AUT

WEARABLE RESISTANCE TRAINING
The Future is Light

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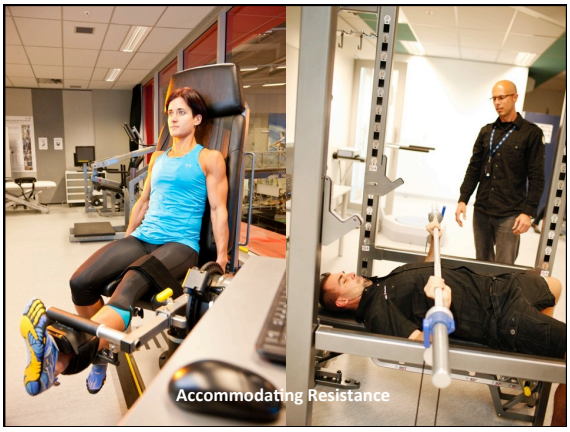
Improving Athleticism

Athleticism Defined

- Athleticism is the quality of being coordinated and physically strong while also having stamina.
- The physical qualities that are characteristic of athletes, such as strength, fitness, and agility.
- Skilled in exercises, sports, or games requiring physical strength, agility, or stamina.

Variable Resistance


Accommodating Resistance

Constant Resistance

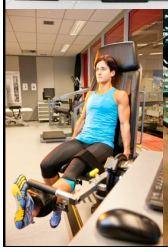
Optimising Transference of Strength Gains Really the Issue

© National Strength and Conditioning Association
Volume 29, Number 3, pages 86–95

Keywords: isokinetic; isoinertial; 1RM; correlation; squat

Does Increasing Maximal Strength Improve Sprint Running Performance?

"For recreationally trained athletes it would seem that ~23% increases in squat 1RM are necessary for significant changes in sprint times (> –2%)." (SCJ, 2007, p.94)



Optimising strength/force transfer to improve athleticism??

Reflections/Limitations
Force orientation
Bilateral
Acyclic
Force-velocity specificity
ROM specificity
Metabolic specificity
Contraction type specificity
Movement variability
Multiple planes of motion
Activity/sport specific

BRIEF REVIEWS

International Journal of Sports Physiology and Performance, 2006;1:74-83
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Transfer of Strength and Power Training to Sports Performance

Warren B. Young

"Although nonspecific resistance training can induce neural adaptations and increase the power production of individual muscles, it appears that to maximize transfer to specific sports skills, training should be as specific as possible, especially with regard to movement pattern and contraction velocity. ..... Adding a load to a sports movement would seem to be a suitable strategy to achieve this specificity, although the amount and direction of added resistance would need to be considered. (Young, 2006, p.80)

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Improving Athleticism

Contents

Wearable Resistance Training

Part 1: Why?

- Mechanical
- Neural
- Metabolic
- Injury Prevention – Movement Variability
- Skill Acquisition – Coaching

Adding a load to a sports movement would seem to be a suitable strategy to achieve this specificity.

Part 2: How?

Although the amount and direction of added resistance would need to be considered.

- Macrocycle Programming
- Evidence Based Practice
  - Jumping
  - Running
  - Sprinting
- Microcycle Programming

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PART 1: THE WHY OF WEARABLE RESISTANCE TRAINING

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A Kinematic Analysis of Acute and Longitudinal Adaptations to Resisted Sprinting

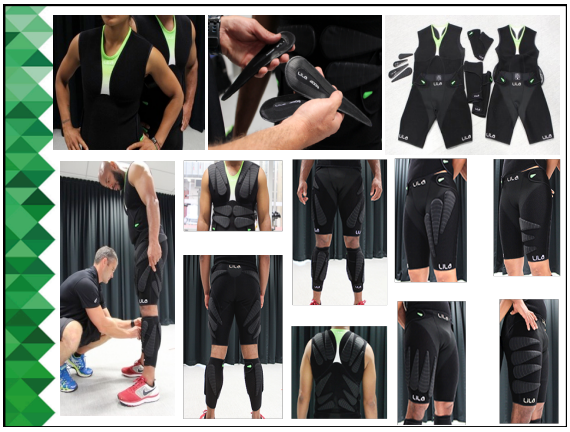
Keir Hansen B.PhEd

Submitted to the Auckland University of Technology for the degree of Master of Health Science

July 2002

Resisted Movement Training: Vests vs. Sleds

Improving Athleticism



WRT – Making Sense

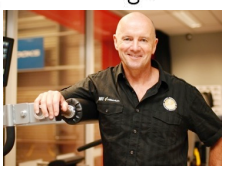
Improving Athleticism

It looks like it ticks all the boxes but lets take a closer look

Limitations
Force orientation
Bilateral
Acyclic
Force-velocity specificity
ROM specificity
Metabolic specificity
Contraction type specificity
Movement variability
Multiple planes of motion
Activity/sport specific

Why WRT-LVRT? Some Thoughts.

Improving athleticism with LVRT



- Neural
- Mechanical
- Metabolic
- Injury Prevention – Movement Variability
- Skill Acquisition - Coaching

Why WRT-LVRT? Some Thoughts.

Neural

- Intramuscular Co-ordination
- Intermuscular Co-ordination

Neurophysiology

Intramuscular Co-ordination

- MU recruitment
- MU firing
- Synchronization
- Reflex activity

Intramuscular Co-ordination

- Move heavy loads
- Move explosively
- Neural intent
- Priming

BRIEF REVIEWS

International Journal of Sports Physiology and Performance, 2006;1:74-83
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Transfer of Strength and Power Training to Sports Performance

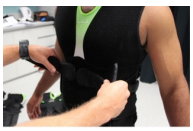
Warren B. Young

"Although nonspecific resistance training can induce neural adaptations and increase the power production of individual muscles, it appears that to maximize transfer to specific sports skills, training should be as specific as possible, especially with regard to movement pattern and contraction velocity. This type of training can be expected to enhance **intermuscular coordination** and ensure that muscles are "tuned" to any newly acquired force-generating capacity. Adding a load to a sports movement would seem to be a suitable strategy to achieve this specificity, although the amount and direction of added resistance would need to be considered. (Young, 2006, p.80)

Neurophysiology

Intermuscular Co-ordination

- Synergistic contribution
- Fixator involvement
- Co-contraction of antagonists



Intermuscular Co-ordination

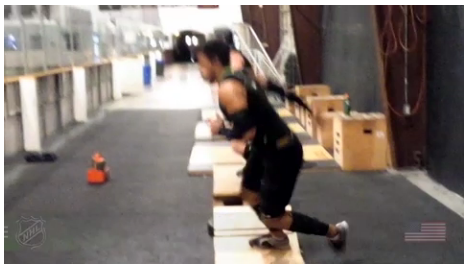
- Movement needs to be activity or sport specific

Neurophysiology

A further way to increase power results from better intermuscular co-ordination. Intermuscular co-ordination describes the ability of all muscles involved in a movement, agonists, antagonists and synergists, to co-operate wholly with respect to the aim of the movement. Improvement of power development of this type is is also movement specific, and therefore not transferable to another movement. The specific strength training in training practice strives mainly for optimiszation of intermuscular co-ordination.

(Schmidtbleicher, 1992, p.385)

Neurophysiology



"Changes in joint angle alter the conditions of muscular work, since muscle length and angle of pull are changed. Muscular strength and leverage change, and consequently so does torque produced by the muscles about a joint."
(Siff, Supertraining, p.100)

Why WRT-LVRT? Some Thoughts.

Mechanical

- Force Development
- Rotational Inertia
- Kinetic Energy

Force/Strength Development

Force = m*a

Force = m*a

Additional Kinetic Energy at the Hip

TABLE 2. Normalized performance variables measured with different loads.*

	% of 1RM							
Variable	20	30	40	50	60	70	80	90
Peak power								
Mean	0.82	0.87	0.92	0.91	0.86	0.81	0.80	0.85
± *SD*	0.17	0.10	0.11	0.07	0.10	0.15	0.19	0.19
Peak ground reaction force								
Mean	0.66	0.70	0.75	0.78	0.81	0.85	0.94	1.00
± *SD*	0.06	0.07	0.09	0.07	0.03	0.03	0.03	0.01
Peak velocity								
Mean	0.97	0.95	0.90	0.80	0.72	0.62	0.58	0.54
± *SD*	0.04	0.06	0.08	0.10	0.09	0.10	0.14	0.10
Force at time of peak power								
Mean	0.60	0.63	0.74	0.78	0.82	0.87	0.94	0.99
± *SD*	0.10	0.08	0.09	0.08	0.07	0.06	0.06	0.03
Velocity at time of peak power								
Mean	0.97	0.95	0.88	0.81	0.72	0.63	0.59	0.57
± *SD*	0.03	0.06	0.08	0.08	0.09	0.09	0.14	0.11

* 1RM = 1 repetition maximum.

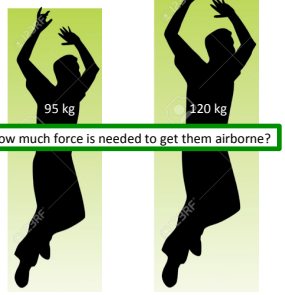
(Squat data with well trained lifters
Zink et al, 2006, JSCR)

$KE = ½m.v^2$
$= ½ \ 100 \ X \ 0.59^2$
$= 50 \times 0.34$
$= 17.4 \ kg.m.s$

Work-Energy Relationship

$KE = ½m.v^2$
$= ½ \ 1.0 \ X \ 6.1^2$
$= 0.50 \times 37.2$
$= 18.6 \ kg.m.s$

Inertia

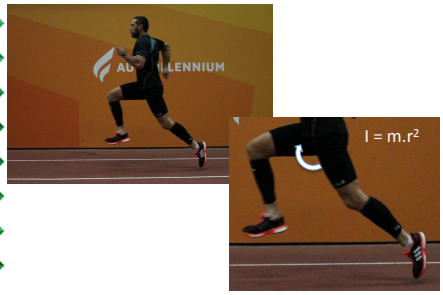


How much force is needed to get them airborne?

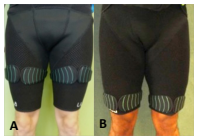
Weight = ~950 N

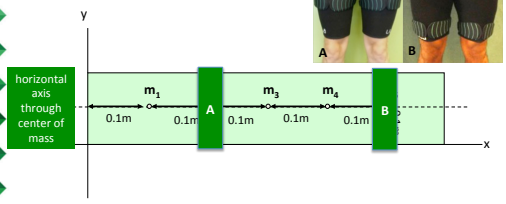
Weight = ~1200 N

Rotational Inertia



Rotational Inertia

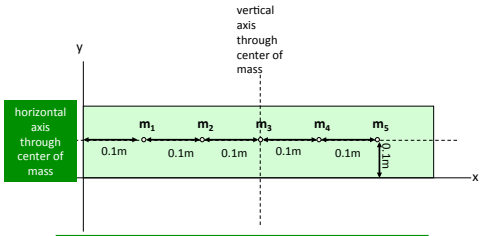




$$I = \sum_{i=1}^{n} m_i r_i^2 = m_1 r_1^2 + m_2 r_2^2 + \cdots + m_{n-1} r_{n-1}^2 + m_n r_n^2$$

Rotational Inertia with LVRT

Rotational Inertia with LVRT

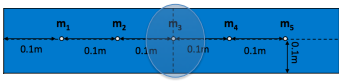


$$I = \sum_{i=1}^{n} m_i r_i^2 = m_1 r_1^2 + m_2 r_2^2 + \cdots + m_{n-1} r_{n-1}^2 + m_n r_n^2$$

I_{y-y} = (2.0kg)(0.1m)^2 + (2.0kg)(0.2m)^2 + (1.5kg)(0.3m)^2 + (1.5kg)(0.4m)^2 + (1.0kg)(0.5m)^2 = 0.725kgm^2

Rotational Inertia with LVRT

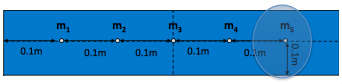
- Rotational inertia of limb loaded mid-femur



Load (kg)	Rotational Inertia	% Increase
0.2	0.743	2.42
0.4	0.761	4.73
0.6	0.779	6.93
0.8	0.797	9.03
1.0	0.815	11.04

Rotational Inertia with LVRT

- Rotational inertia of limb loaded distally



Load (kg)	Rotational Inertia	
0.2		
0.4		
		17.1
	0.925	21.6
1.0	0.975	25.6

Load placement along limb affects rotational inertia and therefore the magnitude of muscular effort – overload.

Why WRT-LVRT? Some Thoughts.

Stamina - Metabolic Conditioning

1. From a practical standpoint, non-specialized tasks make inefficient use of training time and effort.
2. Athletes are usually more enthusiastic about specialized, task-oriented exercises that have direct transfer to competition.

Gambetta Tactical Metabolic Training (1997) SCJ

Stamina - Metabolic Conditioning

Acute effects – six studies

- Dates: Trunk - 1978, 1991
  Lower Limb – 1984, 1985, 1988, 1990
- Loads: Trunk 5.0% to 15% BM; Lower Limb 0.3 to 2.2% BM
- Subjects: 30 to 56 year old male and females to trained distance and cross-country runners.

Main Findings Lower Limb
Trunk – on average ~2.5%, 4.2% and 8.5% increase in energy cost for added loads of 5%, 10% and 15% BM.
Lower extremity inertia - "Research has shown that the cost of supporting, accelerating and decelerating mass located centrally on the body is considerably lower than that for mass carried on the extremities." (Martin & Cananagh, 1990, p.535)

1) 5 to 10% increase in energy cost for 1 kg of added loads.
2) Greater effects with distal – foot and shank loading.
3) Lower extremity kinematics unaffected – loading less than 1 kg.

Stamina - Metabolic Conditioning

Why WRT-LVRT? Some Thoughts.

Movement Variability – Injury Prevention

Movement variability

- Neuromuscular flexibility to adapt to different situations
- Vary point of force application = different anatomical overload = limits overuse injuries

Movement Variability

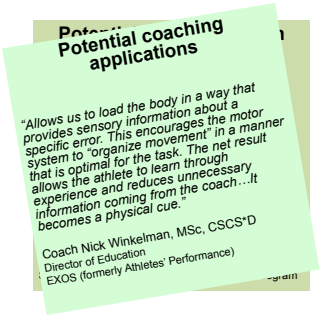
Stamina, Strength and Co-ordination

Why WRT-LVRT? Some Thoughts.

Injury Rehabilitation

Why WRT-LVRT? Some Thoughts.

Coaching/Skill Acquisition



Why WRT-LVRT? Some Thoughts.

Training Tool
vs
Performance Tool

PART 2: THE HOW OF WEARABLE RESISTANCE TRAINING

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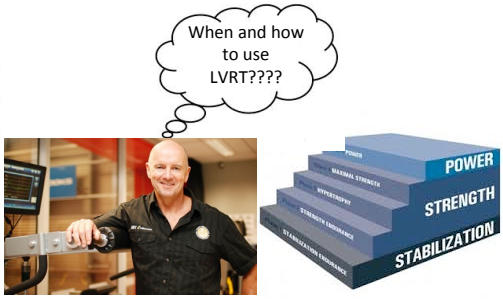
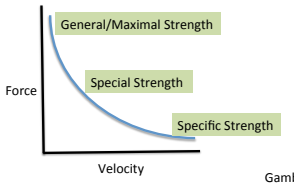
Macrocycle Programming/Periodisation



Macrocycle Programming/Periodisation

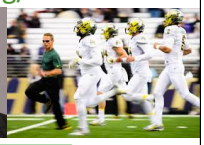
Macrocycle Programming/Periodisation

- General Strength
- Special Strength
- Specific Strength



Gambetta (1995) SCJ August

Macrocycle Programming/Periodisation



Absolute Strength | Relative Strength | WRT-LVRT Training: Dynamic Strength, Elastic Strength

Athleticism

Number 1 factor of great or elite teams – more people that can burst or accelerate the more successful you will be

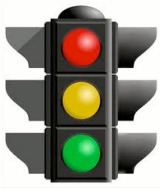
Macrocycle Programming/Periodisation

Simple Periodization/Progression

Assisted
↓
Body Weight
↓
Resisted
↓
Eccentric
↓
Plyometric

Vertical
Horizontal
Lateral

Increasing Intensity
Decreasing Volume



MCS determines entry level to pattern progressions

Microcycle Programming

Some ideas for LVRT loading

Microcycle Programming

Individualisation

Each person is different.

You have to address your own unique needs, situation and environment when planning your training. Do not simply adapt a training program some champion used. Find what works for you. This is a common mistake even among top coaches and athletes - to follow a trend rather than science. LVRT guides you to strategically experiment with both the LOAD volume and orientation in order to identify what works best for you and your sport or activity.

Keep on mind you are in control. Let your feeling, awareness and instinct guide you. If you feel the loading is too heavy, unnatural or uncomfortable then simply reduce the load and/or re-adjust the orientation. Experimentation is needed to find the LOAD that is optimal for you.

LVRT Tip #1: ***IF IT FEELS WRONG, RELOAD*****.** Choose a light load that does not change your skill or movement pattern. It should feel about the same just harder. Get used to the load first. Only progress heavier when that load becomes easy.

Microcycle Programming

Specificity

Adaptations are specific to the stimulus imposed. If you train with heavy loads you get stronger, if your train with light loads at high speed you get quicker, if you train over long periods you build stamina. Doing heavy squats may help build base strength which is a component of power but ultimately it will not make you fast – if it did, sprinters would spend 5-6 hrs/day at the squat rack not the track.

LVRT Tip #2: ***REDUCE THE LOAD NOT THE SPEED*****.** Choose a load that does not reduce your speed (by more than 5-10%). If you are a sprinter or field sport athlete this will likely be very light to start, 1-2% of your body weight. Reducing the speed of a desired movement teaches that movement to be slow and is contradictory to speed enhancement. You need to train at or near you're desired speed to improve at that speed. Once you can comfortably use the lighter load at the desired speed then progress to a higher load.

The focus is to maintain your speed, range of motion and accuracy while gradually increasing the power and intensity with LOADS. This is the difference between movement training Vs traditional weight training.

Microcycle Programming

Progressive Overload

TO IMPROVE OVER TIME, ONE MUST GRADUALLY PROGRESS TRAINING LOAD & VOLUME OVER TIME.

Your body needs rest, especially when undertaking a goal-oriented training regime, to allow your body time to rest, recover and rebuild sufficiently. Remember your body doesn't improve during your training sessions, it approves during your recovery time, that's when it re-build itself. If training is too hard and too often, the body doesn't adapt and improve very well because the recovery time and processes are often insufficient. You wouldn't progress from 5k runs to 10k runs or 50 kg squats to 100kg squats in one week. It's too big a jump. You need to progress gradually just like traditional training. EXOGEN has been scientifically designed in increments of 50 - 300 grams to allow light and continual progression.

LVRT Tip #3: ***PROGRESS IN GRAMS NOT KILOGRAMS*****.** Choose progressions that are small to start. 100-200 grams per limb or body segment not 1-2 kgs.

*Note: The specific position and orientation of the loads is dependent on your individual and specific needs.

Microcycle Programming

- Rotational inertia of limb loaded with 400 gm mid-femur

Load (kg)	Rotational Inertia	% Increase
0.2	0.743	2.42
0.4	0.761	4.73
0.6	0.779	6.93

EXOGEN	WEEK 1-2	WEEK 3-4	Week 5-6	Week 7-8
SHORTS	200 GRAMS	400 GRAMS	400 GRAMS	600 GRAMS
CALVES	200 GRAMS	200 GRAMS	400 GRAMS	400 GRAMS
Total load	400 grams	600 grams	800 grams	1000 grams

Load (kg)	Rotational Inertia	% Increase
0.2	0.775	6.45
0.4	0.825	12.1
0.6	0.875	17.1
0.8	0.925	21.6
1.0	0.975	25.6

Microcycle Programming

Overtraining

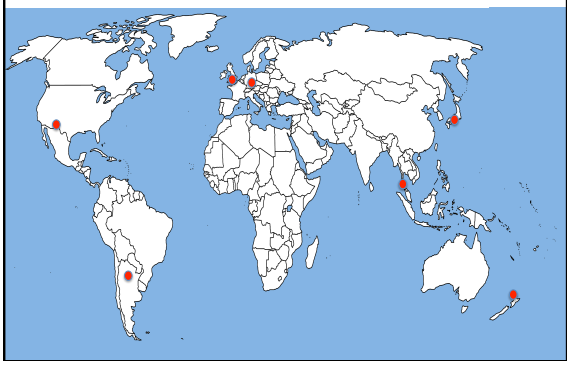
If you do not allow enough recovery you will get over fatigued and injured. This is a risk no matter what exercise you perform - loaded, unloaded, fast, slow. The best way to avoid injury and overtraining is to progress gradually, with guidance and coaching.

LVRT Tip #4*: LISTEN TO YOUR BODY* When training with EXOGEN be very aware that though the LOAD is light ***it is still resistance training!*** A light load moving at high speed can place greater stress on the body than a heavy load moving at slow speed especially over long periods of time. When training with EXOGEN ensure you:

- Have medical clearance before starting a program if you are in a high risk population.
- Adequately warm-up, cooldown and recover.
- Progress intensity and volume gradually over time.
- Follow all LVRT Exogen training guidelines.

Use good judgement - If tired, rest. If it hurts, stop. If it continues to hurt, get checked and if unsure of these guidelines or how to exercise safely, seek professional advice.

Building the Evidence Base



Building the Evidence Base

IRONMAN

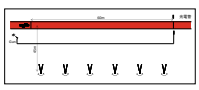
Running – Cycling - Swimming

Building the Evidence Base

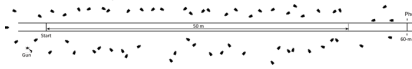
National Institute of Fitness and Sports in Kanoya

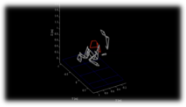
Building the Evidence Base

High-speed cameras

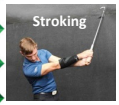


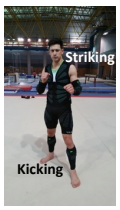
Motion capture system





Where to Next – Building the Evidence Base





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