RESISTANCE TRAINING, THE OVERLOOKED MODALITY OF EXERCISE FOR DIABETICS?

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Objectives and Outline

1. Sarcopenia and its relationship with diabetes

2. The fundamentals of resistance training

3. The benefits of resistance training

4. Differences between Type 1 and Type 2 Diabetics
Skeletal muscle comprises:

A. 40-45% of total body mass

B. Contains 50–75% of all body proteins

C. Accounts for 30-50% of whole-body protein turnover.

D. Is mainly composed of water (75%) and protein (20%),

(Frontera, 2015)
What is Sarcopenia?

- **Greek:**
  - “Sarco” (flesh or muscle) and “penia” (loss) (Rosenberg, 2011)

  - “The age-associated loss of skeletal muscle mass and function.” (IWGS, 2011)

  - “Involuntary loss of skeletal muscle mass and consequently of strength.” (IWGS, 2011)
What is Sarcopenia?

- The age-associated loss of skeletal muscle mass and function.
- Sarcopenia is a complex syndrome that is associated with muscle mass loss alone or in conjunction with increased fat mass.
- The causes of sarcopenia are multi-factorial:
  - Disuse
  - Changing endocrine function
  - Chronic diseases
  - Inflammation
  - Insulin resistance
  - Nutritional deficiencies

- While cachexia may be a component of sarcopenia, the two conditions are not the same.”

(IWGS, 2011)
Cross-sectional area images of a thigh in a 25-year-old (left) and a 65-year-old (right) man. MRI shows significant loss of muscle fibers and fat infiltration in the older, sarcopenic muscle (right).

(Sergi, 2016)
Decreased Skeletal Muscle Mass
Decreased Skeletal Muscle Quality
Increased Low-grade Inflammation
Increased Fat Mass
Increased Insulin Resistance
Decreased Basal Metabolic Rate
Decreased Skeletal Muscle Mass
Decreased Skeletal Muscle Strength
Decreased Physical Activity
Oxidative Stress
Increased Insulin Resistance
(Scott, 2016)
The Korean Sarcopenic Obesity Study (KSOS)
- included 810 subjects (414 patients with diabetes and 396 control subjects)
- Examined using dual-energy X-ray absorptiometry

Prevalence higher in patients with diabetes (15.7%) than the control group (6.9%)

Patients with diabetes had three times higher risk of sarcopenia than subjects without diabetes

(Kim, 2010)
Diabetes Statistics

- Diabetes mellitus is common in older people, with a high prevalence in industrialized countries.

- Diabetes affects 382 million adults worldwide, and this number is estimated to rise to 592 million by 2035.

- Type 2 diabetes (T2D) is the most common form of this disease
  - Accounting for approximately 90% of cases diagnosed

(Bianchi, 2016)
Possible Biological Mechanisms?

- **Insulin Resistance and Hyperglycemia**
  - Increased protein degradation
  - Decreased protein synthesis
  - Mitochondrial dysfunction
  - Glycation of skeletal muscle myosin
  - Oxidative Stress

- **Chronic inflammation and oxidative Stress**
  - Deregulation of protein synthesis and breakdown
  - Mitochondrial dysfunction
  - Muscle apoptosis
  - GLUT-4 down-regulation
  - Inhibition of insulin receptor activity
Possible Biological Mechanisms?

■ Obesity
  - Muscle fat infiltration
  - Reduced insulin sensitivity
  - Worse inflammatory status
  - Reduced oxidative activity and maximal aerobic capacity

■ Physical inactivity
  - Increased weight
  - Worse glycemic control and glucose tolerance
  - Increased insulin resistance
  - Increased risk of diabetic complications
  - Worse inflammatory status
  - Increased intermuscular adipose tissue
Human Muscle Fiber Type

- Human skeletal muscle consists of:

- Slow-twitch oxidative (Type 1) fibers

- Fast-twitch (Type 2) fibers
  - Type 2A: fatigue-resistant/fast-twitch oxidative fibers
  - Type 2B: fast fatigable/fast-twitch glycolytic fibers
  - Type 2X fibers that have twitch properties similar to those of Type 2A
Muscle Fiber Adaptations in Type 2 Diabetics

- Compared with type 2 fast-twitch fibers, type 1 slow muscle fiber are:
  - More insulin-sensitive
  - More insulin-responsive

- Patients with T2D have lower fraction of type 1, slow fiber compared with either obese or healthy control subjects.
  - GLUT-4 expression is normally higher in slow fiber.
Muscle Fiber Adaptations in Aging Adults

- Aging is associated with **reduction** in the number and size of fast-twitch Type 2 fibers.
- Aging adults with diabetes might have the **combination**
  - Age-related pathophysiological changes
  - Diabetes-mediated impairments.
- Insulin resistance is more common in older than in younger individuals with diabetes.

![Image showing muscle mass and adipose tissue loss](image-url)
The Benefits of Resistance Exercise for Diabetics


