles (identification of individuals at risk to intervene quickly), or standards development
 - Limit's ability to understand internal and external load related to analog environments and how to train related to those
 - Suits Survey is a great start to track and categorize injury and if tied to annual/FFA and physiological monitoring could help identify performance/physical training abilities relationship to injury risk down the road (help aide in early ID of at-risk individuals)

Example Integrated Data- “Athlete Management Platform”





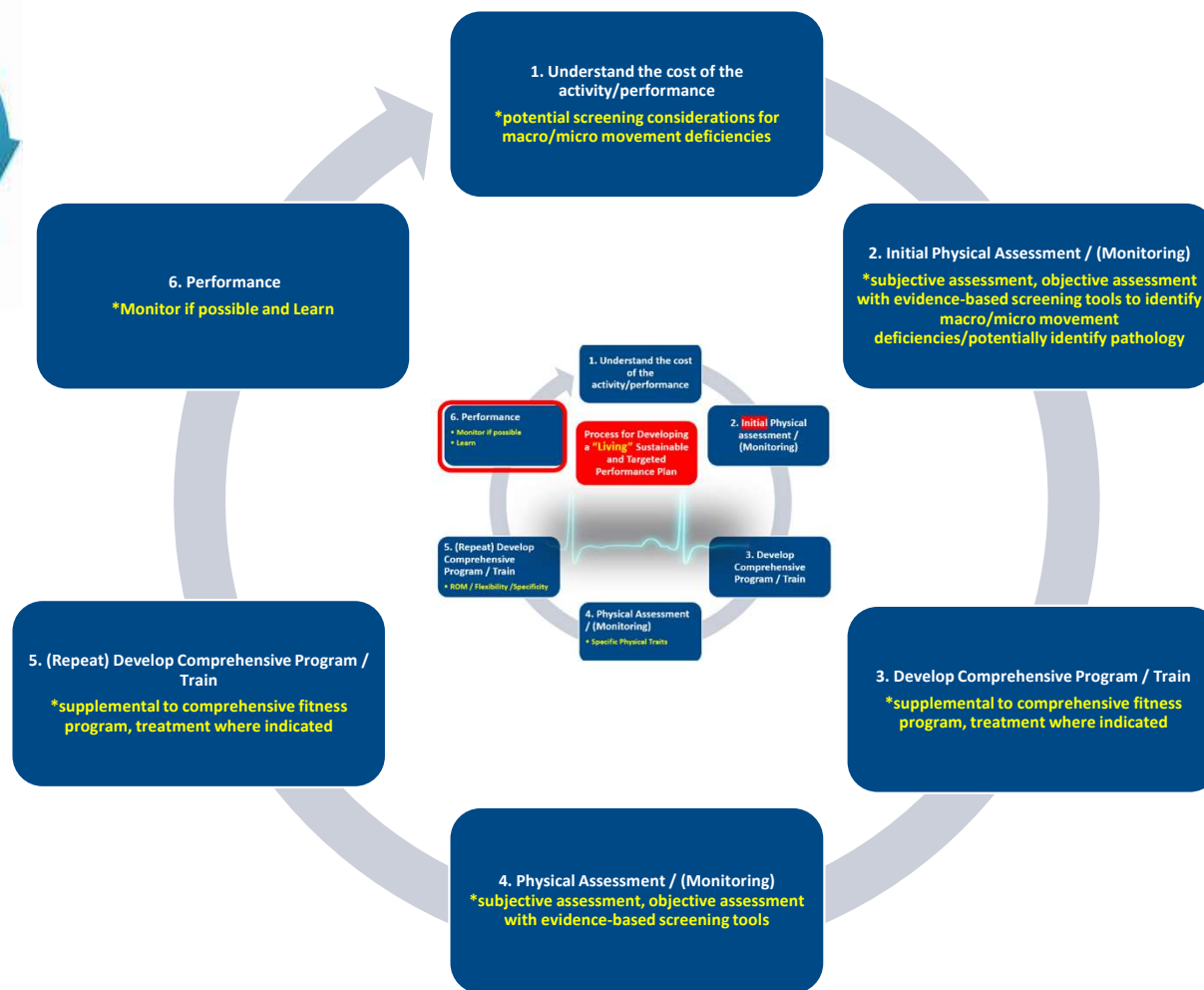
CONCLUSION



Primary Take Home Points:

- Comprehensive performance plans needs to be vertically integrated and properly sequenced over time to improve performance and reduce risk of injury
- A living process with Interdisciplinary focus of the larger goals
- Too much focus on physicality overshadow tactical understanding
- Integrated Data Platform → Daily Ops, Training, Workload, and Performance to better understand analog performance and injury risk considerations
- Proactive Response to Issues/Injuries (Rapid identification, early and conservative intervention!)





QUESTIONS/COMMENTS?

