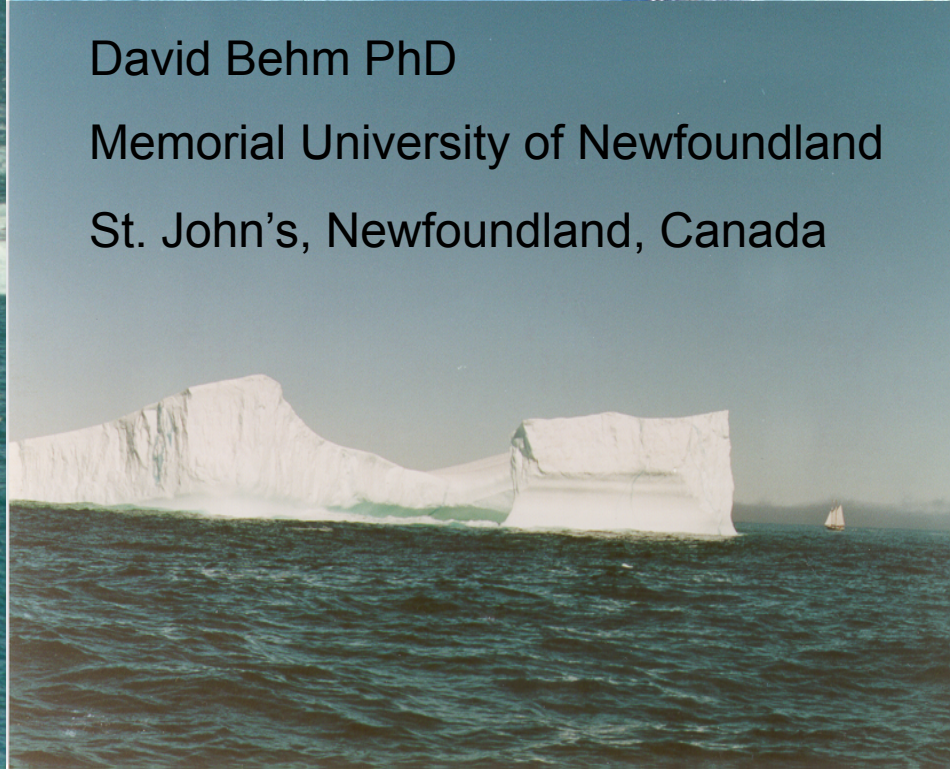




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Basic and Advanced Resistance Training for Children

Canadian Society for Exercise Physiology (CSEP) Position Paper:

Resistance Training in Children and Adolescents

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Applied Physiology, Nutrition and Metabolism
33: 547-561, 2008.

Scientific Acceptance of Resistance Training for Children

American College of Sports Medicine 2006

British Assoc. of Sport and Exercise Science 2004

American Academy of Pediatrics 2001

Sampling of Review articles:

Faigenbaum 2000, Falk and Tenebaum 1996,

Falk and Eliakim 2003, Blimkie 1993, Sale 1989

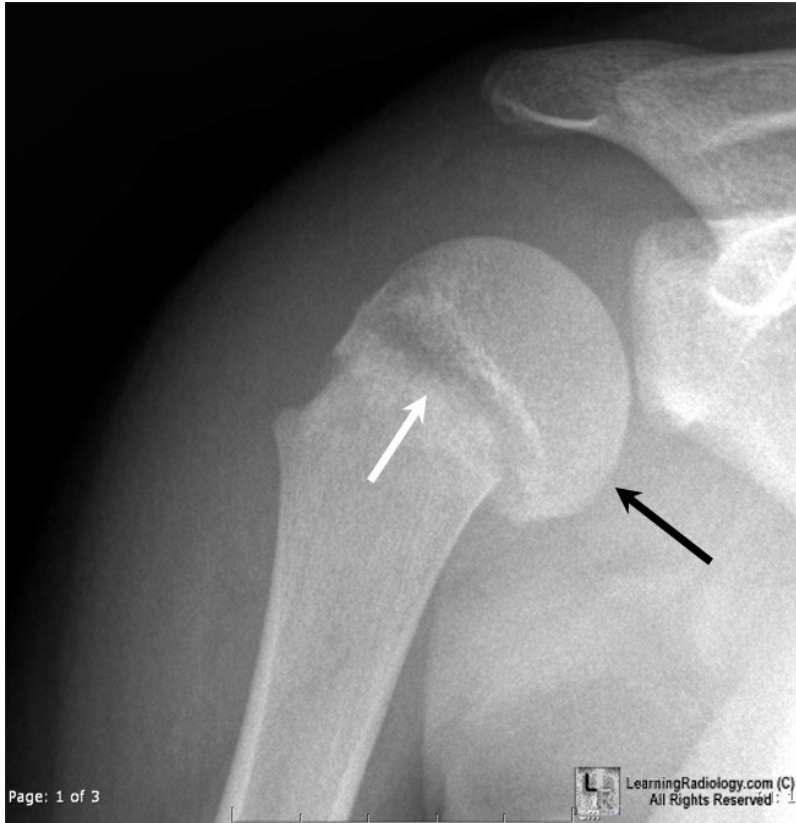
and others)

Why have another position paper?

- Little information on more advanced training techniques for children such as:
- Plyometrics
- Olympic style lifting
- Instability RT devices
- Periodization

Myths

Lack of strength increases
(due to limited testosterone)
Safety issues



Stunted Growth

Epiphyseal plate damage

Epiphyseal Plate Damage

- Injuries of the epiphyseal plates have been suggested to be less likely to occur during childhood than during adolescence, because the growth plates of children may actually be stronger and more resistant to various forces than those of adolescents (Micheli 1988).
- Epiphyseal plate fractures have not been reported in any prospective youth RT study that was competently supervised and appropriately progressed (Behm et al. 2008).

Basically all papers agree that:

- Resistance training for children will improve muscular strength and muscular endurance if performed under the supervision of a qualified instructor, using proper technique, gradual training progressions and proper warm-up and cool down.



Effects of RT in Children and Adolescents

Summary of the effects of resistance training (RT) in children and adolescents.

Effect	Children	Adolescents	Sample References	Notes
Muscle Strength	+++	+++	Blimkie et al. 1989, 1996; Christou et al. 2006; Faigenbaum et al. 1993, 1996a, 2001, 2002, 2005b; Fukunaga et al. 1992; Lillegard et al. 1997; Nichols et al. 2001; Ozmun et al. 1994; Pfeiffer & Francis 1986; Pikosky et al. 2002; Ramsay et al. 1990; Sadres et al. 2001; Sailors & Berg 1987; Siegal et al. 1989; Tsolakis et al. 2004; Weltman et al. 1986	Smaller absolute strength gains in children compared with adults but comparable relative gains

Effects of Resistance Training in Children and Adolescents

Effect	Children	Adolescents	Sample References	Notes
Muscle Power	?	+	Christou et al. 2006; Faigenbaum et al. 1993, 1996a, 2002, 2005b; Lillegard et al. 1997; Weltman et al. 1986	Small if any changes in children; limited data in adolescents
Muscular Endurance	++	+	Faigenbaum et al. 1999, 2001, 2005b; Ramsay et al. 1990; Sailors & Berg 1987	Limited data in adolescents

Effects of RT in Children and Adolescents

Effect	Children	Adolescents	Sample References	Notes
Bone Strength, BMD,	?	?	Blimkie et al. 1996; Nichols et al. 2001	Limited number of studies using RT alone to examine effect on bone
Flexibility	+	?	Christou et al. 2006; Faigenbaum et al. 2002; 2005b; Siegal et al. 1989; Weltman et al. 1986	Small if any changes in children; limited data in adolescents
Agility and Physical Performance	?	?	Christou et al. 2006; Falk & Mor 1996	Changes only shown when RT was combined with specific sports training
Body Composition	-	?	Faigenbaum et al. 1993; Lillegard et al. 1997; Sadres et al. 2001; Siegal et al. 1989; Sothorn et al. 2000; Siegal et al. 1989	Some data suggesting reduced adiposity in overweight children; no data in adolescents

Muscle Hypertrophy

- Strength training can also augment the muscle enlargement that normally occurs with pubertal growth in males and females (Kraemer et al. 1989; Webb 1990) but the magnitude of changes in children's cross-sectional muscle area is smaller than found in adults (Fukunaga et al. 1992; Mersch and Stoboy 1989).

What age should a child start resistance training ?

- When is a child ready to Resistance Train (RT)?
- Whenever they ask or show desire, show a sustained interest, can follow instructions and comply with safety rules.

Resistance Training Guidelines

- Begin each session with a 5 to 10 minute dynamic aerobic warm-up period.
- Higher core and muscle temperatures =
 - Increased neural conduction velocity
 - Increased enzymatic activity
 - Decreased tissue viscosity

Warm-up: Excitation

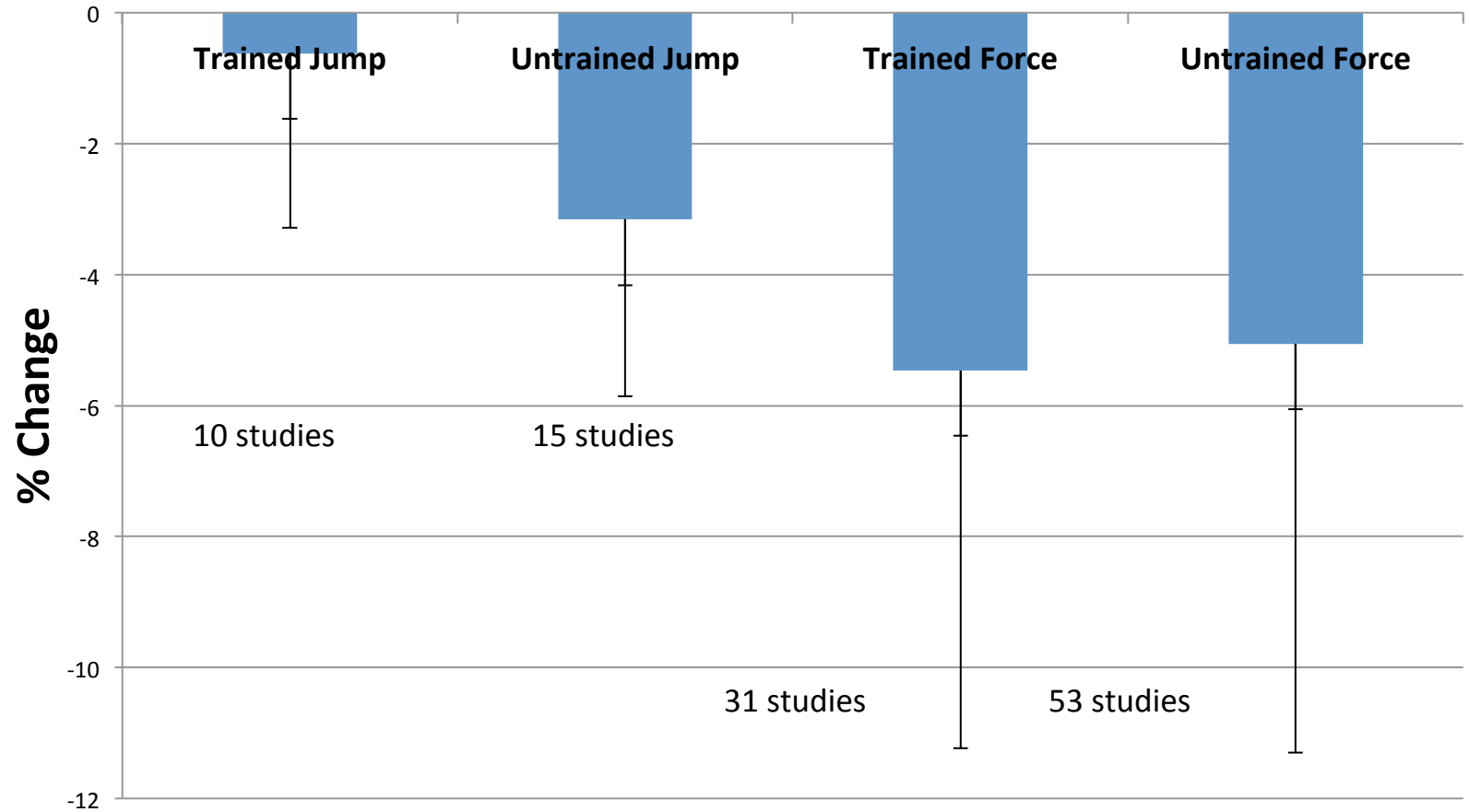
Static stretching can depress the system resulting in impairments in muscle activation, force, power, sprint, reaction and movement time, balance

(Chaouachi et al. 2008, Behm and Kibele 2007, Behm et al. 2001, 2004, 2006, Power et al. 2004, Young and Behm 2002)

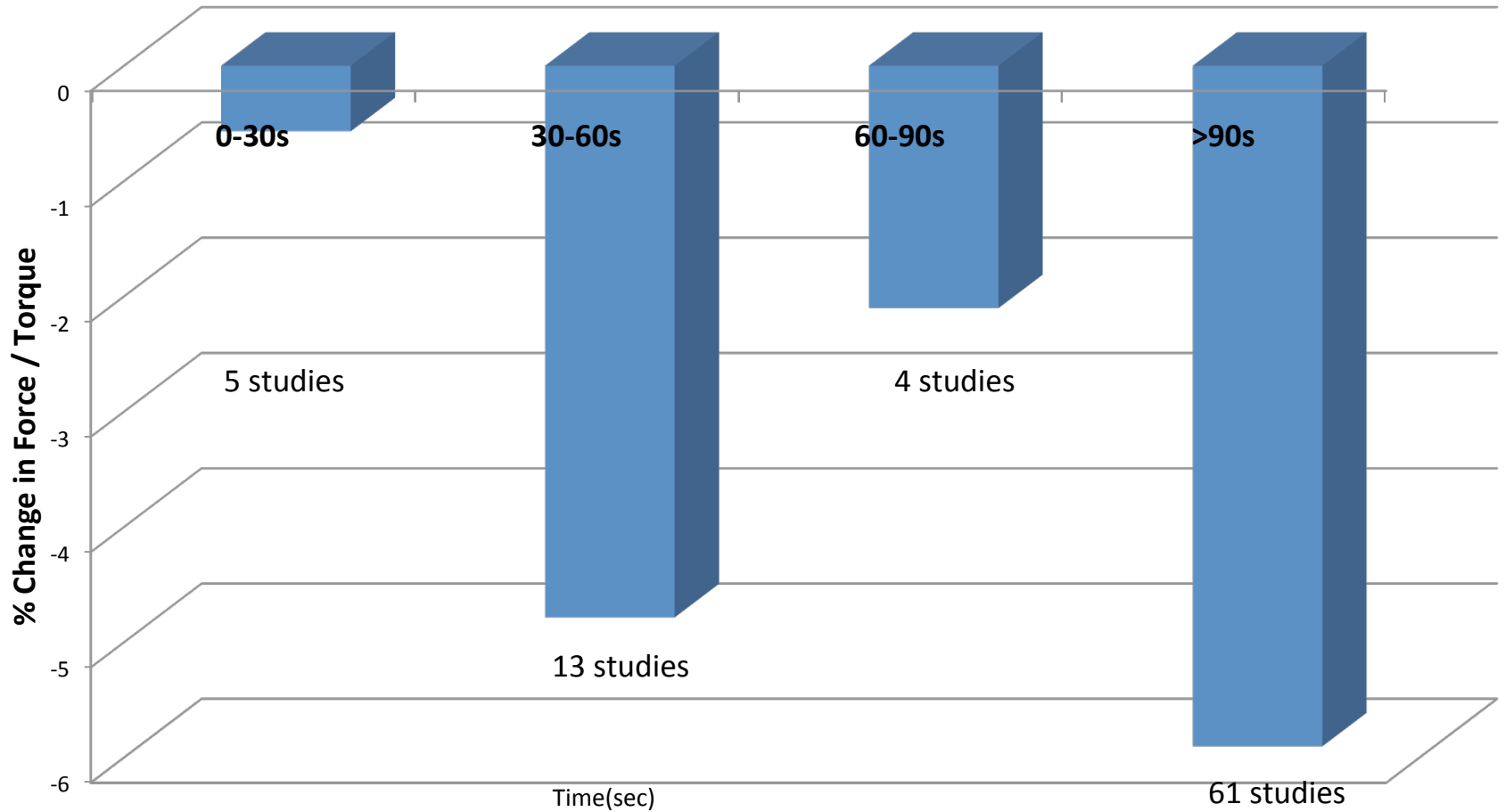
Static stretching impairs performance even in children: ↓ sprint time with 13-15 yr boys

– Chaouachi et al. 2008 EJAP

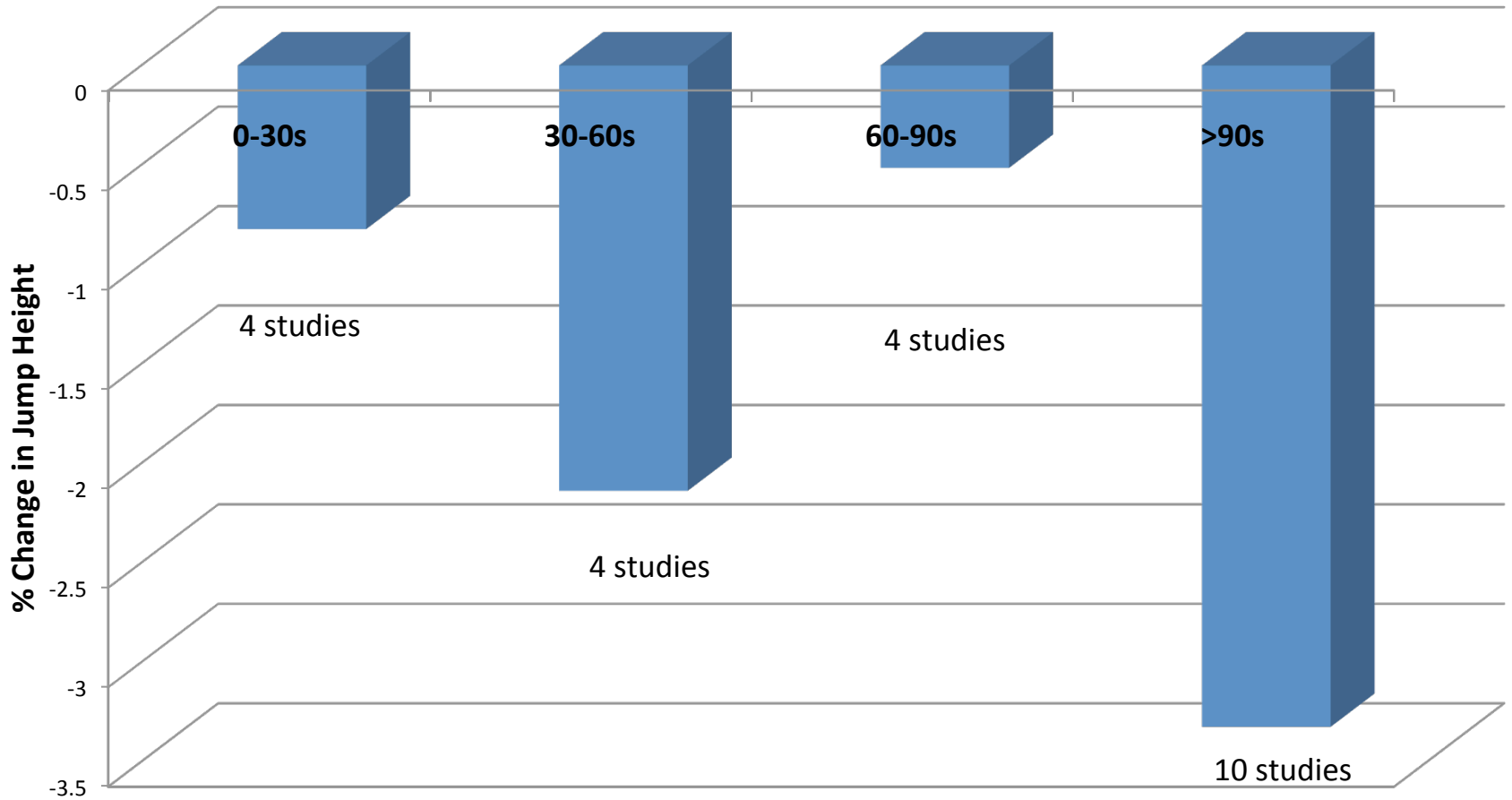
Effect of Trained State on Static Stretch Impairments



Effect of Static Stretching Duration on Force



Effect of Static Stretching Duration on Jump Height



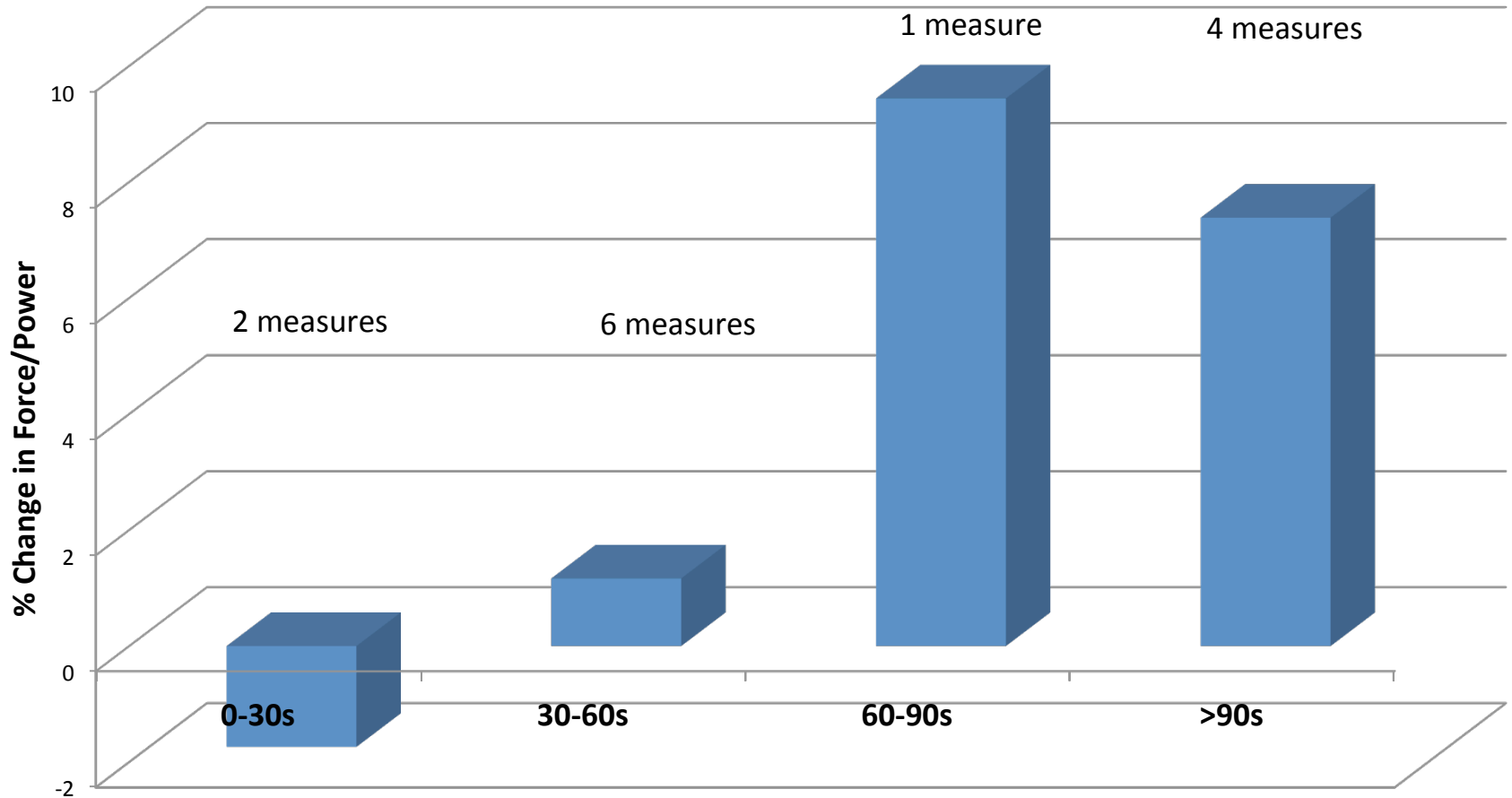
Use Dynamic Stretching in the Warm-up

Dynamic stretching and activities
can excite the system resulting in
facilitation of performance

(Children literature: Faigenbaum et al. 2005a; 2006a; 2006b;
Siatras et al. 2003)

(Adult literature: Behm and Chaouachi 2011, Curry et al.
2009, Hough et al. 2009, Herder et al. 2008, Manoel et al.
2008, MacMillan et al. 2006)

Effect of dynamic stretching duration on force and power

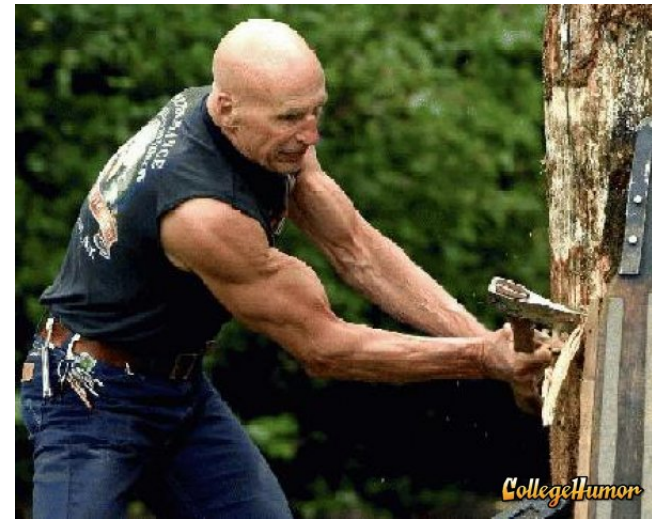


Resistance Training Guidelines

- Focus on learning the correct exercise technique and safe training procedures instead of the amount of weight/resistance lifted.
- Improved efficiency = improved strength

“Old Man Strength”

- When competing; who gets the ball or puck between a typical
- 27 year old, 80 kg athlete vs.
- 17 year old, 80 kg athlete
- (with similar lean body mass)?
- Why?
- Better balance, stability and coordination



Resistance Training (RT) Guidelines

Balance and coordination are not fully developed in children (Payne and Isaacs 2005), balance training may be particularly beneficial for reducing the risk of injury while performing RT, particularly to the lower back.

Include specific exercises that require balance and coordination.

Balance and Stability

A positive correlation (0.65) between maximum hockey skating speed and static balance test in hockey players under 17 years reported

(Behm et al. 2004)



Instability Resistance Training Advantages

1. Use of body weight as a resistance
2. Greater ROM for trunk exercises
3. Balance and stability challenges
4. High Core / trunk activation with lower loads
5. Instability training specificity
6. Variety and fun

Equipment

- Elastic bands, medicine balls
 - Instability
 - Velocity specificity
 - Progressive resistance
- Body weight exercises
- Free weights (barbells and dumbbells)
- Weight machines
- All have been shown to be safe and effective for children and adolescents.

(Annesi et al. 2005; Faigenbaum and Mediate 2006c; Faigenbaum et al. 2005b; Falk and Mor 1996; Ramsay et al. 1990; Sadres et al. 2001; Siegel et al. 1989)

Resistance Training Guidelines

- Gradually progress to more advanced movements that enhance strength and power production.
- Traditional Resistance Training
- Plyometrics: bounding, hopping, jumping
- Olympic style lifting

Plyometrics

- Essentials of Strength and Conditioning textbook (NSCA) stated that an individual should be able to leg press 1.5 times body weight before starting plyometrics.
- Narrow definition of plyometrics!

Plyometrics

Children can train with plyometrics if amplitude and volume are low

Simple games like skipping are plyometric in nature

Can start at any age

Pre-pubertals should not engage in intensive depth-jumping



Plyometrics

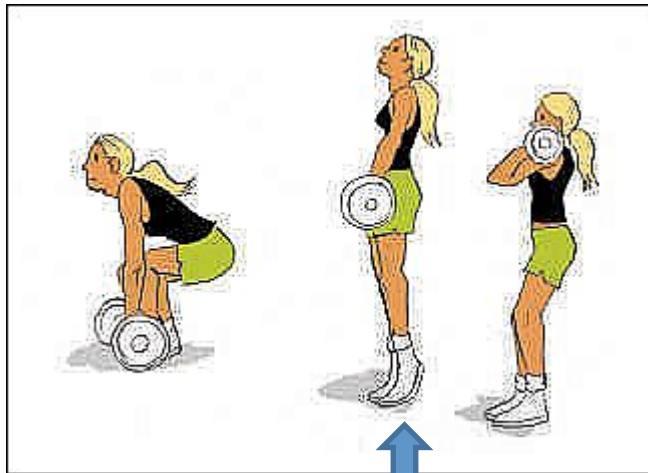
- Begin plyometric training with less intense drills (e.g., double-leg jumps) and progress to more advanced drills (e.g., single leg hops) as competence and confidence improves.
- Studies indicate that few repetitions (i.e., ≤ 10) are needed for training-induced gains in **plyometric performance** (Lephart et al. 2005; Myer et al. 2005; Matavulj et al. 2001).
- Early emphasis on positioning and landing

Emphasis on landing technique for performance and injury prevention



Ballerinas have significantly less knee injuries than similar jumping-related sports such as netball (Leonie Otago: personal correspondence)

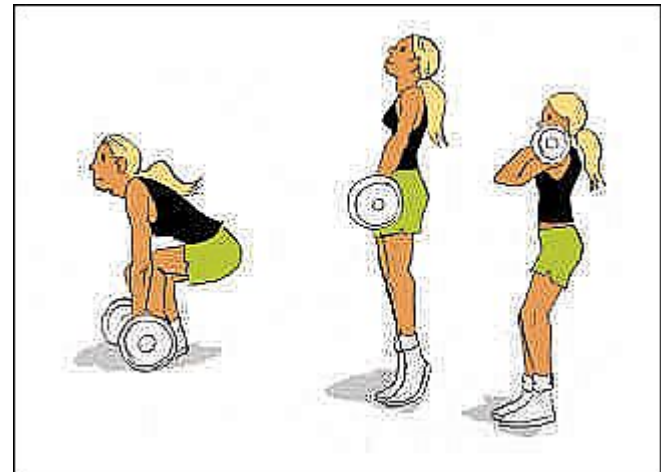
Youth need to develop strength and power from an athletic position

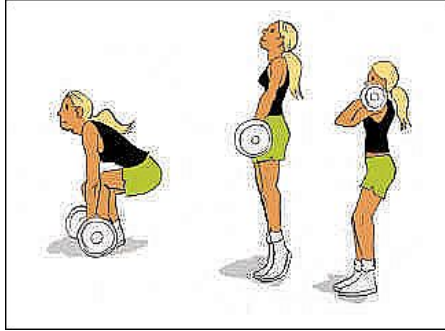


Training Specificity

Athletic Position

What sport is Anna playing?

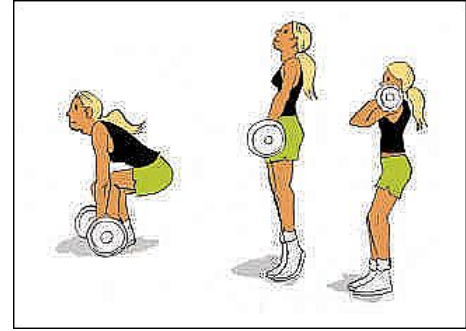




Basketball?



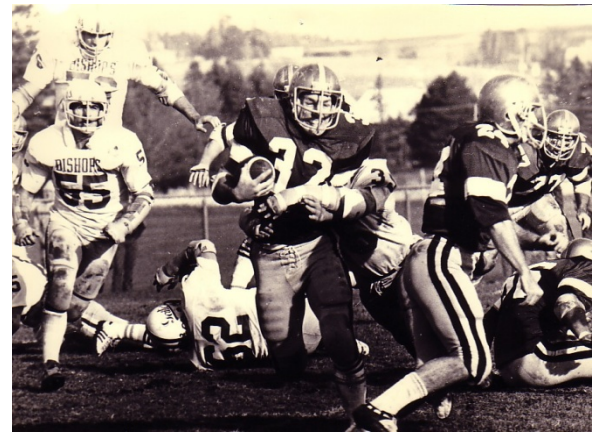
Volleyball?



Hockey?



Football?



Olympic Style lifting

- Olympic-style lifts involve a more complex neural activation pattern and therefore participants need to learn how to perform these lifts early in the workout with a relatively light load (e.g., wooden dowel or unloaded barbell) in order to develop coordination and skill technique without undue fatigue.

Future World Champion?



Resistance Training Guidelines

- 8-12 exercises of low to moderate intensity resistance conducted 2-3 times/week on non-consecutive days with 1-4 sets of 8-15 (about 60% 1 RM) repetitions through a full ROM



Resistance Training Guidelines

- Moderate loads (ex. 50-60% of 1RM) and higher repetitions (ex. 15-20 reps) may be most beneficial for enhancing muscular strength and endurance in youth during the initial adaptation period.
- (Benson et al. 2007; Christou et al. 2006; Faigenbaum et al. 1999; Faigenbaum et al. 2005; Lillegard et al. 1997; Pfeiffer and Francis 1986).

Recovery Intervals???



Falk and Dotan (2006) reported that children recover faster from high intensity exercise due to their lower maximal power output and thus have lower stress levels to recover from.

Authors	Activity	Recovery Interval (RI)	Result
Hebestreit et al. (1993)	2-30 second Wingate anaerobic tests	1, 2 and 10 minutes	Boys recovered faster than adults
Faigenbaum et al. (2008)	3 sets of 10 RM	1, 2, 3 min	Youth better at maintaining strength with similar RI
Zafeiridis et al. (2005)	120 ⁰ .s ⁻¹ isokinetic contractions of 30s and 60s duration.		Boys and teens recovered more rapidly with lower blood lactate values.
Chaouachi et al. 2010	10 reps of isokinetic contractions @ 60 ⁰ .s ⁻¹ or 300 ⁰ .s ⁻¹	2, 5, 10 min	Full recovery or potentiation of most measures for youth at 2 min

Why shorter recovery intervals for children?

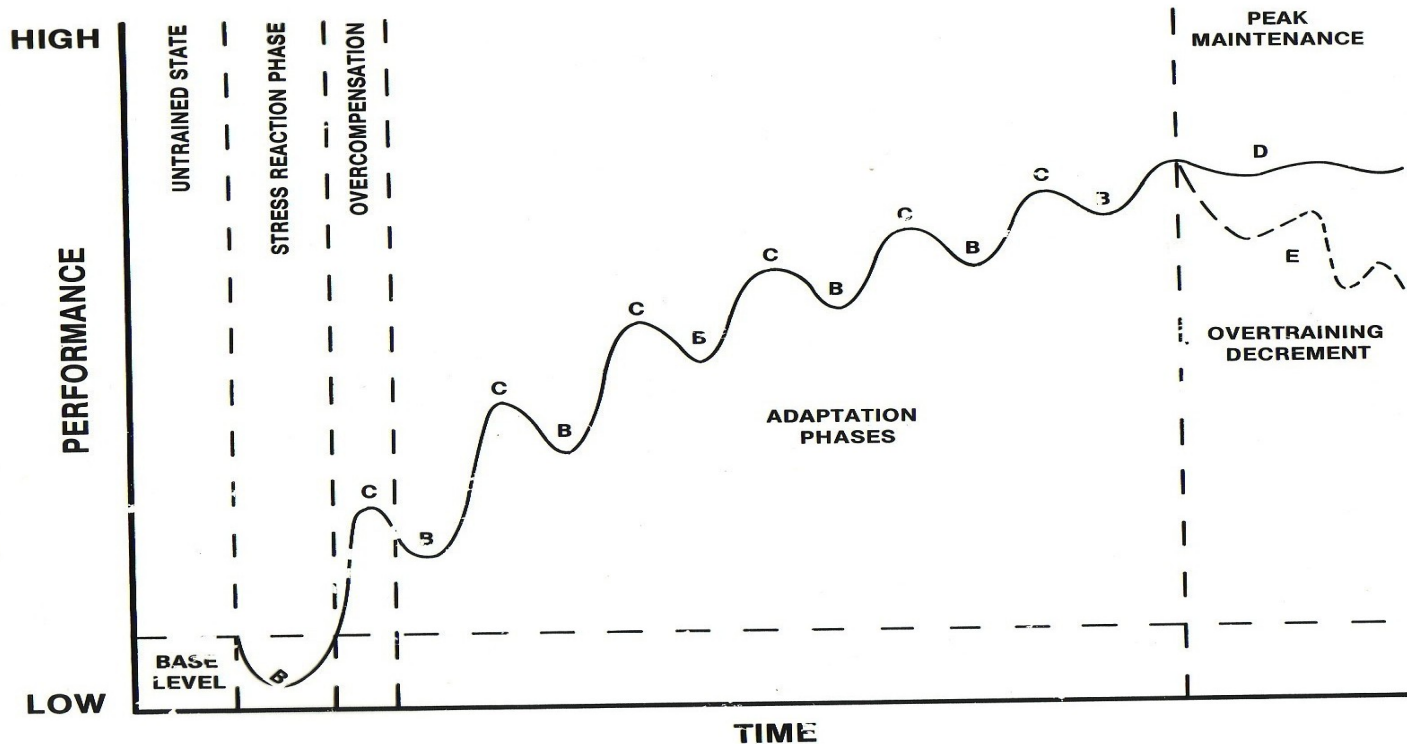
- ↓ anaerobic capacities (Boisseau and Delamarche 2000),
- ↓ lactate concentrations
(Boisseau and Delamarche 2000; Zafeiridis et al. 2005),
- ↓ muscle glycogen levels (Boisseau and Delamarche 2000)
- ↑ phosphocreatine resynthesis rates (Ratel et al. 2003; Ratel et al. 2006b),
- ↑ oxidative capacities (Ratel et al. 2006b)
- ↑ resistance to fatigue (Dipla et al. 2009; Ratel et al. 2003; Ratel et al. 2006a).
- ↓ proportional area of type II (Fast Twitch) muscle fibres (Boisseau and Delamarche 2000; Ratel et al. 2003)

Periodization

- Not uncommon for youth to be involved in many sports/activities, which may limit the possible positive RT training adaptations.
- The training and participation in multiple activities highlight the need for periodized youth RT programs, which vary in volume and intensity throughout the season/year.

Resistance Training Guidelines

- Systematically vary the training program over time to optimize gains and reduce boredom.



Summary

- RT for children is beneficial for health and performance
- Warm-up should involve dynamic stretching and activities to excite the system
- 8-12 exercises of low to moderate intensity resistance conducted 2-3 times/week on non-consecutive days with 1-4 sets of 8-15 (about 60% 1 RM) repetitions through a full ROM

Summary

- Recovery intervals between sets can be 1-2 min
- Learn the correct exercise technique and safe training procedures
- All RT procedures (machines, free weights, elastic bands) can provide benefits with proper supervision and technique

Summary

- Start RT using body weight and emphasize balance and stability
- Next implement free weights as an additional stress to the system
- Introduce proper technique for Olympic lifts for athletes to attain training specific form and power (athletic position)
- Introduce low amplitude plyometrics to improve reactive strength

Summary

- Use periodization to modulate volume and intensity of training especially when playing multiple sports throughout the year
- The variety of periodization also helps to combat mental burnout!
- Emphasize variety and FUN!!

Thank-you!

